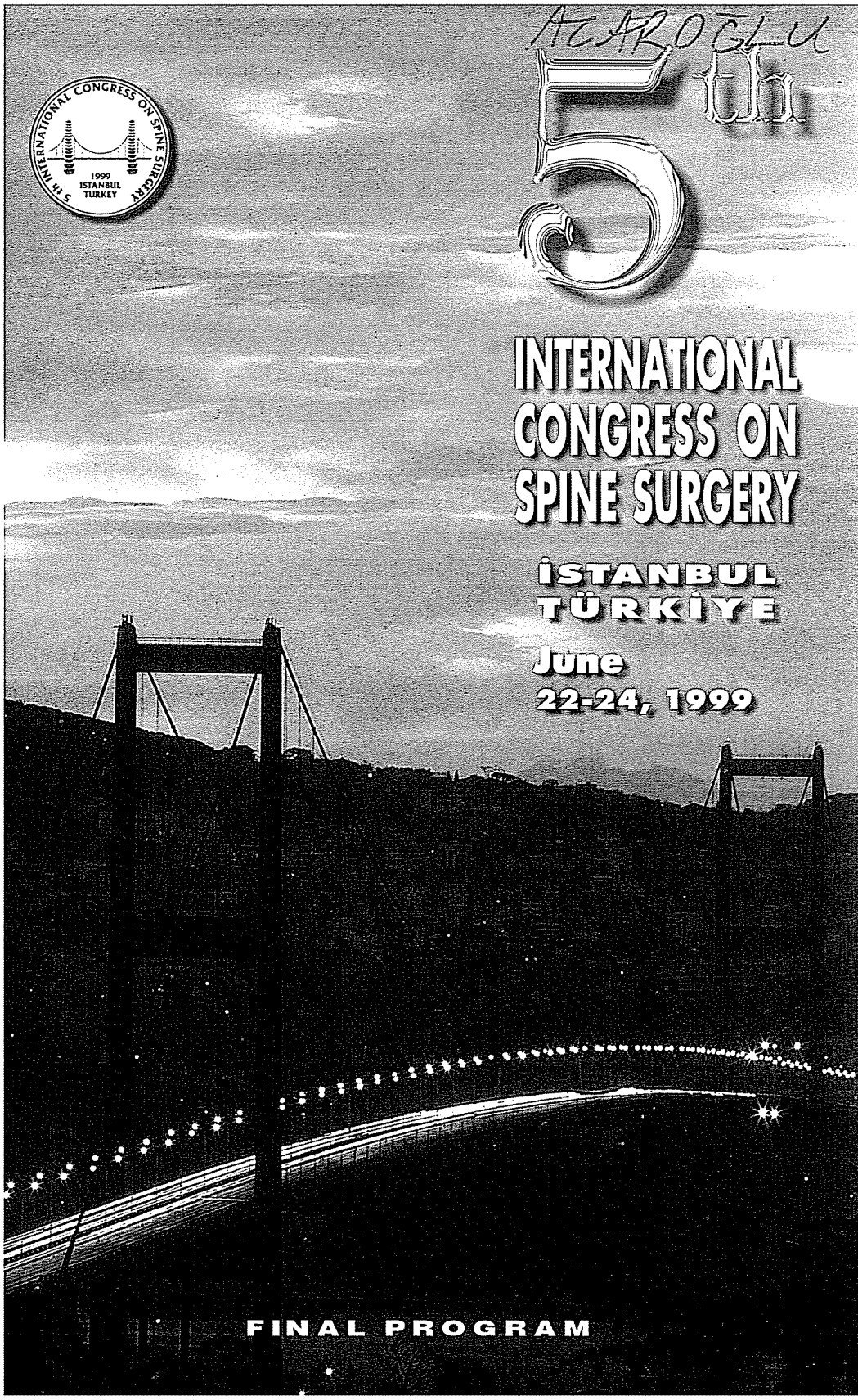
ACAROGLU
5th
INTERNATIONAL CONGRESS ON SPINE SURGERY
1999 ISTANBUL TURKEY
INTERNATIONAL
CONGRESS ON
SPINE SURGERY
İSTANBUL
TÜRKİYE
June
22-24, 1999
FINAL PROGRAM

ACAROĞLU

CONTENTS:

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Ph. BANCEL
H. H. BOHLMAN
J. ABBOTT BYRD III
D. CHOPIN
J.P. FARCY
Y. FLOMAN
J. HARMS
J. LEONG
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General Information

TURKEY

At the geographic gateway East and West, Turkey has been for centuries host to scientists, artists, philosophers, merchants and adventurers - all journeying between Europe and Asia. It was here that the legendary Silk Road ended and here too, that the arts and sciences of East and West merged to produce layer upon layer of extraordinary cultures and civilizations.

İSTANBUL

İstanbul embraces two continents, one arm reaching out to Asia, the other to Europe. Through the city's heart, the Bosphorus strait, courses the waters of the Black Sea, the Sea of Marmara and the Golden Horn. The former capital of three successive empires - Roman, Byzantine and Ottoman - today İstanbul honors and preserves the legacy of its past while looking forward to its modern future. Indeed, it is İstanbul's variety that fascinates its visitors. The museums, churches, palaces, great mosques, bazaars and sights of natural beauty seem inexhaustible.

As you recline on the shores of the Bosphorus at sunset, you will suddenly and profoundly understand why so many centuries ago settlers chose to build on this remarkable site, it is at times like these that you will realize İstanbul is one of the most glorious cities in the world.

CLIMATE AND CLOTHING

The country enjoys a varied climate ranging from the temperate Black Sea region and continental interior to the subtropical warmth of the Aegean and Mediterranean coasts. In late June the weather in İstanbul is usually sunny and warm, ideal for outdoor activities, swimming and sunbathing. However a light raincoat should be taken along for occasional rainshowers.

AVARAGE AIR & WATER TEMPARATURES IN CELSIUS DEGREES FOR MAJOR CITIES

		May	*June*	*July*
Ankara	Air	16	20	23
Antalya	Air	20	25	28
	Sea	21	24	27
Istanbul	Air	16	21	23
	Sea	15	20	23
Izmir	Air	20	25	28
	Sea	20	24	26

CURRENCY AND EXCHANGE

The currency unit is Turkish Lira. Convertible foreign currency can be exchanged at the airports, hotels, banks as well as at the exchange offices. The exchange rates are announced daily in newspapers. International credit cards are widely accepted.

TIME

Turkish time is GMT + 2 hours.

BUSINESS HOURS

Banks : Monday to Friday, 08.30 to 12.00 and 13.30 to 17.00
Shops : Monday to Saturday, 09.00 to 20.00
On Sunday big shopping malls are open.

ELECTRICITY

The voltage is 220 volts with a frequency of 50 Kilohertz.

VENUE OF THE MEETING

The meetings will be held in 5 star Swissotel The Bosphorus.

LANGUAGE

The language of the meeting is English and Turkish. Simultaneous interpretation between English and Turkish will be provided during the sessions.

Istanbul City Tours

PRINCES ISLANDS — ***20 June 1999 / Sunday***
FULL DAY TOUR INCLUDING LUNCH

A cruise to the largest of the Princes Islands, Büyükada;
an island on the Marmara Sea, is a beautiful summer resort with ancient style wooden houses and old summer residences.
After lunch, you will have a tour around the island by horse driven carriages through the pinewoods.
Per person price: US$ 65

OTTOMAN RELICS — ***21 June 1999 / Monday***
HALF DAY AFTERNOON TOUR

Topkapı Palace + German Fountain + Suleymaniye Mosque
Per person Price: US$ 30

İSTANBUL CLASSICS — ***22 June 1999 / Tuesday***
HALF DAY MORNING TOUR

St. Sophia, Blue Mosque of Sultan Ahmet + Obelisk + Hippodrome + German Fountain + Turkish & Islamic Arts Museum + Grand Covered Bazaar
Per person Price: US$ 30

BOSPHORUS ON PRIVATE YACHT & TWO CONTINENTS — ***23 June 1999 / Wednesday***
FULL DAY TOUR INCLUDING LUNCH

Spice (Egyptian) Bazaar + Bosphorus cruise + Rumeli Fortress
Lunch at a typical Restaurant
Dolmabahce Palace + Bosphorus Bridge + Camlıca Hill + Beylerbeyi + Asiatic Bazaar
Per person Price: US$ 65

İSTANBUL BY NIGHT ***24 June 1999 / Thursday***

TURKISH SHOW & DINNER

You will enjoy a dinner and floorshow including belly dancers, local folk dancing, singers and other attractions in a first class night club.
Per person price: US$ 70

GREEN BURSA ***25 June 1999 / Friday***

FULL DAY TOUR INCLUDING LUNCH

You will drive to Yalova by ferry-boat and arrive in Bursa, the first Ottoman capital of the 14th century. Lunch to taste the famous "kebab" at a typical restaurant. Then you will visit the Green Mosque, Ulu Mosque and the Mausoleum of Ottoman Sultans. Time and weather permitting you can take the cable car to the top of Mount Uludağ (Olympus)
Per person price: US$ 70

SPINE SURGERY OPTIONAL PRE / POST CONGRESS TOURS

DAY TRIP TO EPHESUS . *Dates* : *20 June 1999 (Pre)*
25 June 1999 (Post)
Tour Code : *MAG / SPI 001*
By plane + private bus

PROGRAM IN OUTLINE

İSTANBUL / İZMİR / İSTANBUL

Transfer to airport for your flight to İzmir. Upon arrival, proceed to Selçuk for Ephesus sightseeing with lunch at a local restaurant. Then complete rest of sightseeing. Continue to İzmir airport for your late afternoon flight to İstanbul. Transfer to your hotel.

Per person price : US$ 150

IMPORTANT NOTE : Domestic airfare is not included.

CAPPADOCIA
(1 NIGHT)

Dates : *19 - 20 June 1999 (Pre)*
25 - 26 June 1999 (Post)
Tour Code : *MAG / SPI 002*
By plane + private bus

PROGRAM IN OUTLINE

DAY 01 : Transfer to airport for your flight to Kayseri. Upon arrival proceed to Cappadocia for sightseeing with lunch at a local restaurant. Then complete rest of sightseeing. Overnight in Cappadocia.

DAY 02 : Breakfast at the hotel. Proceed to whole day sightseeing of Cappadocia. Lunch will be served at a local restaurant. Continue to Kayseri airport for your evening flight to İstanbul. Transfer to your hotel.

Per person in double room : US$ 270
Single Supplement : US$ 15

IMPORTANT NOTE : Domestic airfare is not included.

CAPPADOCIA AND
THE HITTITE SITES
(02 NIGHTS)

Dates : *18 - 20 June 1999 (Pre)*
Tour Code : *25 - 27 June 1999 (Post)*
MAG / SPI 003
By plane + private bus

PROGRAM IN OUTLINE

DAY 01 : Transfer to airport for your flight to Ankara. Proceed to sightseeing of Ankara with lunch at a local restaurant. Continue to sightseeing. Overnight in Cappadocia.

DAY 02 : Breakfast at the hotel. Proceed to whole day sightseeing of Cappadocia. Lunch will be served at a local restaurant. Overnight in Cappadocia.

DAY 03 : Breakfast at the hotel. Proceed to Ankara via famous Hittite sites such as Hattusas (Boğazköy), the capital city of the Hittites, and Alacahöyük, an open-air shrine dating back to Early Bronze Age. Continue to the Ankara airport for your evening flight to İstanbul. Transfer to your hotel.

Per person in double room : US$ 392
Single Supplement : US$ 30

IMPORTANT NOTE : Domestic airfare is not included.

ANTALYA AND		*Dates*	*: 18 - 20 June 1999 (Pre)*
THE MEDITERRANEAN COAST	*Tour Code*	*:*	*25 - 27 June 1999 (Post)*
(02 NIGHTS)			*MAG / SPI 004*
			By plane + private bus

PROGRAM IN OUTLINE

DAY 01 : Transfer to airport for your flight to Antalya. Upon arrival, proceed to sightseeing of Antalya with lunch at a local restaurant. Continue to sightseeing. Overnight in Antalya.

DAY 02 : Breakfast at the hotel. Proceed to whole day sightseeing of the ancient towns of Perge, Aspendos and Side. Lunch at a local restaurant. Overnight in Antalya.

DAY 03 : Breakfast at the hotel. Transfer to airport for your flight to İstanbul. Transfer to your hotel or interline transfer to international flight home.

Per person in double room : US$ 354
Single Supplement : US$ 26

IMPORTANT NOTE : Domestic airfare is not included.

CAPPADOCIA AND		*Dates*	*: 16 - 20 June 1999 (Pre)*
TREASURES OF THE AEGEAN	*Tour Code*	*:*	*25 - 29 June 1999 (Post)*
(04 NIGHTS)			*MAG / SPI 005*
			By plane + private bus

PROGRAM IN OUTLINE

DAY 01 : Transfer to airport for your flight to Ankara. Proceed to sightseeing of Ankara with lunch at a local restaurant. Continue to sightseeing. Overnight in Cappadocia.

DAY 02 : Breakfast at the hotel. Proceed to whole day sightseeing of Cappadocia. Lunch will be served at a local restaurant. Overnight in Cappadocia.

DAY 03 : Breakfast at the hotel. Then complete the rest of Cappadocia sightseeing. Lunch will be served at a local restaurant or on the way to Ankara transfer to the Ankara airport for your flight to İzmir. Overnight in İzmir.

DAY 04 : Breakfast at the hotel. Proceed for a sightseeing of Pergamum, a major cultural and therapeutic center during the antiquity. Lunch will be served at a local restaurant. In the afternoon continue to sightseeing and drive to Pamukkale (Hierapolis). Overnight in Pamukkale.

DAY 05 : Breakfast at the hotel. After sightseeing of Hierapolis, proceed Ephesus. Lunch will be served at a local restaurant. Continue to sightseeing including the House of Virgin Mary. Transfer to İzmir airport for your evening flight to İstanbul. Upon arrival in İstanbul transfer to your hotel.

Per person in double room : US$ 644
Single Supplement : US$ 58

IMPORTANT NOTE : Domestic airfare is not included.

"ARCHEOLOGICAL EXPERIENCE"	*Dates*	*: 15 - 20 June 1999 (Pre)*
(05 NIGHTS)	*Tour Code :*	*25 - 30 June 1999 (Post)*
		MAG / SPI 006
		By plane + private bus

TROY, PERGAMUM, EPHESUS, İZMİR
APHRODISIAS, HIERAPOLIS, BURSA AND İZNİK

PROGRAM IN OUTLINE

DAY 01 : Departure by private coach from your hotel in İstanbul. Drive to Çanakkale (Dardanelles) via Gelibolu (Gallipoli), the famous battle grounds of the First World War. Overnight in Çanakkale.

DAY 02 : Breakfast at the hotel. Proceed to the legendary town of Troy for sightseeing, lunch, drive to Pergamum. After a complete sightseeing of Pergamum transfer to İzmir. Overnight in İzmir.

DAY 03 : Breakfast at the hotel. Proceed to Selçuk for Ephesus sightseeing with lunch at

a local restaurant. Then complete rest of sightseeing. Continue to Pamukkale. Transfer to your hotel. Overnight in Pamukkale.

DAY 04 *:* Breakfast at the hotel. Sightseeing of Pamukkale (Hierapolis). Then proceed via Aphrodisias to Kuşadası, the famous summer resort. Lunch will be served at a local restaurant. Overnight in Kuşadası.

DAY 05 *:* Breakfast at the hotel. Drive to Bursa, the first capital city of the Ottoman Empire on the lower slopes of Mount Olympos,(2443 m). Overnight in Bursa.

DAY 06 *:* After breakfast at the hotel, drive to İstanbul via (İznik) Nicaea, an important town during three empires and also the seat of the first Ecumenical Council in 325 AD. Transfer to your hotel in İstanbul.

Per person in double room *:* US$ 722
Single Supplement *:* US$ 80

About Sites To Be Visited

ANKARA, the capital city with its prestigious Museum of Anatolian Civilizations, housed in a restored Bedesten (Covered market) gives an opportunity for an amazing overview of the numerous civilizations that inhabited the area for 10.000 years.

İZMİR, one of the major cities of modern Turkey, and the greatest port in the Aegean, is also known as the antique Smyrna, enjoying a rich and lively history as a prosperous commercial centre since the Hellenistic period, though the first settlement go back to the 3rd millenium BC. The famous ancient sites are the Agora and Citadel on Mount Pagus.

EPHESUS, which gained great importance under the rule of Androcles in the Hellenistic period, covers among many others, the Temple of Artemis, one of the ancient wonders of the world, Celsius Library, the Hadrian Temple and the Ephesus Amphitheatre.

PERGAMUM, the ancient capital city of a strong and glorious kingdom, and a prosperous trading centre, was the cradle of the parchment paper industry. There you can admire the whole paletti of antique architecture showing thedistinct classisicm of the Hellenistic period as well as the Roman sceen of grandeur. The Amphitheatre, the Acropolis, the Gymnasium, the Temples of Dionysos, Demeter and Athena and the foundations of the famous Altar to Zeus are only some of the interesting sites to be seen.

CAPPADOCIA is an area of spectacular surrealist landscapes where dwellings have been known since 4000 BC. The early Christians built churches and underground cities within these rock formations to escape the Romans.

ANTALYA, the kingdom of Pamphilia covered the ancient towns of Side, Perge, Aspendos and Antalya, which all shared the same fate gaining wealth and importance in the Hellenistic and Roman periods and declining under Byzantine rule.

SCIENTIFIC PROGRAM

TUESDAY, JUNE 22,1999

08:00-08:29 Opening Ceremony

SESSION I: **Moderators:** **E.E. Transfeldt**
E. Acaroğlu

08:30-08:50 **Lecture:** Infantile and Juvenile Idiopathic Scoliosis
Ph. Bancel

DEBATE: TREATMENT CONTROVERSIES OF HEMIVERTEBRAE

08:51-09:06 Hemiepiphysiodesis
E.E. Transfeldt

09:07-09:22 Hemivertebrectomy
J.W. Ogilvie

09:23-09:38 Floor Discussion

CONGENITAL DEFORMITIES - FREE PAPERS

09:39-09:45 **S.Yalçın,** M.Özek, C.Çabukoğlu, A.Dağçınar, R.Yılmaz,
Paper 1 "Single Stage Posterior Vertebrectomy in Young Children for the Treatment of Congenital Kyphosis and Scoliosis"

09:46-09:52 **N.Ventura,** A.Ey, J.Conill, A.Montaner, E.Vives
Paper 2 "Hemivertebrae Excision in the Surgical Treatment of Patients with Congenital Scoliosis. A Review of 13 Cases in 12 Patients."

09:53-09:59 **U.Talu,** C.Şar, A.Hamzaoğlu, Ü.Domaniç
Paper 3 "Combined Anterior - Posterior Convex Hemiepiphysiodesis for Congenital Scoliosis"

10:00-10:06 **D.Zarzycki,** B.Bakalarek, J.Jukowski
Paper 4 "Surgical Treatment of Congenital Scoliosis Due to Formation Failure"

10:07-10:13 **S.Yalçın,** M.Özek, C.Çabukoğlu
Paper 5 "Kyphectomy and Stabilisation with Vertebral Screws in Spina Bifida"

10:14-10:20 **M. Özek,** S.Yalçın, A.Dağçınar, T.Hiçdönmez,
Paper 6 D. Türkdoğan,M.N. Pamir
"Segmental Spinal Dysgenesis"

10:21-10:35 Floor Discussion

10:36-10:50 COFFEE BREAK

SESSION II: **Moderators:** **J.W. Ogilvie**
A. Surat

ROUND TABLE: ADULT SCOLIOSIS

10:51-11:06 Decision Making and Surgical Treatment
E.E. Transfeldt

11:07-11:22 Indications and Techniques of Sacropelvic Fixation
D. Chopin

11:23-11:38 Sagittal and Coronal Alignment
J.P. Farcy

11:39-11:54 Spinal Osteotomies
Ch. Mazel

11:55-12:10 Floor Discussion

12:11-13:59 LUNCH & WORKSHOPS

SESS ION III: **Moderators:** **D.Chopin,**
E.Alıcı

DEGENERATIVE LUMBAR SPINE

14:00-14:20 **Lecture:** The Source of Pain in Degenerative Lumbar Spine
J.W. Ogilvie

14:21-14:41 **Lecture:** Spinal Stenosis
Y. Floman

14:42-15:02 **Lecture:** Who Should Be Fused in Degenerative Lumbar Spine?
J. Abbott Byrd III

15:03-15:23 **Lecture:** Surgical Treatment of Lumbar Degenerative Diseases
Se-Il Suk

15:24-15:39 Floor Discussion

DEGENERATIVE LUMBAR SPINE - FREE PAPERS

15:40-15:46 S. El Banna, **O. Delahaut**
Paper 7 "Lumbar Spine Fusion in the Treatment of Degenerative Spondylarthropathy: A Review of 146 Cases"

15:47-15:53 **Paper 8**	**K. Yücesoy,** S. Naderi "Reverse Laminoplasty for the Treatment of Lumbar Spinal Stenosis. A New Surgical Technique"
15:54-16:00 **Paper 9**	**A. Göğüş,** M. Şengün, A. Hamzaoğlu "Early Results of Surgical Treatment for Degenerative Lumbar Spinal Stenosis"
16:01-16:07 **Paper 10**	**K. Kumano,** M. Natsuyama, T. Uchida, H. Hasegawa "Surgical Technique of Reduction and Fixation of Lumbar Spondylolisthesis"
16:08-16:14 **Paper 11**	**J.E. Vlachos** "Reinforcement of the Posterior Spinal Ligaments After Discectomy"
16:15-16:25	Floor Discussion
16:26-16:41	COFFEE BREAK

SESSION IV: **Moderators:** **M. Braydo Bruno**
H. Berk

VIDEO ASSISTED SURGERY

16:42-17:02	**Lecture:** Advances in Video Assisted Surgery: Thoracic Spine, Lumbar Spine **E.E. Transfeldt**

VIDEO ASSISTED SURGERY - FREE PAPERS

17:03-17:09 **Paper 12**	**M. Brayda - Bruno,** P. Cervellini, P. Lepori, C. Forni, P. Cinnella "Indications and Technical Aspects of Lumbar Posterior Endoscopic Microdiscectomy: Results of a 18 Months Multicenter Study"
17:10-17:16 **Paper 13**	**J.C. Le Huec,** T. Zdeblick, T. Friesem, J.L. Husson "Laparoscopic L5-S1 Arthrodesis: 20 Cases with a Double Barrel Instrumentation"
17:17-17:23 **Paper 14**	**K.A. Batterjee** "Percutaneous Endoscopic Discectomy"
17:24-17:30 **Paper 15**	**F.P. Girardi,** F.P. Cammisa, H.S. Sandhu, H.K. Parvataneni A. Antonacci, "Anterior Lumbar Interbody Fusion with Threaded Allograft Bone Dowel via a Laparoscopic Approach"
17:31-17:41	Floor Discussion

SESSION V **Moderators:** **M. Weidenbaum**
D. Dinçer

SPINAL TRAUMA - FREE PAPERS

17:42-17:48 **H. Ağuş,** S. Pedükcoşkun, C. Kayalı
Paper 16 "How Should the Thoracolumbar Burst Vertebral Fractures be Treated Conservatively or Surgically"

17:49-17:55 **N. Bilsel,** Ö. Aydıngöz, M. Hancı, A. Gökçe, A. Uzpak
Paper 17 "Kaneda Device Applications in the Treatment of Thoracolumbar Fractures"

17:56-18:02 **M. Tezer,** C. Eryiğit, Y. Kabukçuoğlu, E. Ertürer, İ, Öztürk
Paper 18 "The Surgical Treatment of Thoracolumbar Vertebra Fractures and It's Results"

18:03-18:09 **C.Z. Esenyel,** E. Olcay, E. Merih, T. Gülmez, A.N. Kara
Paper 19 The Biomechanical Investigation of the Effect of Additional Transpedicular Fixation of the Fractured Vertebrae on Stability in Burst Fractures (A Calf Spine Model)

18:10-18:16 **Ö. Karatoprak,** B. Beksaç, K. Akan, H. Babatürk
Paper 20 "The Results of Anterior Surgery for Burst Fractures of the Thoracolumbar Spine"

18:17-18:23 **C. Şar,** U. Talu, A. Hamzaoğlu, E. Bilen, Ü. Domaniç
Paper 21 "Flexion-Distraction Injuries Combined with Fractures of the Vertebral Body"

18:24-18:30 **M.I.S. Kapıcıoğlu,** T.C. Öğün, A.U. Üzümcü, A. Şarlak, M. Yel
Paper 22 Non-operative Management of Stable Thoracolumbar Burst Fractures with TLSO

18:31-18:45 Floor Discussion

WEDNESDAY, JUNE 23, 1999

SESSION VI: **Moderators:** **J.P. Farcy**
T. Yazar

LUMBAR FUSION - FREE PAPERS

07:15-07:21 **V.F. Paliotta,** C.A. Logroscino
Paper 23 "Carbonium Fiber Cages in the Surgical Treatment of Spondylolisthesis"

07:22:07:28 **E.R. Luque**
Paper 24 "Preliminary Report of the use of Morphogenetic Recombinant Human Protein (rhBMP-2) for Producing Posterolateral Bony Arthrodesis in Human Subject"

07:29-07:35 S. El Banna, **O. Delahaut**
Paper 25 "Posterior Lumbar Interbody Fusion Enhanced with Ramps and Cages: A. Review of 60 Cases"

07:36-07:42 **J. Cannas,** J. Mineiro
Paper 26 "A.L.I.F With Screwing Cages"

07:43-07:49 **D. Zarzycki,** B. Bakalarek, B. Jasiewicz
Paper 27 "Spondylolisthesis: A Comparison of 3 Surgical Approaches"

07:50-08:04 Floor Discussion

ROUND TABLE: LUMBAR FUSION

08:05-08:20 Posterior Surgery
J.W. Ogilvie

08:21-08:36 Anterior Surgery
J. Leong

08:37-08:52 Combined Surgery
B. A. Akbarnia

08:53-09:08 Revision Surgery
Ch. Mazel

09:09-09:24 Floor Discussion

SESSION VII: **Moderators:** **J. Abbott Bryd III**
N. Bilsel

ADULT SPINE - FREE PAPERS

09:25-09:31 **H. Kitahara,** S. Minami, M. Tokunaga, Y. Ohtsuka, Y. Nakata
Paper 28 "Long Term Results of Instrumentation Surgery for Spinal Deformity Patients - 20 Years or More After Surgery, in Patients Over Thirty Years of Age"

09:32-09:38 **M. Gülşen,** S. Özbarlas, G. Baytok, M. Altın
Paper 29 "Late Results of Lumbar Closing Wedge Osteotomy Egg-Shell in Ankylosing Spondylitis"

09:39-09:45 **Paper 30**	**B. Atilla,** M. Yazıcı, H. Ali, A.M. Tokgözoğlu, A.M. Alpaslan "Lumbosacral Sagittal Plane Analysis in Patients with Developmental Dislocation of the Hip Joint After Total Hip Replacement"
09:46-09:52 **Paper 31**	**A. Alanay,** M. Asher, S. M. Lai, L. Nelson "Sequential-Simultaneous Reconstruction of Sagittal Plane Deformities of the Thoracolumbar Spine: A Procedural Modification"
9:53-9:59 **Paper 32**	**F. P. Girardi,** F.P. Cammisa, H. Sandhu, P. Sangani, H. Parvataneni, S. Cadag "Incidental Durotomy. A. Spinal Surgery Complication"
10:00-10:06 **Paper 33**	**M.A. El Hefnawi,** "Dural Tears Associated with Lumbar Spine Surgery, Management and Long-Term Outcome"
10:07-10:21	Floor Discussion
10:22-10:40	COFFEE BREAK

SESSION VIII: **Moderators:** **J. Leong**
Z. Korkusuz

DEFORMITY, INFECTION - FREE PAPERS

10:41-10:47 **Paper 34**	**O. Güven,** M. Bezer, K. Gökkuş "The Use of Transpedicular Decancellation Osteotomy in The Treatment of Various Spinal Deformities"
10:48-10:54 **Paper 35**	**T. Lukaniec,** P. Menartowicz, K.Koltowski "The Questionaire Evaluation of Scoliosis Surgery Outcome. Minimum Five Years Follow up"
10:55-11:01 **Paper 36**	**F. P. Girardi,** O. Boachie-Adjei, B. Rawlins "Spinal Sagittal Imbalance Syndromes"
11:02-11:08 **Paper 37**	U. Aydınlı, **O.Karaeminoğulları,** G.Dinçer "Spinal Surgery in Elderly Patients"
11:09-11:15 **Paper 38**	**N. Azar,** Ü.A. Büyükgör, G. Aksu, E. Temurcu "Results of Operative Treatment of Scheuermann Disease"
11:16-11:30	Floor Discussion

POTT'S DISEASE - FREE PAPERS

11:31-11:41 **Paper 39**	**Po-Quang Chen** "TB Spine: Comparison of The Changes in 3 Decades and the Implications to the Spine Surgeons"

11:42-11:48 **M. Altınmakas,** M. Kömürcü, A. Şehirlioğlu, O. Öztoprak
Paper 40 "Tuberculous Spondylitis Classification and Treatment"

11:49-11:55 **Ö. Akçalı,** H. Berk, E. Kıter, H. Tatari, C. Özcan, E. Alıcı
Paper 41 "Anterior Surgical Procedures in the Treatment of Spinal Tuberculosis. Long Term Results"

11:56-12:02 **W.W. Park,** B. Guk Park, K.Y. Lee
Paper 42 "Comparison of the One Stage Anterior Debridement with Combined Anterior Instrumentation and 2 Stage Anterior Debridement and Posterior Instrumentation in Active Tuberculous Spondylitis"

12:03-12:09 **Ö. Karatoprak,** C. Demirçay, O. Poyanlı, K. Akan,
Paper 43 "Surgical Treatment of the Thoracolumbar Spine Tuberculosis"

12:10-12:16 **O. Güven,** M. Bezer, K.Gökkuş
Paper 44 "An Algorhytm for the treatment of Spinal Tuberculosis and Longterm Results."

12:17-12:35 Floor Discussion

THURSDAY, JUNE 24,1999

SESSION IX **Moderators:** **Se-Il Suk**
M. Caniklioğlu

DISC DISEASES, SPONDYLOLISTHESIS - FREE PAPERS

07:30-07:36 **M. D. Woodtli,** D. L. Kaech
Paper 45 "Primary and Secondary Fusion in Lumbar Microdiscectomy"

07:37-07:43 **Ch. Assi,** B. Fassio
Paper 46 "Surgical Treatment of Adult L5 Spondylolysis Using Morscher Hook Screw: Five Year Results"

07:44-07:50 **Ö. Gül,** C. Koşay, H. Berk, M. Bozkurt
Paper 47 "Biomechanical Comparison of Methods Used in the Fixation of Pars Interarticularis Defect"

07:51-07:57 **K.A. Batterjee,**
Paper 48 "Prosthetic Disc Nucleus. Is this Solution for Failed Back Surgery?"

07:58-08:04 **E. Yalnız,** L. Tan
Paper 49 "Complications of Transpedicular Screw Fixation in Degenerative Spondylolisthesis"

08:05-08:11 **D. Dinçer,** I. Gürkan, O. Polat
Paper 50 "Surgical Management of Spondyloptosis"

08:12-08:18 U. Aydınlı, **O. Karaeminoğulları,** G. Dinçer
Paper 51 "The Results of Surgical Treatment of Spondylolisthesis: A Minimum Two Year Follow-up"

08:19-08:39 Floor Discussion

SESSION X: **Moderators:** **H.H. Bohlman**
M. Gülşen

CERVICAL SPINE

08:40-09:00 **Lecture:** Treatment of Degenerative Cervical Spine Disorders
H.H. Bohlman

09:01-09:21 **Lecture:** Upper Cervical Trauma
J. Harms

09:22-09:42 **Lecture:** Lower Cervical Trauma
M. Aebi

09:43-09:59 Floor Discussion

10:00-10:19 COFFEE BREAK

CERVICAL SPINE - FREE PAPERS

10:20-10:26 **F.P. Girardi,** F.P. Cammisa, H. Sandhu, H. Parvataneni
Paper 52 "Posterior Decompression and Fusion with Lateral Mass Plate Fixation for the Treatment of Cervical Stenosis and Multilevel Myeloradiculopaty"

10:27-10:33 **E. Dehoux,** P. Touchard, B. Nurbel, Ph. Segal
Paper 53 "Results of 6 Posterior Atloido Axial Arthrodesis Using Apofix System for Degenerative Unilateral C_1 C_2 Arthrosis"

10:34-10:40 **M. Hancı,** R. Dashti, M. Uzan, C. Kuday
Paper 54 "Cervical Spinal Injury in Elderly"

10:41-10:47 **N. Roidis,** Th. Karachalios, A. Tsirikos, J. Triantafilopoulos, D. Korres
Paper 55 "Fracture Patterns and Architecture of the Axis. A PQCT Analysis"

10:48-10:54 **A. Kartal,** İ. Yıldırım, F. Korkusuz,
Paper 56 "Cervical Spine of Soccer Player: A Biomechanical Study in Comparison with MR"

10:55-11:01 **Paper 57**	**M. Şengün,** A. Göğüş, A. Hamzaoğlu "Surgical Management for Lower Cervical Spine (C_3-C_7) Injuries"
11:02-11:08 **Paper 58**	**C. Şar,** U. Talu, A. Hamzaoğlu, E. Bilen "Three-Stage (Posterior - anterior - posterior) Reduction of Late, Untreated Distractive Flexion Injuries of the Lower Cervical Spine"
11:09-11:25	Floor Discussion
SESSION XI:	**Moderators:** **Y. Floman** **M. Altınmakas**

SPINE TUMOR

11:26-11:46	**Lecture:** Treatment of Primary and Metastatic Tumors in Cervical Spine **J. Harms**
11:47-12:07	**Lecture:** Sacrum Tumors and Treatment **E.E. Transfeldt**

SPINAL TUMORS - FREE PAPERS

12:08-12:14 **Paper 59**	**R.A. Özerdemoğlu,** E.E.Transfeldt, E.Y .Cheng "Primary Sacral Tumors: Features Predictive of Malignancy"
12:15-12:21 **Paper 60**	**L. Eralp,** C. Şar, H. Özger, F.E. Bilen "Results of Surgical Treatment for the Primary Tumors of Sacrum"
12:22-12:28 **Paper 61**	**O. M. Chung,** S.F. Yip, K. C. Ngan, W.F. Ng "Chondroblastoma of the Lumbar Spine: Case Report and Literature Review"
12:29-12:35 **Paper 62**	**F. Giorgiutti,** B. Cappelletto, P. Del Fabro, D. Gervesato, A. Meo "Surgical Stabilization of Spinal Metastases: Our experience in 53 Cases"
12:36-12:46	Floor Discussion
12:47-14:09	LUNCH & WORKSHOPS

SESSION XII: **Moderators:** **M. Aebi**
U. Domaniç

ROUND TABLE: ADOLESCENT IDIOPATHIC SCOLIOSIS

14:10-14:25 Three Dimensional Analysis of the Scoliotic Deformity
Ph. Bancel

14:26-14:41 Anterior Surgery
J. Harms

14:42-14:57 Posterior Surgery
D. Chopin

14:58-15:13 Outcome Analysis in Adolescent Idiopathic Scoliosis Surgery
B. A. Akbarnia

15:14-15:30 Floor Discussion

ADOLESCENT IDIOPATHIC SCOLIOSIS - FREE PAPERS

15:31-15:37 **P. Metz-Stavenhagen,** H.J. Völpel, S. Krebs, O. Meier
Paper 63 "Posterior Distraction Spondylodesis and Concav Chest Wall Plastic for the Treatment of Stiff Thoracic Scoliosis"

15:38-15:44 **E.R. Luque**, R.G. Blackman
Paper 64 "Thoracic Anterior Instrumentation for Thoracic Idiopathic Scoliosis"

15:45-15:51 **J.P. Steib,** J. Bogorin, M. Brax
Paper 65 "Importance of Measuring the Intervertebral Rotation in Estimation of Lumbar Scoliosis Reduction"

15:52-15:58 **U. Talu,** C. Sar, A. Hamzaoğlu, Ü. Domaniç
Paper 66 "Anterior Surgical Correction and Instrumentation of Adolescent Idiopathic Scoliosis"

15:59-16:10 Floor Discussion

16:11-16:28 COFFEE BREAK

SESSION XIII **Moderators:** **B. A. Akbarnia**
M. Yazıcı

ADOLESCENT IDIOPATHIC SCOLIOSIS - FREE PAPERS

16:29-16:39 **Po. Quang Chen**
Paper 67 "Comparison of Anterior and Posterior Instrumentation for King I Scoliosis"

16:40-16:46 **Paper 68**	**M.R. Yılmaz,** E. Okan, S. Örsel, Y. Özcan "Early Results of our Colorado Spinal Instrumentation"
16:47-16:53 **Paper 69**	**T. Yazar** "A New Approach to Scoliosis"
16:54-17:00 **Paper 70**	**A. Alanay,** M. Asher, S. M. Lai "Short Segment Anterior Surgery for Thoracolumbar / Lumbar Idiopathic Scoliosis"
17:01-17:07 **Paper 71**	**H. R. Güngör,** M. Karamehmetoğlu, M. Caniklioğlu, B. Berber, "Lumbar Pedicle Screws Versus Hooks in King Type II Adolescent Idiopathic Scoliosis"
17:08-17:14 **Paper 72**	**N. Erel,** A. Sebuk, L. Karapınarlı, E. Kutluay "New Technique - Transverse Process Stabilisation in the Surgical Treatment of Scoliosis"
17:15-17:21 **Paper 73**	**M. Bascandziev,** V. Strezoski "One Decade Experience with CD Method"
17:22-17:28 **Paper 74**	**S. Özbarlas,** M. Gülşen, S. Zorludemir, K. Dağlıoğlu, L. Tamer "Long Term Effects of Sublaminar Wiring in Immature Pigs: An Experimental Study"
17:29-17:45	Floor Discussion
17:46-17:52 **Paper 75**	**E. Acaroğlu,** M. Yazıcı, V. Deviren, A. Alanay, A. Cila, A. Surat "Does Tranverse Apex Coincide with Regional or Global Apex Levels in Adolescent Idiopathic Scoliosis (AIS)?"
17:53-17:59 **Paper 76**	**V. Deviren,** E. Acaroğlu, M. Yazıcı, A. Alanay, A. Cila, A. Surat "Effects of Anterior Release on Corrections in Coronal and Transverse Planes in the Surgical Treatment of Thoracic Adolescent Idiopathic Scoliosis"
18:00-18:06 **Paper 77**	**N. Azar,** C. Mirzanlı, Ş. Türel, G. Aksu "The Preventive Effect of Sublaminar Wiring to Hook Dislodgement"
18:07-18:13 **Paper 78**	K. Koltowski, **T.Lukaniec,** P.Menartowicz, "The costoplasty and CDI Augmentation of the cosmetic result"
18:14-18:20 **Paper 79**	**İ. T. Benli,** S. Akalın, M. Kış, M. Çıtak, E. Duman, Ö. Karakaş "Frontal and Sagittal Balance Analysis of Late Onset Idiopathic Scoliosis Treated with TSRH"
18:21-18:35	Floor Discussion

POSTERS

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M.Özek, A.Dağçınar, A. Sav, D. Türkdoğan, MN. Pamir

Poster 2 Anterior decompression and anterior instrumentation in thoracolumbar fractures
T.N.Karaismailoğlu, K.Tilki, C.Kökçü, Y.Tomak

Poster 3 Treatment of vertebral tuberculosis by anterior approach
M.Argün, C.Y.Türk, V.Şahin, M.Halıcı

Poster 4 Surgical treatment of spondylolysis
M.Altınmakas, A. Şehirlioğlu, C. Solakoğlu, Ş. Ekinci

Poster 5 Treatment of degenerative lumbar spinal stenosis by decompresive laminectomy and posterior instrumentation.
Ş.Kabak, S.Karaoğlu, M.Halıcı, M.Argün

Poster 6 The correlation between the canal compromise and the increase in interpedicular distance (IPD) in the burst fractures of thoracolumbar vertebrae.
H.Kutlu, C.Mirzanlı, Ö.S.Yıldırım, H.Seyithanoğlu, M.Asiltürk

Poster 7 Transpedicular fixation for the treatment of degenerative spondylolithesis in adults
C.Mirzanlı, H.Kutlu, M.Mert, Ü.A.Büyükgör, M.Caniklioğlu

Poster 8 Operative treatment of adolescent idiopathic scoliosis with poterior derotation systems
A.Cılız, M.A.Tümöz, C.Köse, S.Portakal, B.Bahadır

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A.Cılız, M.A.Tümöz, A.Dayıcan, S.Portakal, B.Bahadır

Poster 10 The surgical treatment of Tarlov cysts
S.Naderi, K.Yücesoy, H.Özer, N.Arda

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K.Yücesoy, S.Naderi, H.Özer, N.Yüceer, N.Arda, T.Mertol

Poster 12 Trace elements in spinal fusion patients
M.H.Tatari, H.İşlekel, E.Altekin, S.Göçen, C.Özcan

Poster 13 Multifocal spinal tuberculous infection. A case report
M.Tezer, B.Aksoy, E.Ertürer, A.Hamzaoğlu, İ.Öztürk

Poster 14 Solitary osseous myeloma of spine treated with anterior and posterior combined surgical methods. A case report.
M.Tezer, R.Özbal, Y.Kabukçuoğlu, C.Eryiğit, Ü.Kuzgun

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Poster 18 Incidence of neural axis abnormalities in adolescent idiopathic scoliosis
M.Karamehmetoğlu, H.R. Güngör, B.Berber, M.Mert

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IDIOPATHIC SCOLIOSIS IN THE FIRST DECADE OF THE LIFE

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Introduction

The care of an infant or a young child before puberty with a progressive true idiopathic scoliosis is one of the most challenging problem of pediatric orthopaedics. But on the contrary, during this period of life and especially during the first three years of life, some scoliotic deformities are completely reversible with or without treatment. It is why we can say that, for the spinal deformities idiopathic type occurring at that age, it can be the better or the worst! Covering there as well the classical infantile as juvenile group, in fact it is logical to study them together because when it is a progressing type of scoliosis, the earlier the lesion starts the worst is the prognosis because the longer is the time to reach the real end of growth.

It is logical also to place this limit at the first decade because we know that the development of respiratory system has an important date between 8 and 10 years old, it is the time where the alveoli no mode multiply.

So if we consider that the spine is the pilar of the thoracic cage, any progressive deformity of this will impair the harmonious organized development of the cage and subsequently the lung alveoli, airway and pulmonary vessels giving the pulmonary function of the child.

So the real challenge is to obtain with these patients the development of the trunk above and below the diaphragm as close as the normal one with the best possible pulmonary function.

Some normal valves for the growth of the spine and thoracic cage must be remembered: according A. Dimeglio, at birth thoracic spine T1 T12 measure 12 cms and 28 at maturity. Lumbar spine change from 7,5 cms to 16,5 during the same time. More important during the first decade, more than 60% of the remaining growth and 50% of the thoracic volume have been obtained coming from 6,5% at birth to 30% at age 5. So any lesion occuring in the development of the thoracic or lumbar spine during these first 5 to 8 years of life are the most dramatic for the final result regarding pulmonary function remembering, that the thoracic volume of a new born multiply 14 times to get the adult one.

It is why spontaneous evolution of progressive idiopathic scoliosis curves initiated during the first years of life will give, as observed in the past, the worst deformities and the worst respiratory disorders leading to cardio respiratory failure with "cor pulmonale" in relativity young age. This shorten the life expectancy by 20 years as demonstrated by swedish authors confirmed by Ponseti later on and explaining more than 60% of the death of these patients. Finally Philip Zorale work and school demonstrated that it was only in such case of scoliosis developed early and especially before 5 years of age that cardio pulmonary compromise was expected.

Natural history and etiology

Idiopathic scoliosis is generally never detected at birth and to my knowledge, I have never seen and I don't know one case reported in the literature.

When existing at birth, the scoliotic deformity is generally secondary to congenital malformation. For idiopathic cases we have in this young age three possibilities:

1. First type: "delayed postural" infantile scoliosis

The rib hump or spinal deformity appears after 2, 3 or 4 months of life, often associated with plagiocephaly. The curve is generally unique, long curve thoracolumbar where it is frequent to see pelvic obliquity with the transverse pelvic alignment following exactly the same direction of the spinal curvature. The hip joint on the convex side of the curve is generally with an abduction contracture. This don't need any treatment and as soon as the child start to walk disappears spontaneously.

We consider this type as a delay in the maturation o the nervous system giving balance in the tonus of the muscles around the axial skeleton.

2. Second type: true infantile scoliosis

The second type demonstrate real scoliotic curve also discovered within the first 3, 6 to 12 months or 2 years with also a earl rib hump, but with a shorter curvature surrounded above and below by compensatory curve running in the opposite direction. This type is much more serious, it can be regressive or progressive. It can be pure thoracic, thoraco-lumbar or double curves.

a) Resolving curves are mostly thoracic, generally never reaching more than 45°, but are really structural and don't disappear in suspension. They resolve spontaneously by the age of 2 or 3. Some of these correcting the lateral curvature but keeping long time the vertebral rotation until 7 or 8 years of age.

b) Progressive curves with here two ways of progression:

*The one called progressive benign can reach very large Cobb angle up to 70° but by an appropriate repeated cast treatment and brace later on can disappear also completely and end the growth with a straight quite normal spine, even if it remains some cuneiform bodies perfectly aligned in 3D.

Most of these cases are straightened before growth spurt and don't need any further treatment until end of growth. But some of them, especially the double curves, at the time of puberty spurt, start again to recur but very slightly and never lead to surgery.

But we have to say that these so called progressive benign left untreated would lead to terrible deformities resembling those coming from the last group of progressive curve that is the progressive malignant type that is really the very very difficult type to treat because no external treatment by repeated cast succeed to correct them. These curves generally thoracic, but also thoraco-lumbar, are built around there consecutive apical vertebrae with big amount of torsion. The intervertebral lordosis which is the basic definition of the scoliotic curve still exist, but the horizontal rotation of these three apical vertebrae is so big that they appear globally kyphotic because the lateral collapsing of 90° horizontal rotation resemble kyphosis for the patient.

From time to time, the aspect of these patients is typical with their skin, hyperlaxity and a little bit "old" aspect of the face. No neurological signs are found. Of course all the paraclinic imaging like MRI have demonstrated normality. If not, they are placed out of the idiopathic group.

To differenciate these groups of regressive or progressive type of this early onset of scoliosis, Min Menta work (1972) has been proven essential with the measurement of the rib vertebra angle as well as the projection of the pedicle upon the edge of the apical vertebra. When phase two and RVAD over 20° progression is more likely to come.

3D computer reconstruction also help to differenciate progressive benign group from malignant one, but in reality it is only the treatment by repeated cast that finally differenciate them clearly.

Cases discovered later on 4, 5 to 8 years old:
These so called juvenile in reality have various aspects and localizations more frequently thoracic (60%) and very few lumbar, resembling in some cases to cases similar to the previous one infantile and for others resembling the puberal or adolescent type with only difference that they appeared earlier. So it is really a gradual transitional group.

In this group, some cases are also non progressing, but more of them (70%) increase and require treatment and among them, more than 50%, will require final surgery.

Contrary to what was observed in the infantile group where boys were more involved than girls, here girls are more frequent from 2 to 4 vs 1. But in the group 3 to 6 years old the rate is 1/1 confirming very clearly this gradual transitional aspect between infantile and puberal adolescent group.

Etiology:
The ongoing hypothesis about the etiology are turning around neuron-hormonal disorder in relation with neuron-transmitter related to proprioception in relation with bipedal condition. It is interesting that in few cases, where we have been able to measure circadian serum levels of melatonin, demonstrate normal levels for resolving type and very decreased levels in the progressive type. This hypothesis is perfectly in agreement with the various evolution observed in clinical and radiological aspects.

Prognosis:
Finally the prognosis for this group of patients lies:
At Present: - in clinical presentation
- in radiological measurement, RVAD
- in precise follow-up checking clinical and X-Rays progression

In a near future: Measurement of neurotransmitter and neuron-hormonal balance

Treatment:
As we have to deal with vertebral torsion, that mean disorganization of the proper alignment, and that we are working with an organ with as a big amount of growth to achieve as it is younger, it is really understable that the first attempt is to reduce the deformity as much as possible and with as less direct damage given by open surgery.

1. It is why conservative treatment is mandatory to be done in the first approach.

It is best done by serial casting done with general anesthesia, with or without collar according the level, with modeling by pressure and counter pressure to achieve detorsion done by the hand of the surgeon who perform the cast. This repeated 3 or 4 times a year trying to reduce completely the deformity.

- Sometimes the correction is complete, and this occurs in the progression benign type and we can leave the patient without any external cast or we can put it in a Milwaukee brace and when stability of the reduction is controlled after 1 or 2 years, we can leave the patient completely free and follow him closely until end of growth without any other treatment. Sometimes these patients go through the growth spurt without any recurrence, sometimes at that time when the correction is not absolutely complete, especially for the double primary curve, it can recur some deformity at the begining of puberty, requiring some bracing or casting for passing this puberal spurt.

- Sometimes the correction is not complete, but improvement is significant and with alternating bracing and casting, growth of the thoracic cage is quite maintained and deformity either is stabilized or progress slowly. The deformity finally remain significant with a more or less important rib hump, but minimal global imbalance and this allows to wait until end of growth where a final posterior fusion instrumentation with or without thoracoplasty.

- Sometimes in spite of repeated precise casting, the deformity and torsion still progress and it is only on such cases that we must discuss insertion of surgical treatment during the growth period.

2. Surgical treatment during the growing time

- In young children, in spite of precise and well realized conservative treatment with serial casting and bracing for the very severe malignant type the curve continue to progress in young age before age 8 and this will require a surgical treatment with apical anterior hem-epiphysiodesis (as demonstrated by Andrew 1985) in conjunction with or without posterior roding without fusion and if possible multiple points of fixation, to prevent the crankshaft phenomenon.

If we do only posterior fusion, we create clearly a crankshaft. But this combined anterior and posterior treatment don't eliminate the external casting and bracing. It is only a help for that treatment that has to be continued until end of growth and sometimes finished by a posterior fusion and instrumentation of the entire curve.

This type of treatment during childhood is very helpful, but has to be understood especially by the parents not definitive, but only to help a better effectiveness of the external bracing or casting.

- In older children around or during the growth spurt when sufficient thoracic cage size is obtained, but before completion of growth, the dilemma is either to wait pubertal peak, so Risser 2, to do the final fusion as in the adolescent curve by posterior fusion and instrumentation, or to do more early definitive radical treatment by instrumentation and fusion, not only posterior but also anterior, to prevent the crankshaft phenomenon that will certainly appear if posterior fusion is done alone before

Risser 1, before closure of the triradiate cartilage, before pubic-hair completion to 2, before breast has reached 2 also and of course if remaining apical horizontal rotation is over 15° and Cobb angle over 30.

In such case we can perform combined anterior and posterior fusion of the curve with hope to obtain a stable and definitive treatment with a relative small loss of spinal and thoracic length.

3. Surgical treatment is frequently indicated at completion of growth: either when the patient is seen for the first time at that age with large intreated deformity or when it is a remnant of more or less successful treatment done during childhood.

For that the strategy for such treatment is to correct progressively the deformity by external manoeuvre with distraction cast supplemented with halo. The halo has the only goal to slow down the pressure on the chin given by the Stagnara distraction cast and to allow free motion of the head in rotation even with the tension given by the distraction cast. This is a big advantage regarding the halo cast where distraction is done directly on the halo. The advantage of the Stagnara distraction cast is that this allow relaxation of the soft tissue structures of the spine, this relaxation helping a lot for the visco-elastic behaviour of the crooked spine. This treatment is performed in conjunction with ventilatory assistance by positive pressure ventilatory machine like BIRD and we observe increase in height, increase in vital capacity, increase in blood gas exchange and decrease of the angle of the curve. This can be done for some months and this is continued until we reach a plateau for height and Cobb angle and mainly vital capacity and gas exchange. The time is then to perform surgery mainly posterior, surgery with instrumentation (often with 2 concave rods) and fusion with always adjunction of tibial strut graft if the starting standing angle was over 100° trying to save as much lumbar disc level as possible but trying also to end with a well balanced spine in 3D as well for thoracic and lumbar spine.

Anterior release can be discussed but the relative benefit in angulation correction often moderate must be placed in balance with the loss of pulmonary function that can result from the approach. Does non invasive method supposed less dangerous for vital capacity will be helpfull? It is too early to answer.

We can discuss the same thing for thoracoplasty and before taking the decision of thoracoplasty it is judicious to do a thoracic CT scan to evaluate the position in 3D of the ribs to be removed and to anticipate the real cosmetic result of the thoracoplasty, all this kind of surgery of course done with as accurate as possible spinal cord monitoring because it is in such cases that personally I found the most dangerous risk of neurological complication, especially by over correction. It is why after a good pre-operative preparation by distraction cast we don't try to correct much more with instrumentation and we are safe with this concept, on the contrary that we have seen when we had in the past neglected such preparation.

Treatment in adulthood

Finally some cases are seen only in more or less late adulthood for neglected deformities from infancy. At that time 2 types of patients:

- Some have cosmetic concern or painful concern of the lumbar or thoraco-lumbar spine decompensation with secondary degenerative changes. For them after precise cardio-respiratory checking and evaluation

of the risk, there the surgery try mainly to restablish good balance and don't try to correct too much the thoracic area.

- The second type is the one where the importance of pulmonary deficit, respiratory and sometimes cardiac symptoms are in the first line.

In such case the pre-operative preparation is a capital step, done on the same model as the one we use for adolescent but of course with a very close cooperation with the respiratory rehabilitation intensive care department. They will check and pilot the pre-operative preparation. At the end of that, we appreciate the improvement or not and if (as very often), the improvement is quite evident from the measurements but also from the patients sensation. The surgery is performed with or without anterior release trying to stabilize the mechanical as well as functionnal respiratory improvement. It is same discussion and technic as previously described.

Conclusion:

For deformities started in the first decade of the life, some of them can drive to vital prognosis from the cardio-respiratory failure secondary to the poor function of the lungs. Whatever the age, the goal of any treatment (non operative or operative) is to recover or protect as much as possible this vital function. It is why any treatment of such patient and of course this his reinforced for operative treatment, has to be realized in close conjunction with the respiratory care intensive and chronic department and assistance in pre, per, and post-operative sequences.

EPIPHYSEODESIS AND CONVEX HEMIARTHRODESIS FOR PROGRESSIVE CONGENITAL SCOLIOSIS

Robert B. Winter, MD

Introduction

Since progression in congenital spine deformities is due to asymmetric growth, it is very reasonable to think that elimination of the pathologic convex growth with preservation of the existing concave growth could cause control of the curve progression and even curve improvement.

History

Convex epiphyseodesis was first described by a Scottish surgeon, Alexander MacLellan, in 1922. (5) The next great champion of this idea was Robert Roaf of Liverpool, England, who wrote several articles on the subject in the 1960's. (7) In 1985, Andrew and Piggott of Birmingham, England described 13 patients of which 10 did extremely well with straight spines at maturity. They emphasized that the ideal case should have no kyphosis problem, have surgery at a yougn age (before 5 years), have both anterior and posterior done under one anaesthetic, and be casted for 6 months. (1)

The next report was by Winter, et al in 1988 (8), also describing 13 patients. They reported one failure (too short a fusion), seven with cessation of curve progression, and five with progressive curve improvement.

Dubousset, et al (2), reported in 1993 on 43 cases done between 1970 and 1985. The chief points of their report were: 1) clear evidence of curve progression, 2) early decision and precise planning of the surgical area, 3) careful anterior and posterior technique, never touching the concave side, and 4) very careful long-term follow-up since not all cases evolve perfectly and further surgery may be necessary.

In 1995, Marks et al (the Birmingham Group) (6), reported on 53 cases, 34 of whom had reached skeletal maturity. The average follow-up was 9 years. They found the best results were in cases of hemivertebrae when the surgery was done before age 5 years, preferably at 18-24 months of age.

Kharrat et al of Lebanon reported in 1996 on 22 patients with an average age of 4 years at surgery (3), The mean preoperative scoliosis was 42° and at follow-up 35°. The children with smaller curves (average 37°) operated early did much better than the children with larger curves (average 49°) operated later.

King, et al, has reported on doing the anterior surgery via a transpedicular posterior approach. (4) Of their 9 children, 4 had curve improvement and the other 5 curve control.

Technique

The patient is placed in a direct lateral position, secured with tapes, and prepped and draped so that both the anterior and posterior incision can be made without changing the patient's position.

Both the anterior and posterior incision are made and markers placed identifying both the upper and lower ends of the fusion in both and anterior and posterior exposures.

Only the convexity is exposed, removing the convex 1/2 of the disc and growth plates anteriorly and only the convex side of the spine posteriorly. Bone chips are added to the decorticated areas, markers placed at the ends of the fusion, and the incision closed.

Under the same anaesthetic, a corrective cast is applied. If a chest tube has been inserted, it is brought out anteriorly through the window in the cast for easy removal. After 3 months a new cast is applied and casting continued for a total of six months. After that, no external support is needed.

Follow-up must continue until the end of growth, since good early results may deteriorate with time, especially during the pubertal growth spurt.

Further surgery may be necessary and the parents must always be warned of this need.

Indications

Since the concept of convex growth arrest is to stop the excessive convex growth and to permit the lesser concave growth to continue, it is essential that there be active concave growth tissue. The problem is how to know whether or not this concave growth exists.

We have had to depend in the past on indirect information, i.e. the interpretation of routine x-rays. Obviously, a patient with a unilateral unsegmented bar is not a candidate unless the bar occupies only a small part of the whole curve. One trick for determining the possibility of concave growth is to look at bending or distraction films.

If the curve's concavity has some flexibility, the possibility of some concave growth tissue is quite high.

A newer tool is the use of MRI to directly examine for growth plates. MRI has proven to be of excellent value in looking at the growth plates of long bones, so why not look at them in the spine also?

Another contraindication is the patient with true kyphoscoliosis due to a postero-lateral hemivertebra. The anterior portion of the growth arrest might be good for the scoliosis, but it aggravates the kyphosis.

Lessons learned over the years are that 1) the child must have a documented progressive curve, 2) the curve should be under 50° on a supine x-ray, 3) the child should be under age 5 years, 4) there should be concave growth potential, and 5) there should be no kyphosis problem.

Conclusions

Convex growth arrest surgery has proven to be very successful in the very select cases with documented progressive curves, no kyphosis, a curve under 50°, a child under age 5, and careful surgical and casting techiques.

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HEMIVERTEBRECTOMY FOR THE TREATMENT OF CONGENITAL SCOLIOSIS

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Fully segmented congenital hemivertebrae can result in progressive spinal deformity which produces sagittal and coronal plane deformity. The adult consequences of these deformities can be painful and disfiguring. Compromise of cardiac and pulmonary function can result from severe curves when the deformity exceeds 50° by the age of five years. The non-operative treatment of progressive congenital scoliosis is not effective in controlling the primary curve. Anterior-posterior hemiepiphysiodesis or in situ fusion of congenital scoliosis can be successful in controlling lesser curves in the younger age group.

Complete (anterior-posterior) resection of the hemivertebra as reported Roaf was accompanied by an unacceptable high incidence of neurologic complications. In 1990 Boachie and Bradford reported on the successful resection and cast immobilization of hemivertebrae in the lumbar spine. Correction of the deformity through shortening of the spine rather than distraction is an added safety feature.

Single stage resection of the hemivertebrae by the anterior transthoracic extra pleural approach followed by posterior resection and the application of compression instrumentation is definitive treatment and does not depend on cast correction. Sublaminar sutures, laminar compression hooks or unilateral pedicle screw constructs can be used depending on the local anatomy. Transpedicular hemivertebrectomy and compression instrumentation is usually reserved for vertebrae below the level of cord. All patients worn a cast for immobilization for a total of six months post surgery. In 20 patients undergoing hemivertebrectomy of the thoracic or lumbar spine, our average correction was 25° (16°-34°).

Complications have included one pseudartrosis (incomplete removal of the hemi) and one transient L-5 nerve root lesion.

Although technically demanding, congenital hemivertebrectomy followed by compression instrumentation for progressive scoliosis or unacceptable deformity is a safe and effective treatment.

INDICATIONS AND TECHNIQUES OF SACROPELVIC FIXATION IN ADULT SCOLIOSIS

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Fixation to the pelvis is one the more challenging situation in adult scoliosis surgery. Poor quality of sacral bone, difficulties to adjust frontal and sagittal balance, higher rate of pseudarthrosis are some of the aspects of the problem.

TECHIQUES OF SACROPELVIC FIXATION

Sacral fixation in adult patients and particularly in the oldest has to deal with the poor quality of the sacral bone, and at same time increasing stress of the long lever arm of the fused spine above, in an ambulatory patient.

Fixation with hooks and staples were rapidly found to be inefficace. J. Dubousset used the ilio sacral screw inserted from the iliac crest posterior to the sacro iliac point, directed at 45° to the vertebral body of S1. This provide a solid fixation, but technically demanding and with limited control of flexion extension of the pelvis.

The alternative is the use of sacral screws. The S1 screw is directed from the base of articular facet of S1 and directed upward and inward 5° to 10° to the promontary. This is the strongest part of the bone.

However if this fixation is strongh enough for short fusion, long instrumentation needs supplementary fixations. A second divergent scraw outward to the sacral alar increases the quality of fixation but also the difficulty to introduce the longitudinal rod.

The CD sacral block provided the possibility to have those 2 points of sacral fixation with one point of connection for the rod.

Anchorage is increased with the Colorado sacral plate were the sacral alar screw is not only oblique outward but also upward, making the 2 sacral screws in completely 3 different planes.

However, in particularly osteoporotic bone, sacral fixation had to be reenforced with a 3rd pelvic fixation in the iliac wing. The iliosacral plate with its lateral extension allows the insertion of a 3rd screw between the two cortices of the posterior iliac wing. This long screw completly inside the iliac wing is safe, easy to insert, and provide a high resistance to pull out forces as demonstrated by biomechanical tests.

Connection between the rod and the plate is realized by a special clamp adapted to an end part of the plate. Some degrees of rotation are allowed aroud the axis of the part till the final locking. This facilitates adaptation and correction with the rod.

With long instrumentations, it is recommanded to have a pedicular screw fixation on L5 at leastone side in order to have a repartition of the stress and diminish the risk of lombosacral pseudarthrosis.

Indications for fixation to the pelvis in adult scoliosis

Indication is discussed in twos principles circumstrances: pain and imbalance due to lumbo sacral junction.

1. Lumbo sacral pain can be of various origin in adult scoliosis.

a) Some could be treated without lumbo sacral fusion

. Refered pain form thoracolumbar area desappear after fusion of the lumbar cure.
. Facet pain on the concavity of the hemilumbosacral curve, is a consequence of asymetric loading on the facets. If the lumbosacral area is still mobile, correction and restoration of the balance of the spine above is efficient.

b) Degenerative lumbo sacral disc can be a matter of discussion.
On can assume that it will became or remain painfull if it is not included in the fusion.

Because of the higher morbidity of pelvic fixation 51 patients were fused down to L4 or L5 and reviuwed with a minimum of 5 years of follow-up. 35 patients were under 50 years at surgery and a mean angulation of 65°9.

Extension to L5 was necessary 2 times and to S1 only one time. 16 patients were over 50 years and extension to S1 was necessary in 2 cases.

Therefore systematic inclusion of degenerative lumbo sacral discs does not seem to be justified is the balanca can be restore.

2. Correction or prevention of imbalanca

Degenerative changes of the lumbo sacral area can be responsable of a fixed obliquity of L4 to S1 with facet synostosis, and or disc syndesmophitics.

Isolated correction of the kyphoscoliosis above will create or increase coronal decompensation to the convex side of the main curve due to fixed obliquity of L4-L5-S1.

According to the amount of obliquity frontal alignment must be carefully control avoiding over correction of the lumbar curve. Posterior lumbo sacral release and alignment of both lumbar, lumbo sacral curves by approximation to the bended rods, without any longitudinal forces can be sufficient.

However, when the curves and obliquity of L4 is more important, it is necessary to act on the anterior column to level L4 over the pelvis.

When bone quality is good a symetric PLIF with a cage on concave side L4-L5 and L5-S1 and compression on the opposide side can be done.

In most of the cases bone quality is too poor and a transpedicular resection is done on the convex side of the lumbo sacral curve L5 or generally L4.

Lumbar curve above is just aligned in frontal plane on 2 bended rods to restore lordosis.

3. Limited correction of lumbo sacral junction

This specific situation concerns young adults with an obliquity of L4, secondary to asymetric degenerative L4-L5 and L5-S1 disc. The lumbar curve must be almost completly corrected on convex bending in terms frontal angulation and rotation.

A limited lumbo sacral fusion with and asymetric PLIF L4-L5-L5-S1 levels L4 parallel to the pelvis and obtain spontaneous correction fo the curve above.

ADULT SCOLIOSIS:
SAGITTAL AND CORONAL ALIGNMENT

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Introduction:

Definitions: Prior to discussing the significance of the coronal and sagittal planes in scoliosis, a clear agreement on these terms must be established. The midsagittal plane is a plane which is vertical between the anterior and posterior midline and bisects the standing body into right and left halves. The coronal plane is also a vertical plane which is perpendicular to the sagittal plane. The midcoronal plane (frontal plane) divides the body into anterior and posterior halves. (figure 1)

The adult scoliosis: Scoliosis in the adult can result from a variety of causes ranging from adolescent deformities present in adulthood to degenerative and traumatic deformities. Most frequently, however, the adult scoliosis is the result of either Adolescent Idiopathic Scoliosis (AIS), de-nova degenerative adult scoliosis (DDS), or a combination of both. Significant differences exist in not only etiology but also pathoanatomy and pathophysiology between the AIS group and the degenerative group. In terms of sagittal and coronal plane considerations these differences are evident:

In adolescent idiopathic scoliosis the coronal plane deformity is significant and guides prognosis as well as treatment. The sagittal plane changes in AIS include thoracic hypokyphosis, lumbar hypolordosis and junctional kyphosis between thoracic and lumbar curvatures. The sagittal plane must be scrutinized particularly in the junctional zones for it plays an essential role in deciding upon levels of fusion. The sagittal and coronal plane components in AIS are examined together and as surgical correction focuses upon the coronal plane correction, the sagittal aspect of the deformity is indirectly addressed.

In the denovo degenerative scoliosis, the coronal and sagittal plane considerations are significantly different from AIS. Most obviously, the coronal plane component of DDS is often minor but the sagittal plane component is significant and it is clear that in DDS a kyphoscoliosis is always present. The key component in treatment is thus addressing the sagittal plane and correction will indirectly affect the coronal plane.

Spinal contour and alignment:

In the treatment of spinal deformity separate consideration to regional spinal contour and global alignment are important. Much attention has been directed toward spinal contour in the healthy population. Stagnara, Ascher, Jackson and others have defined segmental and regional sagittal angular values in standing subjects. Significant variability in the 'healthy' population is evident. On the other hand, the coronal plane contour variations are very limited.

Global alignment values have also been analyzed in terms of plumb line measurement in standing subjects and patients. Jackson recently examined sagittal plane contour in healthy subjects and found a narrow range of plumbline deviation from the sacral promontory (Spine 1994). Our research service has examined sagittal balance in the context of flatback deformity and found that plumbline variations when drawn from the odontoid were well tolerated with up to 5 cm displacement from the anterior sacral promontory. Deviation greater than that was associated with pain, and poor response to

conservative clinical management. Dubousset has developed the concept of the economy cone which defines a narrow range of optimal alignment. Global balance which falls in outer ranges of the economy cone will require significant energy expenditure to maintain balance. (figure 2)

Our understanding of spinal balance in a dynamic system is much more difficult to analyze, since our current tools focus on static image analysis. The spine is a crucial portion of body balance and positioning in space, this function has not been studied in detail. This dynamic aspect of spinal balance has been described as a metronome with the head swinging widely above the pelvis but ultimately finding balance centred in the midline in frontal and sagittal planes. Zeller and Dubousset have recently initiated research on this dynamic aspect of spinal motion through sequential radiographic measurements through various positions in scoliotic patients.

The Degenerative Pathway

It has been established that disc degeneration is already noted in the 4 th decade of life in healthy people. Furthermore, it is thought that disc degeneration always precedes other degenerative changes in the degenerative pathway. Thus the 'classic' cascade of events begins with anterior disc heigt loss and degeneration followed by facet degeneration and ligamentous degeneration (hypertrophy, buckling). With bone loss and eventual settling or collapse of the vertebral body significant shortening of the anterior column in respect to the posterior column may occur. An overall kyphosis is evident and with some regional instability rotation and lateral deviation ensues (kyphoscoliosis).

In most cases this degenerative pathway which is inevitable with aging, does not lead to significant symptoms. Therefore, one can stipulate that there is an 'ideal degeneration' which is without marked clinical impact. This 'ideal degeneration' is essentially an ankylosis of the motion segments with a resultant balanced spine that although kyphotic is well compensated for.

In a small segment of the population, the degenerative cascade in the spinal column becomes clinically significant. This 'problematic degeneration' is essentially a degeneration which leads to instability/pathologic motion. The adaptive ankylosis which occurs in the 'ideal degeneration' is in some manner overcome and progressive deformity in the coronal and sagittal planes ensues. There is a failure of complete facet ankylosis and significant hypertrophy with persistent motion can occur. The neural passages can become significantly narrowed (central, foraminal stenosis). (figure 3) Furthermore, with progression of deformity, particularly in the sagittal plane, the compensatory mechanisms which come into play to maintain effective balance can become overwhelmed. Global imbalance with significant anterior plumbline shift can then be noted.

Compensatory Mechanism to Coronal and Sagittal deformity

The spine is well adapted to positional changes in normal functioning and is also capable through compensatory mechanism to adapt to pathologic changes in spinal alignment. These adaptive or compensatory mechanism can be artificially divided into two groups, regional and global mechanisms.

The regional compensatory mechanisms are local tissue responses which come into play during the degenerative process. These tissue reactions are termed compensatory since they counter some of the intrinsically destabilizing/deforming forces in the degenerative cascade. The regional stabilizing or compensatory mechanisms thus include facet ankylosis posteriorly, disc calcification and thus anterior stabilization, and the formation of anterior bridging osteophytes.

Global compensatory mechanisms are those which attempt to counteract the deforming and stenosis effects of the degenerative pathway in the spine. In order to counter the kyphosing aspect of degeneration compensatory spinal curvatures or modification of spinal contour may occur. To maintain level vision, cervical hyperlordosis can develop. A patient can also assume conscious postural modifications of forced extension across remaining mobile lumbar segments and even some reduction in thoracic kyphosis. If lumbar stenosis becomes clinically marked then the inverse in postural modification can be noted, namely forward flexion to relieve foramina and perhaps central stenosis.

Additional significant compensation to sagittal plane deformity can occur through pelvic retroversion and hip/knee positioning. We have investigated the role of pelvic rotation (measured as a Sagittal Pelvic Tilt Index, SPTI) as a compensatory mechanism to sagittal plane deformity. In a series of 106 volunteers and patients a statistically significant age related pelvic rotation was identified. It is postulated that loss of lumbar lordosis with aging leads to compensatory pelvic retroversion to displace the hip joints anteriorly and thus maintain the gravity line between the hips. This would appear to minimize energy expenditure to balance an evolving spinal alignment with aging.

Treatment considerations for coronal and sagittal deformity:

When conservative measures fail and surgical treatment is planned attention must be directed not only to the regional pathology (stenosis, instability....) that may be causing clinical symptoms but also to the deformity and balance of the spine. The surgical goals must therefore include the following considerations:

a. correction of regional kyphosis and global balance in the sagittal plane - It is essential to address the primary deformity in adult scoliosis namely the kyphotic element. To obtain proper regional contour and global alignment anterior and posterior surgical approaches my be necessary in order to reconstruct anterior column height and obtain sagittal balance.

b. global balance in the coronal plane - Although most cases of adult scoliosis do not lead to plumb line imbalance in the coronal plane, this parameter must be evaluated and if necessary corrected through controlled manipulation of the foundations during posterior surgery. If significant imbalance is present then uneven chevron osteotomies will permit controlled correction and restoration of lordosis.

c. coronal plane scoliosis correction - It should be emphasized that the correction of the scoliotic curve is very secondary to other parameters. These curvatures are usually mild and the restoration of proper lordosis will induce sufficient correction of the lateral deviation (coronal plane curvature).

d. solid arthrodesis - Obtaining proper fusion is the endpoint of surgical intervention and lack of adequate bone stock can be a considerable problem. Proper fixation and meticulous preparation of the fusion bed is essential (facet osteotomies) and bone graft extender (corraline bone, calcium sulfate) as well as demineralized bone matrix are frequently employed.

e. fusion must end on a viable level - In ambulatory patients under the age of 65 it is important to limit fusion proximal to the sacrum. At the same time, one must cautiously end an instrumented fusion on a viable level to avoid rapid junctional failure. The end level caudally must thus be properly aligned in frontal and sagittal planes and the adjacent disc should demonstrate adequate hydration on MRI. Facet changes and stability on flexion/extension radiographs are also valuable parameters in judging the viability of the inferior junctional level.

f. fusion to the sacrum must include a reliable foundation - When the surgical plan includes a fusion across the lumbosacral junction then a careful strategy for the caudal foundation must be developed. The long lever arms and poor bone stock in the elderly make divergent and multiple fixation points essential. Techniques to consider include divergent sacral screws, iliac nail/screw galveston type supplementation, iliosacral screws and the Jackson instrasacral technique.

Technical considerations in surgery for degenerative scoliosis:

Osteotomies:

Since the sagittal plane correction is an essential part in the surgical treatment of adult scoliosis, the surgical plan my require osteotomy of the spine. The posterior osteotomies will afford shortening of the posterior (and middle columns in some cases) and can also permit coronal plane corrections.

The selection of osteotomy technique is dependant on multiple factors including the degree of sagittal plane correction required, the experience of the surgeon, and the need for coronal plane adjustment. In general, when limited amount of sagittal plane correction is necessary then a chevron or multiple Smith-Peterson osteotomies are used. Compression across the proximal and distal foundations will afford controlled correction of deformity. When large corrections and particularly focal kyphotic correction is sought then pedicle subtraction osteotomy is a good option. In this technigue it is absolutely essential to have all instrumentation in place prior to osteotomy. One side of the spine is then linked between proximal and distal foundations in order avoid sudden motion across the spine while osteotomy is performed. Sliding compression across the rod-rod connectors between proximal and distal instrumented foundations will permit controlled closure of the osteotomy. An additional option in correction of sagittal plane deformity of adult scoliosis is the anterior-posterior technique. The advantages are marked correction capability and anterior strut grafting or cage placement that will augment chances of successful fusion. Disadvantages are the additional insult to the patient that raise the complication risks (OR time, blood loss, length of surgery...) and surgeons fatigue that can affect technical success.

Four-rod technique:

Correction of sagittal plane deformity in the elderly must rely on solid anchorage to the spine. The four rod technique permits the creation of two solid foundations, one cephalad, one caudad, across the deformity. By first establishing these foundations increased control is possible during the destabilizing aspects of the reconstructive surgery. Furthermore, once osteotomies and realignment have been performed, the interlocking of the foundations requires no further excess leverage across any particular screw or hook and final tightening and assembly occur across the two sets of rod-rod connectors (dominoes), and closure can begin on the case. By having placed all instrumentation prior to any osteotomy minimal blood loss is incurred. The osteotomy can then be performed with the knowledge that prolonged bleeding with poor visualization is minimized since wound closure begins shortly after the final instrumentation is interlocked and compressed. A further advantage of the four rod technique is the added freedom in translating the two foundations with respect to one another. In addition to optimal sagittal plane correction, coronal plane deformity with offset between the cephalad and caudal levels of the spine can also be corrected by adjustments between the upper and lower foundations through the rod-rod connectors and individual rod contouring as well as final compression/distraction maneuvers. In this manner correction forces are exerted across the two instrumentation constructs and multiple fixation points. Careful adjustments can be performed across the foundations to selectively correct sagittal and coronal plane deformity. In the setting of spinal

osteotomies the four rod technique permits linkage across one side of the spine during osteotomy avoiding any transient instability.

Figures:

Figure 1

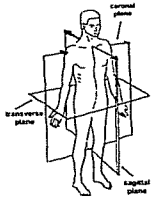
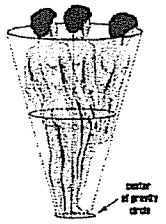


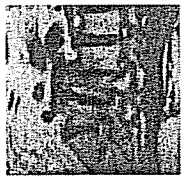
Diagram illustrating the anatomic planes.

Figure 2



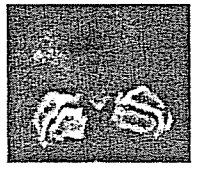
Sketch of the economy cone (Dubousset). Limited trunk displacement is possible while maintaining balance. Increased trunk shift to the outer borders of the cone requires significant increase in energy expenditure to maintain balance.

Figure 3A



Transverse CT-myelogram image illustrating significant stenosis. Degenerative changes involve facet hypertrophy, disc bulging, ligamentous hypertrophy all leading to marked narrowing of the central canal and foramina.

Figure 3B



Sagittal image of a lumbar MRI demonstrating advanced degeneration. Note the kyphosis, retrolisthesis and disc collapse which all contribute to deformity and foramenal encroachment.

THE DIFFERENT SPINAL OSTEOTOMIES IN THE SURGICAL TREATMENT OF ADULT SCOLIOSIS

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The treatment of adult scoliosis as a double goal mechanical with reduction of deformity and fusion of the reduced spine. Neurological decompression is the last step of the surgical treatment but not always necessary.
Suprisingly reduction of the definity is not always as difficult as expected spontaneous anterior interbody fusion is rare. Stiffness of the deformity is mostly related to the facet fusion or arthrosis. Thus reduction is currently acheaved throught a posterior approach at thoracic or lumbar spine.
In our current pratice anterior interbody disk release is no more used since 1992.
Stiffness of the curve can anyhow exist and needs an osteotomy to be reduced.
3 different types of osteotomies can be decsribed-facet osteotomy-postero lateral twisting osteotomy-posterior wedge osteotomy.
Facet osteotomy is performed in case of spontaneous facet fusion or previously fused deformity.
Resection of facet enables regularly to recover motion at disk level.
Multi level correction is necessary because reduction is limited in it's possibilities level by level.
Postero lateral twisting osteotomy is mostly interesting in thoracic spine. Performed through a posterior approach a 360° osteotomy with a Gigli saw is achieved this technic was initialy described for en bloc tumor resection and enables sagittal and coronal reduction.
Posterior wedge osteotomy is mostly used in lumbar spine at cauda equina level.
Posterior arch resection and posterior vertebral wedge resection enables kyphosis correction.
These osteotomies must always be considered as an important increase of surgery morbidity and needs to be strictly indicated.

LUMBAR SPINAL STENOSIS

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The dural sac with the floating cauda equina within and the spinal nerve roots occupy the lumbar spinal canal and the intervertebral foramina. The boundaries of the spinal canal and the neural foramina are formed by a complex osteoligamentous structure i.e. the vertebral bodies, intervertebral disc, posterior joints and lamina, the ligamentum flavum and other ligaments. Spinal stenosis is a condition that is characterized by constriction of the spinal canal and nerve root canals. Previously, the anatomy of the spinal canal and neural foramina and its relationship to the dural sac and cauda equina was only partially delineated by conventional radiography and myelography. The availability of modern imaging modalities like CT and MR have provided a far better and more detailed cross sectional as well as sagittal anatomy of the normal and degenerative spine. In addition the use of cryomicrotomy have enabled a better knowledge of the anatomy of the spinal canal and its relationship to the cauda equina both in health and disease (1).
In the upper lumbar spine an oval shape canal is encountered, whereas a more triangular shaped canal is common in the lower lumbar spine. A trefoil shape canal in which a distinct lateral recess is present is more commonly encountered at L5 level. The latter shape has less room in the lateral recess and neuroforamen to accommodate changes of degenerative disc disease. In general there are 4 distinct anatomical sites for neural compression in lumbar stenosis: central, lateral recess, neuroforamen and extraforaminal.

Pathologic Anatomy: Lumbar spinal stenosis can be classified into 3 major groups:
a: congenital (normal adults with a small canal), b: developmental (for example in achondroplasia) and c: acquired due to degenerative disc disease (degenerative lumbar spinal stenosis). It is not uncommon to encounter a combination of congenital idiopathic stenosis with acquired degenerative spinal stenosis. Degenerative spinal stenosis constitutes the majority of cases that come to clinical attention. Although degenerative lumbar spinal stenosis was described at the beginning of the century. it's recognition as common clinical entity is attributed to the publications of Verbiest in 1954 (2) and Kirkaly-Willis (3). The incidence of degenerative lumbar spinal stenosis is about 2% of the general population (4). Degenerative spondylolisthesis especially at the L4-L5 level is 4 times more common in females (5). Degenerative spinal stenosis occurs as a sequel of degenerative disc disease. The following pathological processes occur: disc degeneration results in desiccation of the disc with replacement of type 2 collagen by type 1 collagen and reduction of the proteoglycan content of the nucleus pulposus. Disc degeneration reduces disc height and foraminal dimensions leads to disc bulging and osteophyte formation. As a result of disc degeneration facet joint osteoarthritis develops as well as in folding and hypertrophy of the ligamentum flavum. All these changes lead to narrowing of the canal and neural foramina. In addition segmental instability in the form of either retrolisthesis, degenerative spondylolisthesis or lateral olisthesis especially in cases with degenerative scoliosis my be also encountered.
In normal individuals as well as in patients with spinal stenosis the sagittal dimensions of the spinal canal increase with spinal flexion and dimish with extension. In flexion the interlaminar space increase, the annuli become tauter and disc bulging diminishes. In extension disc bulging increases, the space availabe for the neural elements decreases, the ligamentum flavum buckles and the nerve roots become broader, all leading to relative stenosis of the spinal canal.
Central lumbar canal stenosis compresses the cauda equina while stenosis of the lateral recess or the

foramen compress a single nerve root. Central canal stenosis is usually accompained by lateral recess stenosis. The latter occurs due to facet joint overriding and arthritis together with ligamentum flavum buckling ("hypertrophy"). Lateral recess stenosis can also occur as an isolated phenomenon. Verbiest (6) differentiated between relative and absolute stenosis. A mid-sagittal diameter of 10-14 mm was considered as relative narrowing of the canal while values of less than 10 mm were considered as absolute stenosis. A relative stenosis my become symptomatic in middle age as degenerative disc disease further narrows the spinal canal. Absolute stenosis on the other hand becomes symptomatic in younger adults. Lateral stenosis may occur in the subarticular zone, pedicle zone, exit zone and "far out". Lateral recess stenosis my be also asymptomatic.

Symptoms: Symptomatic degenerative lumbar stenosis usually has an insidious onset arount the 5th to 7th decades of life. The patho-physiological events leading to clinical symptoms of spinal stenosis are not entirely clear. If only absolute narrowing of the canal would have mattered symptoms would have been constant and in any spinal posture. However it is well known that the symptoms of spinal stenosis appear variably and are related to activities and posture. The most logical explanation for symptom production in spinal stenosis is probably related to root ischemia-nutritional deficit (7). Spinal arteries dilate with nerve stimulation (as during exercise). Canal narrowing may not allow for dilatation of these arteries and thus cause root ishemia. In addition venous engorgement with upright posture and walking add to further canal stenosis and further ischemia. Furthermore CSF flow is disturbed due to the stenosis leading to further derangement of nutritional and metabolic needs (8).
The typical clinical picture is that of neurogenic claudication. Neurogenic claudication is a constellation of symptoms of buttock and leg pain that may be accompained by numbness and weakness, exacerbated by standing or walking and is usualy relieved completely by sitting. Mild back pain may be also common.
In-patients with severe central stenosis perineal numbness and occasional urinary incontinence may be encountered. Symptoms are usually distributed along the L4-L5 and S1 roots. Amundsen et al. (9) reported that the most common symptoms in-patients with spinal stenosis were claudication, leg pain and back pain. It must be noted that pain at rest and night pain is also common (10). On physical examination pain may be reproduced by spinal extension while straight leg raising test is negative in the vast majority of cases. Neurological deficit is usually absent although a superimposed acute disc herniation may induce such a deficit. Occasionally post-exercise neurologic examination may reveal neurologic findings. The presence of hyper-reflexia or pyramidal signs should raise the suspicion that cervical disc disease with cervical myelopathy is also present. The latter co-morbidiy is a fairly common in-patient with lumbar spinal stenosis. The differential diagnosis of neurogenic claudication is claudication due to a peripheral vascular disease. Not-rarely the two conditions coincide. Sometime the condition of spinal stenosis may be confused with peripheral neuropathy or hip joint pathology.

Diagnostic studies:
Conventional radiography: on the lateral view one should look for the presence of short pedicles (congenital), disc space narrowing or degenerative spondylolisthesis, on the antero-posterior view look for narrowing of the interpedicular distance or shingling of the laminae, oblique views may demonstrate narrowing of the intervertebral foramina.
CT is the imaging study of choice in the diagnosis of spinal stenosis. It provides excellent visualization of all 3 major regions where spinal stenosis is found, central, lateral recess and at the neural foamen. An axial cut in the pedicular region give a good estimation of the bony stenosis while a cut through the disc will provide information on the soft tissue component leading to spinal canal narrowing. An A-P diameter at the pedicular level of less than 11-mm is considered as compatible with the diagnosis of spinal stenosis as is a diameter of 10 mm at the disc level (11).
Myelography and especially post myelography CT, provide further information on the presence or

absence of dynamic stenosis. CT myelography is the study of choice in cases of stenosis associated with spinal deformity.
While CT provides excellent delineation of the osseous structures, MRI depicts better soft tissue pathology responsible for the stenotic symptoms. These include demonstration of thickened ligamentum flavum and anterior joint capsules as well as disc herniation. Most importantly MR provides excellent assesment of the degree of thecal sac deformation and neural entrapment. In-patients that are surgical candidates it is recommended that both studices should be obtained.
It must be remembered that abnormalities depicted on CT and MR imaging represent only the pathological changes in the spinal motion segment, but do not necessarily evoke clinical symptoms (12). As a matter of fact there are many asymptomatic individuals with CT or MR evidence of spinal stenosis. Therefore it is of utmost importance to correlate these changes to the patients symptoms. Elderly individuals with documented spinal canal stenosis on CT and MR imaging my suffer from other pathological entities that may produce claudication such as tumors or various vascular problems. A high index of suspicion is therefore important for proper diagnosis.

Treatment: Increased longevity of the population and modern imaging modalities has resulted in ever increasing number of individuals diagnosed with spinal stenosis. Although the results of operative management of spinal stenosis (both short and medium term results) have been published, little is known on the natural history of spinal stenosis. Johnsson et al. (13) reported on 32 untreated patients diagnosed both clinically and radiographically with spinal stenosis. After follow up of 4 years, 15% of the patients improved, 70% were unchanged and only 15% experienced aggravation of the symptoms. The mean canal diameter in the patients that remained mildly symptomatic was 6.8 mm, in these that the symptoms improved it was 8.2 mm and in those that got worse the average canal diameter was only 4.7 mm. More recently Herno et al. (14) reported on 91 non-operated patients with spinal stenosis with a mean follow up period of 8 years. In 41 patients the clinical picture improved in 27 it remained the same and in only 23 did the condition deteriorate. What can be learned from these reports is that in the vast majority of patients with spinal stenosis, the severity of symptoms remains the same or even improves. The reasoning for surgical intervention in individuals with spinal stenosis is therefore to improve their quality of life rather than to prevent an ongoing worsening or neurologic catastrophe. Therefore observation seems to be an alternative to surgery in some patients with spinal stenosis.
Non operative treatment includes the use of NSAID's (with caution), epidural steroid injections and physical therapy. An early report by Porter and Miller (15) claimed that administration of calcitonin might alleviate the symptoms of spinal stenosis. In my experience the use of calcitonin either by injections or nasal inhalation did not prove to be efficacious.
Failure to respond to non-operative treatment for at least a couple of month with significant reduction in the quality of life is considered as a proper indication for operative intervention. The planned surgical procedure must take into account the extent and number of levels involved by the constrictive process and the presence of associated instability and deformity as well as the general health status of the patient. Surgery is performed in view of relieving leg pain rather than back pain. Proper decompression should be expected to relieve radicular type pain or leg pain of a claudicating nature. Decompressive surgery is performed with the aim of enlarging the constricted spinal canal and nerve root tunnels. It is usually achieved by performing a wide laminectomy and facetectomy. This "wide excision" approach usually dictates the concominant performance of a stabilization procedure with insertion of pedicle screws and bilateral lateral arthrodesis. This can be supplemented in selected cases with interbody fusion (PLIF) using threaded titanium cages. Arthrodesis is mandatory in most cases of spinal stenosis accompained by degenerative spondylolisthesis. In 1991 Herkowitz and Kurz (16) published a controlled prospective study of patients with degenerative spondylolisthesis randomized to either decompression or decompression with bilateral lateral fusion. The clinical outcome was signifi-

cantly better in-patients who underwent a concomitant arthrodesis. Bridwell et al. (17) studied patients with degenerative spondylolisthesis who underwent fusion with or without pedicle screw fixation. They found that arthrodesis was significantly more successful with pedicular instrumentation. Arthrodesis with instrumentation should strongly be considered also in cases with significant degenerative scoliosis. Since arthrodesis inreases the morbidity of the surgical procedure there is a trend in recent years for a more conservative decompressive approach. Thus hemilaminectomy and partial facetectomy, multilevel interlaminar decompression with preservation of the midline structures such as the spinous process and interspinous ligament have obviated the need for concomitant arthrodesis surgery (18). Grob et al. (19) reported that patients who underwent decompression without fusion fared as well as those who underwent additional arthrodesis.

Short term, good to excellent results of decompressive surgery with or without arthrodesis are in the vicinity of 70-85%. The best operative results were reported in patients with a canal diameter of less than 6 mm, with symptoms less than 4 years and in patients that did not have co-morbid conditions that affect walking (20). Long term good to excellent results drop by 15-20%, mainly due to ongoing degenerative disc disease (21). Postacchini and Cinotti (22) reported that about 10% of patients that underwent laminectomy showed post-operative evidence of laminar re-growth, especially in those patients that had degenerative spondylolisthesis. Arthrodesis seemed to inhibit laminar re-growth. Katz (21) reported that 17% of patients underwent reoperation after 3-7 years of follow up, this ratio increased to 23% after 7-10 years (23). Airaksinen et al. (24) reported a good result in only 63% of the operated patients after more than 4 years of follow up. Patients with a total myelographic block before surgery fared better. Bad prognostic factors were diabetes mellitus, pathology of the hip joint, and previous osteoporotic spine fracture (24). Similar results were reported by Turner et al (25). In-patients older than 80 years, surgery should be prescribed with utmost caution. Dyeo (26) and Ciol (27) found that post-operative mortality increased from 0.8% to 2.3% in-patients older than 80 years. Complications were doubled in the older age group. Herno et al. (28) as well as Stewart and Sachs (29) reported that repeat surgery for lumbar spinal stenosis my be also successful in many patients.

In summary the operative management of degenerative spinal stenosis has been show to successfully improve life quality at least in short and mid term studies and should be considered in appropriate well-selected candidates.

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WHO SHOULD BE FUSED IN THE DEGENERATIVE LUMBAR SPINE?

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A) Fusion-Degenerative Lumbar Spine
Etiology-W. II. Kirkaldy-Willis-Three Joints-Complex
- Intervertebral Disc
- Two Facet Joints-Disc
Degeneration Begins the Cascade
- May Lead to Nerve Root Compression
- May Lead to Instability

B) Fusion-Degenerative Lumbar Spine
Two Primary Indications for Lumbar Surgery
- Nerve Root Compression
- Spinal Instability

C) Fusion-Degenerative Lumbar Spine
Two Primary Surgical Treatments for the Lumbar spine
- Decompress Nerve Roots
- Stabilise the unstable spine

D) Fusion-Degenerative Lumbar Spine
What is Lumbar Instability? - Difficult to define
- No accepted fixed criteria
- Different meanings for different surgeons

E) Fusion-Degenerative Lumbar Spine
Radiographic Criteria For Lumbar Instability
- 3 mm slip on Flexion-extension films
- 11 degrees of angular displacement
- 25% lateral translation-Progressive deformity

F) Fusion-Degenerative Lumbar Spine
Lumbar Instability
-Actual
Must obtain dynamic studies
-Potential
Must be aware of the possibility

G) Fusion-Degenarive Lumbar Spine
Surgical Treatment of The Unstable Spine
Is Spinal Fusion

H) Fusion-Degenerative Lumbar Spine
The Big Question Is ????
To Instrument or Not to Instrument

I) Fusion-Degenerative Lumbar Spine
Advantages of Lumbar Instrumentation
-Provides immediate stability
-Corrects Deformity
-Improves fusion rate

J) Fusion-Degenerative Lumbar Spine
Historical Perspective of Lumbar Instrumentation
-Lange (1902) Rods/wires fixed to spinous processes
-King (1944) and Boucher (1959) Facet Screws
-Harrington Instrumentation (1960s) hooks/rod
-Luque Instrumentation (1970s) sublaminar wires/rods
-Roy-Camille (1970) Pedicle screws and plates
-Steffee (1986) Pedicle screws and specializsed plates

K) Fusion-Degenerative Lumbar Spine
Advantages of Pedicle Fixation
-Provides control of all three vertebral columns
-Allows complete neural decompress via lamina and facet removal
-Fixation does not depend on distractive forces which minimizes the risk of flatback

L) Fusion-Degenerative Lumbar Spine
Advantages of a Rod vs Plate Screw System
-Applicable to coronal and sagittal plane deformities
-Increased area for bone graft material

M) Fusion-Degenerative Lumbar Spine
Development of the Synergy Pedicle screw-rod system
-Began in 1984 as the PWB System
-Synergy is the fifth generation implant
-Top loading
-Unique rod clamping mechanism

N) Fusion-Degenerative Lumbar Spine
Indications for pedicle fixation
-Instability
-Multi-level fusions
-Correction of deformity
-Stabilization of interbody fusion
-Pseudoarthosis repair

O) Fusion-Degenerative Lumbar Spine
Conclusions
-Lumbar fusion should be done whenever actual or potential lumbar instability is present
-Lumbar instrumentation provides immediate stability, corrects deformity and increases fusion rate
-The current state of the art for lumbar instrumentation is pedicle fixation
-The Synergy Pedicle Fixation System is biomechanically sound, low profile and easy to implant

SURGICAL TREATMENT OF LUMBAR DEGENERATIVE DISEASES

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Degenerative lumbar disease forms a wide spectrum from simple disc herniations to severe deformities with significant derangement of spinal balance. They cause symptoms by producing neurologic compromise and/or derangement of the mechanical function of maintaining stability and spinal balance. So in treating these problems the neurology and the biomechanics-should be taken into consideration. The purpose of this lecture is to share the knowledge and the experience accumulated through thirty years of treating degenerative lumbar diseases.

1. Herniated intervertebral discs: They are the most common forms of degenerative lumbar spine disease. Though most of the patients do well with a conservative treatment, surgical treatment is indicated when severe pain and/or neurologic compromise causes difficulty in performing the activities of daily living. When it is not accompanied by significant instability or spinal stenosis, simple discectomy, be it open or percutaneous, offer a satisfactory result.

2. Spinal stenosis: This is a more advanced form of degenerative lumbar disease caused by combined loss of disc height and hypertophy of the facet joints. To ameliorate the neurologic compromise, a wide decompression of the neural element is mandatory. Addition of a stabilization procedure, preferably a posterolateral fusion with segmental pedicle screw instrumentation improves the functional results in most of the patients allowing early mobilization.

3. Degenerative deformities: They arise from combined incompetence of the anterior and the posterior stabilizers and comprise spondylolisthesis, de novo scoliosis and kyphosis. As they are the most advanced forms of lumbar degenerative disease, they are invariably accompanied by instability and stenosis. Treatment consists of neural decompression, stabilization/fusion with a deformity correction procedure to improve spinal biomechanics. However, as these diseases afflict more elderly population with multiple comorbidities, a strictly individualized treatment, carefully weighing the risks and benefits of each procedure, is necessary.

LUMBAR SPINE FUSIONS: WHO SHOULD HAVE POSTERIOR?

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The posterior surgical approach to the spine is indicated whenever intra spinal pathology must be addressed. This includes neural element tumours and nerve compression from herniated discs or spinal stenosis. Spinal arthrodesis can be accomplished through several options. If short segment lumbar fusions are indicated for discogenic pain, anterior retroperitoneal exposure and interbody fusion is minimally disruptive of normal anatomy.

The transforaminal lumbar interbody fusion (TLIF) method in addition to pedicle screw fixation provides the following advantages: 1. Restoration of interbody height and indirect decompression of the neural foramina, 2. Excision of the disc as a source of pain, 3. Interbody fusion under compression for maximum immobilization of the vertebral motion segment, 4. Minimal neural element retraction, 5. Avoidance of the necesittiy for transverse process exposure, 6. Maintenance or restoration of lumbar lordosis, 7. Preservation of the posterior longitudinal ligament to protect the neural elements from posterior displacement of the interbody bone graft, 8. Avoidance of the necessity for anterior abdominal exposure. Segmental fixation in compression with pedicle screw-rod constructs is required for TLIF.

With TLIF, anterior and posterior surgical exposure is seldom required for circumferential fusion of the lumbar spine.

ANTERIOR SPINAL FUSION FOR MECHANICAL LOW BACK PROBLEMS

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In low back problems due to mechanical course, anterior interbody fusion has been proven to be highly effective, with good long-tern results, provided that patients with the appropriate indications are selected for the procedure.

There are 4 main groups of patients who will benefit from anterior interbody fusion:
a) Prolapse of intervertebral disc
b) Non-prolapsing disc disease
c) Spondylolisthesis
d) Segmental spinal instability

Prolapse of intervertebral disc:
Anterior discectomy and interbody fusion is indicated when there is marked narrowing of the intervertebral disc space (indicating significant degenerative changes), in patients with back pain with or without sciatica and who are manual workers who wish to go back to that type of work.

Non-prolapsing disc disease
i) Internal disc disruption.
The are several subtypes.
ii) Degenerative disc disease with micro tears in the annulus fibrosus causing "discogenic pain"
iii) Isolated disc resorption

Internal disc disruption has been referred to the literature by Dandy (1941) as concealed rupture of the intervertebral disc; by Morgan and King (1957) as primary instability; and by Crock (1970) as internal disc disruption. It is believed by Crock tobe characterized by alteration in the internal structure, as well as the metabolic functions of the disc. Symptoms could arise from irritation of adjacent structures due to leaking products of disc metabolites, which may also enter into the general circulation causing constitutional upsets. Diagnosis is by production of concordant pain during discography, and the discogram will also show radiopaque dye spreading beyond the normal confines of the nucleus zone.

Discogenic pain refers to the condition of degenerative disc disease with micro tears in the annulus fibrous. The tears can be best demonstrated by CT-discography.

Isolated disc resorption has been referred to by Williams (1932) and Kirklkaldy Willis and Hill (1979). Patients present with intermittent back pain and bilateral leg pain, but is unusual to have limited straight leg raising or absent lower limb reflexes. The radiologic findings include gross descrease in disc height, sclerosis of the adjacent end-plates, subluxation of the posterior facet joints, and intrusion into the intervertebral foramen by the superior articular processes.

In internal disc disruption and discogenic pain, removal of the disc together with anterior interbody fusion is the most logical treatment, as the disc itself is the cause of the pain. Posterior spinal fusion will not deal with the problem, as it will not have removed the source of pain, and the stability afforded by the posterior fusion will not eliminate the micro-movement still possible in the intervertebral disc. In isolated disc resorption, intedbody fusion will open up the disc space, and the lateral

bral disc. In isolated disc resorption, intedbody fusion will open up the disc space, and the lateral nerve root canal, and is therefore and effective method of treatment, although posterior procedures will also be effective.

Spondylolisthesis:
In grade 1 or grade 2 isthmic spondylolisthesis, where the symptoms are predominantly back pain, with no true nerve root compression, anterior interbody fusion can be used as a primary procedure. Reduction of one grade of the olisthesis is often achieved.

Spinal instability:
This subject is controversial, and no attempt will be made to discuss about the diagnosis of spinal instability. However, when low back pain is associated with definite radiological signs of spinal instability, anterior interbody fusion is indicated.

These radiological signs include:
a) traction osteophytes at one level.
b) to and fro translational movements with flexion and extension lateral views
c) abnormal reversal of lordosis of motion segments.

Results in Deranged Lumbar Intervertebral Discs

The biggest experience for anterior interbody fusion in the Department of Orthopaedic Surgery, the University of Hong Kong, has been for deranged lumbar intervertebral disc. In a review of 97 cases (1980), with an average follow up of 4-years (range 2 to 15 years), complete relief of back pain was obtained in 60% and of sciatica in 85% of patients marked improvement of back pain in 29% and of sciatica in 10%. The fusion rate for one-level lesions was 85%, but for 2-levels lesions it dropped to 48%. 75 patients returned to full occupation, 19 did housework or were retired, and only 3 were not working.

In a review of 20 adolescent patients (1982) after an average of 4 $^{1}/_{2}$ years follow up (range 1 to 12 years) 95% of patients showed excellent or good clinical results. The fusion rate was 90%.

The long-term results of this procedure was reviewed in a series of 40 patients (1983) who presented at least 10 years (average 12.7 years, the longest 21 years) following surgery. The proportion of patients who had complete relief or only isolated transient symptoms at the 5-review (67,5%) showed only a very slight fall over the years, at final follow up, (65.0%). The union rate was shown to improve with time.

In a further series of 126 patients (1984) treated more recently and followed up for an average of 7-6 years (range 2 to 20 years), the definite non-union rate for one-level fusion was 4.7%, and for 2-levels 11.3%. There were patients whose x-rays were described as "functional union" because they had a radiolucent line at one of the bony interfaces, but no movement on flexion and extension films, and clinically good or excellent results. These patients have been found to attain a solid radiological union gradually with time.

In order to study the effect of anterior lumbar interbody fusion on the juxta-fused segments, segmental deformations of the lumbar spine, from maximum extension to maximum flexion, in 30 asymptomatic volunteers and 52 pain-free patients who had single-level L4-5 or double-level L5-S1 fusion were measured on radiographs and compared (1995). The results showed a decrease in total flexibility of

juvta-fused segments, the segmental deformations were also decreased after either a single or double-level fusion. Thus the juxta-fused segments, were not deformed beyond their physiological limits, and accelerated degeneration in these segments is unlikely to be due to hypermobility.

Results for spondylolysis and isthmic spondylolisthesis

In a review of 20 adult patients (1989) with an average follow up of 10.5 years (2 to 20 years), 19 patients had excellent or good results. 16 patients were fully employed before the operation, and 15 returned to work afterwards, 12 being heavy manual workers, 3 patients changed to a lighter job. The time of return to work after operation averaged 6.7 months. At final follow up, 16 patients had a solid union. The other 4 patients still had a radiolucent line on one side of the graft. 3 of the patients had no movement at the affected level on flexion-extension radiographs, and were asymptomatic. One patient continued to have pain, and flexion-extension radiographs showed some movement at the affected level.

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ANTERIOR COLUMN SURGERY FOR LUMBAR DEGENERATIVE DISORDERS

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Degenerative conditions of the lumbar spine can be divided into degenerative disc disease; degenerative spondylolisthesis, and degenerative scoliosis with or without spinal stenosis. The indications for anterior column surgery for isthmic spondylolisthesis, iatrogenic instability, and pseudarthrosis will be covered in different chapters. We will include discussion of anterior column surgery performed either through the anterior or posterior approach or both.

The treatment of degenerative, painful segments has traditionally centered on arthrodesis. The rationale for arthrodesis is that cessation of motion at a pain-causing segment will relieve symptoms. Focus has been placed on the anterior column for multiple reasons. Pain generators, namely the discs, are located here. Maintenance or restoration of normal sagittal alignment is important for prevention of junctional syndromes that can develop in motion segments adjacent to fused segments. Also, anteriorly there is more surface area and better vascularity for fusion. Additionally, anterior surgery, when and if it can be performed without posterior surgery, can avoid the disadvantages of disrupting paraspinal musculature.

DEGENERATIVE DISC DISEASE

Indications

The ultimate goal of anterior surgery has traditionally been axial back pain relief through arthrodesis and restoration of sagittal alignment. The first question is whether arthrodesis of the lumbar spine is efficacious in treating degenerative diseases, i.e. effective in relieving back pain, achieving stability, and preventing progression. Although arthrodesis is a nonphysiologic procedure, several studies indicate that fusion is effective given the proper patient selection.

The patient selection process is uncertain at best. Many attempts have been made to define indications for fusion. Several studies have tried to preoperatively determine whether decrease in spinal motion will decrease pain. One study of chronic low back pain patients (greater than 6-month duration) attempted to select patients based on their pain relief upon placement in a pantaloon cast. Patients who , failed conservative therapies were placed in pantaloon casts for a 2- to 4-week trial period. Of the 31 patients who experienced significant pain relief, 23 were treated with posterior fusion. Only 74% of these patients had significant pain relief at an average follow-up of 14 months. Another study used external transpedicular fixation as a preoperative screening for fusion. Twenty-nine patients were subjected to anterior lumbar interbody fusion (ALIF) with the external frame as a stabilizing device for 4 months. Prospective follow-up of these patients at 1 and 2 years revealed results of lumbar fusion corresponding to the preoperative fixation test. This underscores the significance of anterior column fusion.

Attempting to localize the pain generator preoperatively has also been a source of study. Discograms have been used to attempt to assess structural integrity and pain response to injection of the disc. The discogram has been controversial in its benefit in preoperative assessment. The mechanism of pain provocation in discography is thought to possibly be due to increasing disc pressure or biochemical stimulation. The increasing disc pressure may irritate the mechanoreceptors in the annulus. In addition, the pain may be mediated via biochemical and neurochemical stimulation such as substance P in the dorsal root ganglia. Weinstein et al. demonstrated ; changes in substance P concentration in dorsal root ganglia with discography. Walsh et a demonstrated that positive discograms demonstrate morphologic radiographic abnormalities and elicit patient symptoms.

The importance of noting the source of pain preoperatively is highlighted by the variable success rate of fusion surgery for back pain. Surgery for discographic concordant pain is controversial, although patients with a single-level dark disc on T2-weighted MR images and discographic concordant pain appear to benefit. Clinical success rates of 75% were reported in a group of patients with positive discograms and positive MRI scans after anterier interbody fusion while a success rate of only 35% was noted by others. A study of five patients with confirmed posterior fusion showed, by discography, that the disc within the fused segment was the source of symptoms. Pain was relieved in all patients by anterior interbody fusion.

In a debate over which surgical treatment is most effective for lumbar discogenic pain, O'Brien states that the pain generator is anterior and that the treatment should be anterior discectomy and interbody fusion combined with posterior fusion and fixation (for which he uses transarticular facet screws).

Facet joint blocks have also been used as a diagnostic tool. Using the hypothesis that immobilization of a painful facet joint by fusion will abolish pain, some surgeons have used relief of pain upon injections of local anesthetic in the facet joint as a predictor of fusion success. Esses and Moro retrospectively analyzed patients with diagnostic facet blocks and correlated this with operative and nonoperative treatment. No significant association was found between facet blocks and outcome of lumbar arthrodesis.

Treatment Options

For suspected discogenic axial back pain, we treat patients conservatively for at least 6 months. In the absence of response and with continued severe and disabling low back pain, we follow an algorithm as outlined in. The algorithm, of course is not absolute and exceptions are made based on the individual patient, physiologic age, psychological profile, and possible secondary gain. In the previously unoperated spine, we use multilevel disc disease as a relative contraindication for fusion.

If the surgical treatment is considered, possible options discussed are: (1) posterior arthrodesis with or without instrumentation, (2) posterior lumbar interbody fusion (PLIF) with instrumentation, (3) discectomy with anterior-only instrumentation and fusion or (4) anterior discectomy and fusion followed by posterior instrumentation and fusion. The choice of posterior arthrodesis alone is an option and is widely discussed in the literature, although we do not believe that it addresses the site of pathology in all cases. Although posterior arthrodesis with instrumentation can result in foraminal height restoration, intrapedicular distraction without anterior support can place increased strain on the instrumentation and disc collapse may occur

Anterior-only Approaches

Of these choices, the anterior-only approaches avoid disruption of the posterior musculature and address the presumed site of pain directly. Early reports of anterior lumbar interbody fusion were discouraging. Flynn and Hoque reported long-term follow-up on 50 patients. A nonunion rate of 44% and unsatisfactory clinical results of 48% were obtained with the autogenous iliac graft healing on average at 2.5 years and autogenous fibular graft healing at 5.2 years. Gill and Blumenthal, however, have shown 75%.clinical success rate and 80% fusion rate for patients undergoing ALIF at L5-S 1 with autogenous graft. Due to the fear of settling and collapse of grafts alone, we prefer placement of an interbody prosthesis during anterior fusion, especially when performing a multilevel procedure or when fusing other than L5-S 1.

For anterior exposure, standard open laparotomy approaches have been transperitoneal or retroperitoneal. Laparoscopic approaches have been predominantly transperitoneal, requiring an experienced general surgeon for exposure, and usually allow only L5-S1 and inconsistently L4-5 exposure. An alternative technique is a gasless laparoscopic approach, which was developed by Drs. McColl, Chin, and Moll' based on their rising concern about the effects of CO2 on the patient undergoing laparoscopic surgery. The gasless exposure of the spine is a new technique but does not entail a new operation, and therefore can be more easily performed by the orthopedic surgeon. This approach will be discussed further in the chapter on Frontiers of Anterior Column Reconstruction. We believe that an interbody spacer is mandatory in anterior-only fusion Anterior instrumentation in the form of plates or rods is possible only down to L4. Anterior instrumentation below L4 is problematic due to implant prominence near the bifurcation of the aorta and vena cava. Since degenerative lumbar disorders usually involve these caudal segments, plate or rod constructs are usually not practical. Other options include the threaded cages such as BAK (Spine-Tech) or Ray (Surgical Dynamics), the titanium interbody spacers (Synthes), or the carbon fiber cages (AcroMed). Good restoration of disc height and sagittal balance can be obtained with the anterior-only approach.

During open laparotomy or laparoscopic procedures, the use of sequentially wider spreaders can help to gradually distract the disc space. Since vertebral end plate fractures and settling of the prosthesis can occur with such manipulation anteriorly, consideration should be given to posterior instrumentation. It has been observed that patients who exhibit subchondral sclerosis adjacent to the vertebral end plates tend to resist implant subsidence compared to patients who do not have this radiographic finding.

ANTERIOR PROCEDURES PERFORMED FOSTERİORLY OR THROUGH COMBİNED ANTERİOR/POSTARIOR APPROACHES

In younger patients with more than one-level disc disease, in the presence of significant sagittal imbalance, in the presence of symptomatic disc herniation or facet hypertrophy, or in patients with high risk of pseudarthrosis, we prefer the posterior interbody approach or combined anterior and posterior surgery. Some believe that sufficient nerve decompression can be obtained by the ALIF procedure without instrumentation, and normalization of myelographic pattern has been observed. Without instrumentation, significant graft collapse has been noted and long-term studies with anterior instrumentation alone are not available to prove maintenance of improved sagittal balance. With the presence of significant nerve root impingement, therefore, we prefer the posterior approach. The advantage of the posterior interbody approach is that anterior column support and restoration of height can be obtained without a formal anterior procedure. The available techniques are: (1) the standard PLIF procedure with or without implants anteriorly, (2) wide laminectomy and placement of threaded cages alone, and (3) transforaminal technique (TLIF) , advocated by Harms, in which the disc is removed through a complete unilateral facetectomy and two titanium mesh cages are introduced if implants are used

Fusion rates of 96% and clinical success rates of 86% are reported with the PLIF procedure supplemented with posterior pedicle fixation. Steffee advocates the use of two Brantigan-type carbon fiber ramps with the use of spreaders (PLIG instruments) in the disc space to restore height. These ramps are designed with a posterior taper to restore lordosis. Disc space distraction, with the use of instrumentation as a working tool allows for multilevel deformity correction in the coronal, axial, and sagittal planes.

The standard posterior interbody fusion (PLIF) is relatively contraindicated in patients with previous surgery due to epidural adhesions. In patients with previous surgery, there is increased incidence of nerve root injury due to amount of mobilization and traction that is needed to insert the prostheses in a scarred spinal canal. In these cases the transforaminal lumbar interbody fusion (TLIF) can be performed since a far-lateral, foraminal exposure of the disc is possible without excessive retraction of the dura; however, disc space distraction may put the scarred nerves at increased risk. We supplement the PLIF with posterior stable fixation and have not used the threaded cages alone through the posterior approach without fixation.

Combined anterior and posterior approaches can also be used for multilevel disease and sagittal imbalance. Linson and Williams report an overall success rate of 80% with the use of the combined procedure. Use of allograft for anterior fusion followed by posterior stabilization has been shown to have a 97% fusion rate and 77% good clinical outcome. The authors, however, are quick to point out that this procedure should be reserved for patients who are considered to be at high risk for achieving fusion. Multiple-level fusion for degenerative disc disease is rarely, if ever indicated. Two cases are shown which illustrate the restoration of normal sagittal alignment and the obvious interbody fusion that is obtainable with anterior and posterior surgery.. A graft-retaining plate is used to prevent slippage of allograft. Most recently we have been using the gasless retroperitoneal approach for insertion of allograft.

DEGENERATIVE SPONDYLOLISTHESIS

Patients with degenerative spondylolisthesis experience better outcomes with fusion surgery. This may be due to presence of significant instability being a reliable radiographic marker for selecting the correct lesion to be treated. Degenerative spondylolisthesis most commonly occurs at the L4-5 level. Since the neural arch is intact, it limits the amount of olisthesis, which usually remains less than 30% of the sagittal width of the vertebral body. The pathogenesis of this process is degenerative disc disease, with facet joint hypertrophy and ligamentons laxity resulting in segmental instability. Spinal stenosis can result from a combination of decreased disc height, spondylolisthesis, and posterior element hypertrophy. From the prospective, randomized studies performed by Herkowitz et a, it has been shown that fusion can improve the results of decompression. In patients with concomitant arthrodesis, 96% excellent or good results were seen, compared with 44% in the unfused group. In this study, no instrumentation was used, and 28% of the fused patients had increased slip after surgery. Johnsson , in a study of patients decompressed for spinal stenosis, showed a direct correlation between postoperative olisthesis and unsatisfactory outcomes. Bridwell also showed that a higher proportion of patients without radiographic progression of their slip reported improvement with surgery. He also showed that noninstrumented patients had significantly increased progression of spondylolisthesis compared with instrumented patients. The resultant sagittal contour has been thought to be important in decreasing the incidence of accelerated degeneration at adjacent levels. Progression of degenerative spondylolisthesis often results in the development of lumbar kyphosis or compensatory lumbar hyperlordosis. To restore and maintain normal sagittal contour, instiumentation in the form of pedicle screws has been used. Correction of sagittal alignment by posterior pedicle screw fixation and manipulation is limited, however, without the addition of anterior column support.

Moon et al reported on anterior fusion alone for both isthmic and degenerative spondylolisthesis. They showed significantly better results with anterior fusion for degenerative spondylolisthesis, attributing this to the increased instability with isthmic-type spondylolisthesis. They showed a solid fusion rate of 94% and concluded that ALIF in the case of degenerative spondylolisthesis is a useful procedure while, for isthmic type, it is not advisable as a routine procedure.

In the presence of spondylolisthesis with symptomatic stenosis, most authors have favored posterior fusion to directly decompress the neural elements. However, greater than 2-year follow-up of 34 patients with degenerative spondylolisthesis treated with anterior interbody fusion has shown correction of the malalignment of the lumbar spine, reduction of the slip, restoration of disc height, and resolution of nerve compression by enlargement of the stenosed canal. Due to the resolution of intersegmental instability, anterior interbody fusion has consistent and satisfactory clinical results at long-term follow-up. Long-term results (average 12 years) of anterior interbody fusion have shown 76% satisfactory results at 10 years, 60% at 20 years, and 52% at 30 years. These patients generally maintained satisfactory results up to 65 years of age, irrespective of their age at surgery. Satomi et al. have suggested criteria for deciding whether posterior decompression is necessary. They define the early stages of degenerative spondylolisthesis and stenosis as a time when mainly inferior articular process is the main factor of compression (central stenosis). For such patients, they recommend anterior lumbar interbody fusion. In the later stage, when the superior articular process of the lower vertebra causes compression (lateral recess stenosis), they recommend posterior decompression. The relief of stenosis by anterior-only procedure is controversial, yet it has been shown that anterior interbody distraction can relieve foraminal stenosis. A cadaveric study with BAK cages showed that with a posterior disc height increase of 37% at L4-5 and 45% at LS-S 1, the neuroforaminal areas increased by 29% and 33.8%, respectively.

Treatment Options

Standard posterior fusion with instrumentation is usually successful in treatment of low-grade degenerative spondylolisthesis with adequate preoperative disc height maintenance. However, for patients with symptomatic spondylolisthesis unresponsive to conservative management, physiologic age less than 65, and foraminal narrowing due to collapsed disc space, we prefer the posterior interbody approach. With the PLIF instruments as described above, it is possible to directly visualize and decompress the nerves and restore foraminal height with gradual reduction of the spondylolisthesis . We have used implants in the form of carbon fiber ramps or titanium mesh cages, although bone grafting alone is also possible.
Relative contraindications to performing the PLIF rather than simply fusing (in situ or with instrumentation) are physiologic age greater than 65, concomitant multilevel disc disease and collapse, and previous surgery limiting mobilization of the dura.
Without posterior transpedicular instrumentation, we would not recommend wide laminectomy with posterior placement of interbody-threaded cages. In selected cases, however the threaded cages alone may be used through an anterior approach, yet we would advocate use of a rigid lumbosacral orthosis in these patients and usually limit the fusion to one level .

DEGENERATIVE SCOLIOSIS WITH OR WITHOUT SPINAL STENOSIS

Degenerative scoliosis can be divided into de novo degenerative scoliosis and untreated idiopathic scoliosis with secondary degenerative changes. Patients may complain of mechanical pain secondary to instability or accelerated disc degeneration. These patients are also more prone to acquiring spinal stenosis. The volume of the spinal canal decreases with age while the deformity increases with age. The asymmetric joint loading results in accelerated disc degeneration, lateral or rotatory listhesis, and osteophyte formation or hypertrophy leading to stenosis. The resultant stenosis can cause neurogenic claudication. Pedicle approximation, pedicular kinking, facet hypertrophy, and facet subluxation can result in lateral recess and foraminal stenosis. This usually occurs in the concavity of the fractional lumbosacral curve or in the concavity of the major lumbar curve. Osteoporotic compression fractures can also cause exacerbation of the stenosis, and osteopenia was noted in 38 of 48 patients treated by Bridwell. Preoperative evaluation includes standing full-length x-rays for evaluation of sagittal and coronal balance, flexion-extension x-rays for evaluation of instability, and MRI scan. Myelography followed by standing flexion and extension radiographs followed by CT scan may be the imaging study of choice since it allows for weight-bearing evaluation of stenosis and provides axial, sagittal, and coronal views of the spine. Selective nerve root injections and EMG or dermatomal SSEP may be helpful for selection of symptomatic levels of compression. Discography may be helpful for evaluation of the cause of axial back pain and determination of the levels to be included in arthrodesis. The deformity in such patients frequently includes a lateral tilt at L4-5 and a rotatory subluxation at L3-4 . As stated above, usually two curves exist, an upper curve (major lumbar curve) and a lower curve (fractional lumbosacral curve). The deformity at L3-4 and L4-5 may cause significant imbalance in the coronal plane. In the sagittal plane, flattening of sagittal contour is noted with C7 falling well in front of LS-S 1.

The treatment of degenerative scoliosis is initially conservative, with use of nonsteroidal antinflammatory drugs (NSAIDs) and epidural injections. Physical therapy concentrating on increasing extensor tone and flexibility, low-impact endurance muscle strengthening, as well as orthotics to increase lordosis and improve balance may provide some benefit.

The surgical indications are failure of conservative management and significant progression of the deformity. The surgical options are decompression alone decompression with posterior fusion and instrumentation, or decompression with anterior and posterior fusion and instrumentation. Decompression alone has a high risk of development of further problems, including restenosis or instability. Selection crite- ria for this procedure are crucial to success. Patients with large vertebral osteophytes anteriorly with minimal motion on flexion and extension radiographs without rotatory subluxation are good candidates for decompression only. Those with major coronal or sagittal deformities or those with significant rotatory subluxations are at risk for further problems. Decompression with posterior fusion and instrumentation should be considered in these cases. However, unless the patient's overall deformity is mild, the instability is mild, and they have good correction of their deformity on side-bending and hyperextension lateral radiographs, posterior instrumentation and fusion may not be sufficient.

The advantages of anterior column surgery include: (1) enhancement of fusion rate for multilevel posterior fusion and instrumentation, (2) restoration of intrapedicular height, thereby enlarging neural foramina, and (3) restoration of sagittal and coronal balance. Since the majority of lumbar lordosis occurs in the discs themselves, anterior column reconstruction directly addresses both the disc disease and the site of loss of lordosis. These benefits can be obtained either through separate anterior surgery or through the posterior interbody approach. Alternatives for anterior column support are fresh frozen allograft (either femoral ring or tricortical iliac) or cages (either titanium mesh or carbon fiber). Both are usually packed with autogenous bone.

With posterior interbody fusion, there is no need for a separate anterior procedure, and balancing of the spine in sagittal and coronal planes is possible. Due to the risk of neural damage with dural retraction above L3, the transforaminal (TLIF) approach may be used at more cephalad levels .
The decision of fusion levels is important to avoid junctional syndrome above and below the fusion. This decision should be based on the evaluation of symptomatic level of neural impingement and evaluation of the overall balance. If a long fusion is performed, it is necessary to fuse and instrument all levels being decom pressed. The decision needs to be made whether to correct the major lumbar curve or fractional lumbosacral curve alone, or to correct both. If the major curve is to be fused, standard scoliosis principles should be applied. Generally, it is recommended to fuse to the neutral and stable vertebrae. The normal sagittal alignment should be considered.1 Therefore, the fusion should not end at the apex of a sagittal curve (i.e., L3 in the lumbar spine, T7 in the thoracic spine) or adjacent to a rotatory subluxation.
Controversy exists regarding fusion to nonrotated and stable vertebrae at the thoracolumbar junction. The thoracolumbar junction is normally neutral in the sagittal plane. The thoracolumbar junction is a region of stress concentration since it is the transition from kyphosis in thoracic vertebrae, stabilized by ribs, to lumbar vertebrae, which are in lordosis and without ribs. In any fusion procedure, concern remains as to distal disc integrity. Discograms of the distal discs may be helpful in questionable cases. If the LS-S 1 disc space is severely degenerated or subluxed, fusion and instrumentation to the sacrum should be considered.

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REVISION SURGERY IN LUMBAR FUSION

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Indication of a revision after fusion is dependant on the operative delay. In fact revision will be indicated in three different periods:

1. **Short term**
2. **Medium term**
3. **Long term**

Revision will be proposed at **short term** in case of post operative complication recurrent after the fusion. Complications are mostly: Instrumentation impegment-persistant root compression-hematoma with/without cord ischemia. The symptoms are mostly abnormal pain after surgery and deficit. Plain, X rays, CT, myelography are the best investigations post operatively.

In most of the cases surgery has to be proposed on an emergency base. Decompression by removal of persisting compression misplaced screw or hematoma needs to be perform.

Medium term revision in lumbar fusion it will mostly be related to non union. The diagnosis of non union is assessed by recurrence of pain after a first period of improvement. Diagnosis is given by plain X rays, dynamics X rays or CT scan. The failure of the insrumentation is one of the major point leading to the diagnosis of non union. Failure of insrumentation can sometimes be only a screw loosening a bone lysis around the screw or a dismantling. Recurrence surgery will be proposed in front of an important pain that can not be accepted. Insrumentation removal and assessment of non union and new bone grafting with instrumentation is necessary.

Long term revision in lumbar fusion is a major point but not always well understood. After a first period the patient presents with a recurrence of pain. Very often the instrumentation intolerance is diagnosed. Is it important to be aware of the possibility to see a late non union, or a upper adjacent level pathology.
Removal of instrumentation is not always the solution.
Assessment of the upper adjacent disk pathology is important. Two different pathologies.. upper stenosis and upper discopathy. The frequence of the stenosis is 4.2% after five years post op. Instability or discopathy as a frequence of 2.6% at three years post op. Diagnosis is mostly related to myelography and CT.
Treatment is not only the instrumentation removal but more often an extension of the laminectomy sometimes an extension of the fusion.
These late complications enable to understand the importance of spinal inbalance during the first operative session.
A flat back will often lead to such upper vertebral level pathology.

CONCLUSION

Three different period post operatively after an instrumented fusion can lead to a revision surgery. Assessement of a correct diagnosis and a good surgical procedure will enable to obtain good functional and clinical results.

Robinson Anterior Cervical Discectomy and Arthrodesis for Cervical Radiculopathy

LONG-TERM FOLLOW-UP OF ONE HUNDRED AND TWENTYTWO PATIENTS*
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Acute cervical radiculopathy most commonly occurs without preceding trauma, and it is usually associated with herniation of a disc fragment with or without the formation of spurs. In the early stage of cervical spondylosis, the disc becomes dehydrated and eventually collapses; roentgenographically, it appears to be narrowed. At this early stage, the disc may herniate as a soft fragment, and chondro-osseous spurs are not yet evident. At later stages in the course of the disease, spurs form along the posterior and posterolateral margins in response to the altered mechanics of the segment3.

In 1955, Robinson and Smith described an operative procedure in which the surgeon removes the cervical intervertebral disc through an anterior approach, without attempting to remove chondro-osseous spurs; arthrodesis is effected by the insertion of an iliac-crest bone graft. Robinson et al. believed that once a solid fusion has been achieved, the spurs will resorb by the normal process of bone-remodeling8.

Since the early 1970's, anterior discectomy and arthrodesis for cervical disc disease has been the technique preferred by many orthopaedic surgeons and neurosurgeons. There have been few reports on the long-term results of non-operative or operative management of patients who have cervical radiculopathy that have assessed the degree of neurological recovery, the rate of recurrence of radiculopathy at other levels, and the prevalence of pseudarthrosis and its effect on function and on the need for repair. This paucity of reports is probably due to variation in the types of operative procedures performed and in the numbers of different surgeons involved in the management of a given group of patients, as well as to the need for the neurological status of a patient to be determined with a clinical examination and not merely with a questionnaire. We analyzed the longterm results of the Robinson technique of anterior cervical discectomy and arthrodesis without the removal of osteophytic spurs, done for cervical radiculopathy by one surgeon (H. H. B.) at one hospital.

Materials and Methods

One hundred and sixty-two patients who had cervical radiculopathy were managed with a Robinson anterior cervical discectomy and arthrodesis with an autogenous iliac-crest bone graft at one or more levels at the University Hospitals of Cleveland between 1974 and 1987. Radiculopathy was defined as pain in the arm or neurological findings, or both, consistent with nerve-root impingement. We excluded from the study patients who had only pain in the neck or myelopathy, those who had evidence of large chondro-osseous uncovertebral spurs or osteophytic ridges producing compression of the spinal cord, and those who needed a partial vertebrectomy. Of the remaining patients, 122 had been followed for at least two years (mean, six years; range, two to fifteen years).

Of the 122 patients, sixty-three were men and fiftynine were women. The average age was fifty years (range, twenty-five to seventy-eight years). Seventy-six patients had herniation of a disc in association with cervical spondylosis (characterized by roentgenographic evidence of degeneration of the disc with narrowing and the formation of at least one chondro-osseous spur), and forty-six had herniation of a disc without roentgenographic evidence of spondylotic spurs. Fourteen patients believed that the herniation of the disc had been the result of a traumatic episode; it is possible that the trauma may have triggered the symptoms of radiculopathy. Two patients had a pre-existing pseudarthrosis at a level other than those producing the clinical symptoms. Fifteen patients who had evidence of congenital stenosis on lateral roentgenograms and computed tomographic scans had mild cervical myelopathy, characterized by hyperreflexia without any weakness of the lower limbs or problems with walking. Ten patients had already had at least one cervical operation: eight had had an anterior discectomy and arthrodesis, and two had had a laminectomy. Six of these operations were performed at other institutions. Of the 122 patients, fifty-one were white-collar workers, thirty-four were blue-collar workers, thirty were homemakers, and seven were retired; only ten were receiving Workers' Compensation. A review of the anesthesiology and hospital-admission records revealed that fifty-seven of the patients smoked cigarettes.

Symptoms had been present for more than one year before operative intervention in fifty-five patients, for seven to twelve months in twenty-four patients, for one to six months in forty-two patients, and for less than a week in one patient. Preoperatively, 118 of the 122 patients had pain in the neck and arm, one patient had no pain but had neurological deficits consistent with radiculopathy, and three patients had pain in the neck with neurological deficits but no pain in the arm. Fortysix had subjective weakness in the arm, and eighty-nine noted paresthesia or numbness in the forearm, hand, or fingers, or some combination thereof. Fifty-five patients (sixty-seven upper extremities) had detectable weakness in at least one motor root; twelve of these patients had bilateral weakness. The degree of weakness was graded with manual muscle-testing methods, with 5 as the highest possible grade. Forty-one extremities received a grade of 4 (the patient could move the extremity against resistance); nineteen, a grade of 3 (the patient could move the extremity against gravity); four, a grade of 2 (the patient could move the extremity when gravity was eliminated); and one, a grade of 1 (the patient was capable of palpable muscle contraction only). Motor strength was not documented in two of the patients. Thirty-nine patients had weakness in the triceps (sixth or seventh cervical-nerve-root compression); eighteen had weakness in the biceps, deltoid, or external rotators of the shoulder, or some combination thereof (fifth cervical-nerve-root compression); sixteen had weakness of pronation or wrist flexion, or both (seventh cervicalnerve-root compression); six had weakness of wrist extension or supination, or both (sixth cervical-nerveroot compression); and six had weakness of the intrinsic muscles of the hand (eighth cervical-nerve-root compression).

Seventy-seven patients had sensory loss on physical examination: thirty-five, along the sixth cervical dermatome; five, along the seventh cervical dermatome; and twenty, along the sixth and seventh dermatomes. The remaining seventeen patients had involvement of other cervical dermatomes.

Preoperatively, forty patients continued to function at work or at home despite the symptoms; sixty-eight were unable to work, but were able to perform the activities of daily living, such as personal hygiene and driving. Thirteen could not perform the activities of daily living. The preoperative functional status of one patient was not recorded.

Roentgenographic Analysis

Preoperative anteroposterior, lateral, and oblique roentgenograms of the cervical spine were made for all patients. A distance of 1.8 meters (six feet) was maintained between the tube and the patient. Anteroposterior roentgenograms were evaluated for the presence of uncovertebral osteophytes, cervical ribs, or destructive osseous lesions. Lateral roentgenograms were examined to determine the presence of osteophytes, narrowing of the disc space, and evidence of congenital narrowing of the spinal canal (characterized by a sagittal diameter of thirteen millimeters or less)

Because the oblique roentgenograms were not made with a consistent technique, it was difficult to determine the exact degree of foraminal encroachment by the osteophytes. Preoperative lateral roentgenograms with the cervical spine in flexion and extension were not routinely made unless the lateral roentgenograms showed evidence of subluxation. Myelography was performed on all patients to determine the presence of impingement on the nerve-roots or compression of the spinal cord. After 1980, computerized tomographic scans were made for thirty-eight patients. Between 1984 and 1987, magnetic resonance imaging was performed for ten patients. Postoperatively, anteroposterior and lateral roentgenograms were made with the cervical spine in flexion and extension to determine the presence of osseous union; union was considered to have occurred when the lateral roentgenograms showed the interspinous distance between the fused vertebrae to be one millimeter or less.

Preoperative lateral roentgenograms showed narrowing of the disc space in twenty-nine patients, narrowing of the disc space with posterior osteophytes in seventy-six degenerative changes and anterior subluxation of one vertebra on another in seven, and congenital spinal stenosis in thirty-one; the lateral roentgenograms of eight patients revealed normal findings. Anteroposterior roentgenograms revealed the presence of osteophytes in the uncovertebral joint in sixteen patients and disc-space narrowing in fortyfive; the anteroposterior roentgenograms of the remaining patients revealed normal findings.

The myelograms were interpreted by a neuroradiologist as showing nerve-root cut-off in forty patients, a central defect in twenty-four, and a transverse anterior bar defect in fifty-seven patients. The myelogram showed a complete block in two patients, and flattening and widening of the spinal cord in two others. The myelogram of one patient, who had dynamic subluxation, revealed normal findings.

Computerized tomographic scans, made after myelography for thirty-eight patients, showed that six patients had lateral herniation of a disc, eleven had central herniation of a disc, twenty had foraminal stenosis from uncovertebral osteophytes, seven had flattening of the spinal cord, one had a dumbbell-shaped cord associated with anterior compression, and one had normal findings. Ossification of the posterior longitudinal ligament was not present in any patient, to our knowledge.

We now routinely use magnetic resonance-imaging studies, but, as mentioned, this technology was available for only ten patients in our review. These ten studies showed lateral herniation of a disc in two patients, central herniation of a disc with flattening of the cord in five, and an indented dumbbell-shaped cord in one patient.

One scan showed a small atrophic spinal cord on the sagittal images, and one scan could not be interpreted due to the presence of artefacts produced by orthodontic braces.

At the time of follow-up, information was obtained regarding the severity and location of pain, the presence of numbness or weakness, the level of function at home or work, and the use of medication for pain. Neurological examination was performed by one of us (H. H. B. or S. E. E.), and anteroposterior and lateral roentgenograms were made with the cervical spine in flexion and extension. One hundred and seventeen patients were evaluated in our office, while five patients, because of the distance involved, had a physical and roentgenographic examination at the office of an orthopaedist or neurologist who practiced in the patient's community.

Postoperative pain was graded according to the criteria of Robinson et a. The pain was classified as mild if there was no restriction of activities and the patient occasionally used anti-inflammatory medication for relief, as moderate if there was a slight limitation of activities and the patient frequently used non-narcotic medication for relief, and as severe if there was regular restriction of activities and the patient used narcotic medication for the relief of pain. The parameters were evaluated both preoperatively and postoperatively.

Indications for Operative Intervention

Before operative intervention, all patients were managed with a cervical orthosis, physical therapy, and various analgesics. These measures were usually used for a minimum of six weeks to determine if a coordinated program could alleviate the symptoms. However, most patients had, in fact, already been managed for an average of nine months with various non-operative measures, such as the use of a cervical collar, antiinflammatory medication, physical therapy, and cervical traction.

The determination that non-operative management had failed was based on the magnitude rather than on the duration of pain. The indications for operative intervention were the failure of non-operative management to relieve pain in the neck and arm; a persistent neurological deficit, indicated by the loss of motor function; and roentgenographic evidence of compression of at least one nerve-root. One patient was operated on one week after the first appearance of symptoms because non-operative measures, which had included one week of hospitalization and the use of intravenous narcotic medication, had not relieved the excruciating pain and severe weakness of the triceps muscle.

The results of the myelography were a critical factor in the decision regarding operative intervention. These results are important because pain patterns and sensory symptoms may not correspond to a specific dermatome, and the motor weakness may be the result of compression at more than one level. We have found this situation to be particularly common in the triceps muscle, which is innervated by the sixth and seventh cervical dermatomes. Furthermore, spondylotic changes may be seen at multiple levels on the plain roentgenograms. Therefore, the clinical presentation may not point clearly to the exact level of the lesion. We have found that myelography and computerized tomographic scanning after myelography with water-soluble contrast medium provide more information about the compression of the nerve root than do magnetic resonance-imaging studies.

Operative Technique

We followed the operative technique described by Robinson and Smith. After a transverse skin incision had been made, the sternocleidomastoid and carotid sheath were retracted laterally and the strap muscles were retracted medially to expose the anterior longitudinal ligament, which was then incised at the predetermined level[1]. We used a fiber-optic headlight for illumination and loupe magnification for better visualization. The interspace was curetted, and three puncture holes or more were made in the end-plates to allow vascular access to the bone graft. We made no attempt to remove posterior or uncovertebral osteophytes or the posterior longitudinal ligament, although we did remove disc fragments that were protruding through the ligament. A tricortical iliac-crest graft that provided a snug fit was used to widen the disc space to a height of at least five millimeters in order to distract the foramen and relieve pressure on the nerve roots. The natural concavity of the end-plates helped to prevent extrusion of the graft either anteriorly or posteriorly.

Postoperatively, the head of the bed was elevated to 30 degrees. A rigid orthosis, extending from the head to the thorax, was used by 115 patients. For various reasons, seven patients could not tolerate the rigid brace and used a soft cervical collar instead. Every patient wore the orthosis twenty-four hours a day for six weeks. The patients did not have a specific physical-therapy or exercise routine postoperatively.

Statistical Methods

The chi-square test was used for statistical evaluation of the association between the presence of a pseudarthrosis and the independent variables of age, sex, number of segments operated on, and smoking. The Mann-Whitney-Wilcoxon test was used to evaluate the association between pain and the independent variables, the patient's Workers' Compensation status, and the presence of a pseudarthrosis .

Results

Of the 122 patients, sixty-two had an anterior cervical discectomy and arthrodesis at one level; forty-eight, at two levels; eleven, at three levels; and one, at four levels, for a total of 195 levels operated on. Thirty-six of the one-level procedures were performed at the fifth and sixth cervical disc space, and nineteen were performed at the sixth and seventh cervical disc space; the remaining seven were distributed among the other levels. Most of the two-level procedures involved either the fourth and fifth and the fifth and sixth cervical vertebrae or the fifth and sixth and the sixth and seventh cervical vertebrae. The second and third cervical vertebrae never had an arthrodesis, and only six patients had an arthrodesis at the seventh cervical and first thoracic levels.

The intraoperative findings showed posterior protrusion of a disc in forty-three disc spaces, extrusion of a disc fragment under the posterior edge of the vertebra in forty-two disc spaces, herniation of disc material through the posterior longitudinal ligament at eight levels, degeneration without herniation of the disc at eightteen levels, and subluxation with degeneration at two levels. The subluxation was not severe enough to produce compression of the cord, but it did produce symptoms of radiculopathy. The operative records did not provide a description of the findings in nine patients.

Postoperatively, 108 of the 122 patients had no impairment of function and were able to return to their normal daily and work activities. Eighty-one patients had no pain in the neck or arm at the time of the latest follow-up, and six had mild residual pain in the arm. Thirty-seven patients had residual pain in the neck; the pain was moderate in eleven of these patients and mild in twenty-six. Twenty-two patients had postoperative pain in the neck despite a solid fusion; the pain was moderate in five patients and mild in seventeen. Fourteen of the twenty-two patients who had pain in the neck had a few minor restrictions in their work or recreational activities. Of the ninety-one patients who had been employed preoperatively, seventy-nine returned to their preoperative employment, one changed occupation, and eleven did not return to work. Of the ten patients who had been receiving Workers' Compensation, three had no pain, six had mild pain, and one had moderate pain at the time of follow-up; eight of the ten returned to work.

The age, sex, history of smoking, number of levels operated on, and Workers' Compensation status of each patient were not significantly associated with postoperative pain ($p > 0.05$). There was a significant association between the presence of a pseudarthrosis and postoperative pain in the neck or arm ($p < 0.01$).

Of the 122 patients, fifty-five (sixty-seven extremities) had neurological deficits preoperatively. All but two of the patients had complete recovery of motor function postoperatively. The two patients who had incomplete recovery of motor function had a pseudarthrosis. One of these two patients had had severe (grade-1) motor weakness preoperatively. Seventy-one of the seventy-seven patients who had had a loss of sensory function preoperatively regained sensation postoperatively. None of the patients had an increase in neurological symptoms.

In eleven patients, symptoms of radiculopathy developed at another level after the initial operation. One patient was involved in a motor-vehicle accident in which the automobile was hit from behind; this accident precipitated recurrent symptoms with a new herniation of a disc at the level caudad to the earlier fusion. Another patient had a slight protrusion at a second level that had been evident on the preoperative studies but had been deliberately left untreated. She did well until two years after the operation, at which time she had an operation at the untreated level for increasing symptoms. Nine patients had additional operative intervention because symptoms developed due either to a new herniation or to degenerative changes at the level adjacent to the one that had been operated on. The average time between operations was five years (range, thirteen months to nine years and six months). Eight of these nine patients had an anterior cervical discectomy and arthrodesis, and one patient had a posterior arthrodesis for degenerative osteoarthrotic subluxation caudad to the three-level anterior arthrodesis that had been performed five years earlier. In one patient, approximately two years after an anterior cervical discectomy and are throdesis at the sixth and seventh cervical levels, herniation of the disc between the fourth and fifth cervical vertebrae developed; this warranted operative intervention. Seven years later, a herniation developed at the third and fourth cervical interspace, and she had a third operation. Sixteen months after the third operation, she was doing well.

Roentgenograms were available for an average period of six years (range, two to fifteen years) for 113 patients; for the remaining nine patients, roentgenograms were available for an average of eighteen months (range, seven to twenty-three months). Of the 195 levels that were operated on and grafted, 171 fused. There were twenty-four pseudarthroses in twenty-four patients. Eight of these patients had no pain in the neck or arm, fifteen had mild or moderate pain in the neck, and one had mild pain in the arm. A pseudarthrosis developed in seven of sixty-two patients who had

had a one-level arthrodesis, in thirteen of forty-eight who had had a two-level procedure, and in three of eleven who had had a three-level procedure. In one patient who had had a four-level arthrodesis, a non-union developed at one of the levels. Only four of the patients who had a pseudarthrosis had sufficient symptoms to warrant the operative repair of the pseudarthrosis. Although multiple-level arthrodesis was highly correlated with the risk of pseudarthrosis ($p < 0.01$) when compared with one-level procedures, none of the patients had a non-union at more than one level. Age and sex did not correlate with an increased risk of pseudarthrosis. Smoking was suggested as a related variable, on the basis of a p value of 0.08. Of the seven patients managed with a soft collar, a pseudarthrosis developed in one. The number of patients who had been managed with the soft collar was too small to allow us to draw any meaningful conclusions regarding postoperative orthoses and pseudarthrosis.

Complications

One patient, who had no history or preoperative evidence of cardiac disease, died in the recovery room secondary to myocardial infarction. At the time of the autopsy he was found to have three-vessel coronary artery disease. The data on this patient were not included in the data that were used to assess the results. No patient had an increase in neurological deficit postoperatively. No graft dislodged in any patient; however, the graft collapsed in one patient who went on to have a solid fusion of the vertebrae. Postoperatively, three patients had hoarseness that resolved spontaneously, and there were no permanent recurrent laryngeal-nerve palsies. Three patients had dysphagia; this resolved by six weeks for two patients and by twelve weeks for one patient. There were two cervical wound hematomas that were drained. No patient had an infection of the neck wound or of the graft site. Two patients had hematomas at the graft site that resorbed, and one patient had a fracture at the graft site that healed with non-operative treatment. Two patients had pain at the donor site of the bone graft, but there were no lateral femoral cutaneousnerve injuries. One patient each had pneumonia, urinary tract infection, and temporomandibular joint irritation from the brace; all patients were managed successfully. In one patient, the tape that was used to secure an endotracheal tube produced a severe skin reaction; the patient was given corticosteroids.

Discussion

There have been several reports in the orthopaedic and neurosurgical literature on the results of anterior discectomy and interbody arthrodesis as treatment for cervical disc disease. Robinson et al. described the cases of fifty-six patients who had arthrodesis with a horseshoe-shaped tricortical iliac-crest graft8. Forty-one (73 per cent) of these patients had complete or nearly complete relief of pain, and a pseudarthrosis developed in seven patients (13 per cent). However, these authors excluded patients who had had radiculopathy or a preoperative diagnosis of chronic pain in the neck. Williams et al., in 1968, reported on sixty patients, forty-five of whom had radicular symptoms. The duration of followup ranged from two to nine years, but twenty-four patients had follow-up by telephone only.

In 1969, Simmons et al. reported on eighty patients in whom an anterior discectomy and interbody arthrodesis was done with the use of either a keystone graft or the Cloward dowel technique, for a variety of diagnoses. Thirty patients had had chronic pain in the neck, fifty-one had had evidence of a neurological deficit, and three had had either myelopathy or a fracture-dislocation. Fifty-five (81 per cent) of sixtyeight patients in whom an interbody arthrodesis was done with the use of a keystone graft

had a good or excellent result, compared with eleven (65 per cent) of seventeen patients in whom an arthrodesis was done with the use of a Cloward dowel-type graft. The authors noted that the two populations were not the same, in that multiple-level operations were performed with the use of the keystone-graft technique.

In a retrospective review, DePalma et al. reported on the results in 229 patients in whom the Robinson anterior cervical discectomy and arthrodesis technique had been used to treat cervical disc disease. One hundred and eighty-eight patients had radicular symptoms, only 149 were examined at follow-up, and roentgenograms were not available for seventy-nine patients. One hundred and forty-four patients (63 per cent) reported good or excellent relief of pain; the results in those who had had radicular symptoms were considered to be worse than those of the other patients in the series. The rate of pseudarthrosis was 7 per cent per level (twenty of 283 levels in patients whose roentgenograms were available for follow-up), but no symptoms were attributed to failure of fusion.

White et al. used the Robinson method of arthrodesis for sixty-five patients, thirty-seven of whom had radicular symptoms. Forty-four patients, including twenty-eight of the thirty-seven who had radiculopathy, had a good or excellent result. Sixteen patients (25 per cent) had a pseudarthrosis, and the authors found that a successful fusion did correlate with a better result. Gore and Sepic, in 1984, reviewed the cases of 146 patients who had had anterior discectomy and arthrodesis; follow-up information was available for 114 patients. Ninety-nine patients had had pain in the arm preoperatively, but there was no mention of any preoperative or postoperative neurological deficit. Bone graft was taken from the tibia, iliac crest, or fibula. Postoperatively, three patients had a pseudarthrosis, and 111 had partial or complete relief of pain. In the neurosurgery literature, Lunsford et al. reviewed the cases of 253 patients who had cervical discectomy for herniation of a disc. Approximately one-half of the patients had an arthrodesis as well. Ten surgeons were involved, and the follow-up data were obtained with the use of a questionnaire. The duration of follow-up ranged from one to seven years, with no reported average. Sixtyseven per cent of the patients were considered to have a good or excellent result, on the basis of subjective relief of pain and of motor and sensory symptoms.

Our review is based on the long-term clinical and roentgenographic follow-up of 122 patients, all of whom had had cervical radiculopathy preoperatively. Patients who had chronic pain in the neck or myelopathy alone were not included. Postoperatively, 108 patients had no impairment of function in their daily activities. One hundred and thirteen patients (93 per cent) had either no pain or mild pain and were considered to have a good or excellent result. This percentage is higher than that in some reports but lower than that in others. Persistence of radicular pain postoperatively was unusual. If patients who had a symptomatic pseudarthrosis are excluded, 82 per cent of the patients had no pain at the time of the latest follow-up. Our data differ from those of DePalma et al. with regard to pseudarthrosis and the final outcome but are in agreement with the data of White et al., which indicate that better results are achieved with a solid fusion. This theory is supported by the statistically significant association of pseudarthrosis and pain outcome ($p < 0.01$) in our study. It should be emphasized that flexion and extension roentgenograms are necessary to determine union, because although the fusion may appear solid on lateral roentgenograms, some lucency can often be detected at the interface.
Fusions that had looked solid three to four months postoperatively were later found to have a pseudarthrosis on the roentgenograms; this situation emphasizes the need for longer follow-up.

The rate of pseudarthrosis in the current study is the same as that reported by Robinson et al. more than thirty years ago. The same operative technique was used; however, our period of immobilization was onehalf that of the earlier study (six weeks rather than three months). While this comparison is certainly not a controlled one, it suggests that longer postoperative immobilization does not seem to affect the rate of pseudarthrosis. Brown et al. retrospectively compared the rate of lumbar fusion in smokers with that in nonsmokers and demonstrated a statistically significant increase in pseudarthrosis in the smokers, with a confidence level in excess of $p = 0.001$. The Po2 level was 78.5 per cent in smokers and between 95 and 97 per cent in non-smokers. These authors suggested a possible relationship between smoking and pseudarthrosis, but the relationship fell short of any statistical significance.

We were surprised at the high percentage of pseudarthrosis in our study, and even though only a few patients needed an additional operative procedure, we believe that the best clinical results are obtained with a solid fusion. Since this review, we have modified the Robinson technique for bone-grafting. Rather than puncture of the end-plates with an angled curet, we now recommend the removal and flattening of the osseous end-plates with a high-speed burr to expose bleeding subchondral bone. Meticulous technique is important to provide an anatomical fit of the tricortical iliac graft. Although this method theoretically increases the risk that the graft will sink into the softer cancellous bone of the vertebral bodies, we have not noted that to be a problem.

An increase in the number of operative levels also correlated with an increase in the rate of pseudarthrosis. This correlation raises a question as to whether, after multiple-level discectomies, vertebrectomies should be performed, followed by the use of one long strut graft. This would provide two rather than multiple surfaces for healing and theoretically could decrease the rate of pseudarthrosis. Although we routinely perform vertebrectomies to treat cervical spinal-cord compression, we have not chosen to utilize this technique for twolevel or three-level discectomy procedures. Instead, as noted, we have modified the Robinson technique by
burring the end-plates to expose bleeding subchondral bone. The long-term results of this modification in multiple-level procedures are not yet known, but early analysis of matched groups of approximately thirty patients each has revealed a higher rate of fusion when the new technique is used.

To our knowledge, no report has documented the degree of postoperative neurological recovery in patients who had operative treatment of cervical radiculopathy. Our data suggest an excellent prognosis for patients who had weakness or sensory findings on physical examination preoperatively. All patients who had had weakness of motor function improved; fifty-three of fifty-five patients (sixty-five of sixty-seven extremities) had recovered full strength and sensory function on neurological testing at the latest follow-up. The two patients who did not have complete recovery had a pseudarthrosis; one had mild residual pain in the neck, and the other had mild residual pain in the arm. These findings suggest that motion and the presence of chondro-osseous spurs at the level of the pseudarthrosis may contribute to residual nerve-root compression. Although the course may vary, it appears that pain is the first symptom to resolve or improve, followed by the return of motor strength and, lastly, by the return of sensory function.

In a small number of patients, symptoms develop at another cervical level. Other authors have noted an increase in degenerative changes at other levels in a considerable proportion of their patients. We do know that approximately 50 per cent of the normal population will have cervical degenerative osteoarthrosis and disc disease by the age of fifty years. The percentage of patients in our study who had an

operation at a second level is similar to that in other studies. One of our patients had obvious new trauma, and a second, we believe, had a small herniation at a second level that had been present initially but was not addressed at the time of the index procedure.

Robinson anterior cervical discectomy and arthrodesis has proved to be a safe and reliable method of management for patients who have cervical radiculopathy. A careful preoperative neurological, roentgenographic, and neuroradiological evaluation permits accurate selection of patients. Relief of radicular pain is predictable, and for patients who have preoperative neurological deficits, the rate of recovery of neurological function is very high.

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ANTERIOR CERVICAL DECOMPRESSION AND ARTHRODESIS FOR THE TREATMENT OF CERVICAL SPONDYLOTIC MYELOPATHY

TWO TO SEVENTEEN-YEAR FOLLOW-UP
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Cervical spondylosis is a result of degenerative changes in the disc and the formation of chondroosseous spurs, which ultimately can lead to compression of the spinal cord and myelopathy. Clarke and Robinson demonstrated the progressive nature of untreated cervical spondylotic myelopathy, and operative intervention is indicated in many such patients to improve or at least to preserve the neurological condition.

The present study is a review of the cases of 108 patients managed at one institution, over a nineteen year period, with anterior decompression and autogenous bone-grafting at one level or more for the treatment of cervical spondylotic myelopathy. Our goal was to report the long-term clinical outcome, with regard to pain, neurological recovery, late deterioration, and complications, and to relate the preoperative variables, such as the age of the patient and the grade of the myelopathy according to the system of Nurick, to the clinical and roentgenographic results.

Materials and Methods

Onu hundred and eight patients with cervical spondylotic myelopathy who had had anterior decompression and arthrodesis at our institution between 1974 and 1993 and had been followed for at least two years were included in the present review. Myelopathy was diagnosed if abnormal reflexes, such as clonus, a positive Babinski sign, or a positive Hoffmann sign, were evident on physical examination or if the patient had a demonstrable disturbance of gait and hyperactive reflexes. Patients who had hyperreflexia but not other signs were not included. Neuroroentgenographic evidence of compression of the cervical spinal cord from herniated disc material or osteophytes, or both, was necessary to confirm the diagnosis. Patients who had segmental ossification of the posterior longitudinal ligament were included, but those who had continuous ossification of the posterior ligament over several vertebral levels were not. Patients who had neck pain alone, radiculopatpy perform vigorous activities at home but were able to perform the activities of daily living, sixteen had an impaired ability to perform the activities of daily living, twenty-four had an impaired ability to walk in the community, two were only able to walk about the house, and nine used a wheelchair. The system of Nurick was used to classify the severity of the disability associated with the myelopathy before the operation and at the long-term follow-up examination. Preoperatively, thirty-eight patients had grade: 1 myelopathy; nineteen, grade -2; twenty-six, grade: 3 seventeen, grade: 4 and eight, grade: 5. The average grade of myelopathy was 2.4.

Roentgenographic Analysis

Preoperative anteroposterior roentgenograms revealed uncovertebal spurring in eighty-seven patients and normal findings in twenty-one. Lateral roentgenograms demonstrated disc-narrowing and posterior osteophytes in 102 patients, disc-narrowing alone in four, and normal findings in two. Twenty-three patients had concomitant anterior subluxation, seven had retrolisthesis, and eight had mild kyphosis

(less than 15 degrees). Preoperative lateral roentgenograms, made from a standard distance of six feet (1.8 meters), were used to measure the sagittal diameter of the fifth cervical body, the normal sagittal diameter of the spinal canal posterior to the fifth cervical body, and the sagittal diameter of the spinal canal at the narrowest point, with osteophytes taken into consideration. The Pavlov ratio was calculated to identify patients who had congenital narrowing of the spinal canal. It was possible to determine these measurements for 105 of the 108 patients.

Myelography was performed in 103 patients, and the findings included a complete or nearly complete block (twenty-five patients), a transverse anterior bar defect (forty), a nerve-root cut-off (twenty-nine), and ventral extradural defects (thirty-nine). Compression at multiple levels of the spinal cord or nerve roots was demonstrated in most patents. Seventy-five patients had computer-assisted tomography after myelography, and the findings, included moderate-to-severe deformation of the spinal cord (seventy patients), mild flattening of the cord (six), and segmental ossification of the posterior longitudinal ligament (thirteen). Compression of the spinal cord was attributed to disc herniation alone in four patients and to a combination of disc herniation and osseous compression in the remaining seventy-one patients. Magnetic resonance imaging was performed on sixty-six patients, and it was the only preoperative neuroroentgenographic study made for five of them. The findings generally paralleled those of the myelographic studies, although an atrophic cord was revealed by one magnetic resonance imaging study and parenchymal signal changes consistent with myelomalacia were demonstrated by another.

The cross-sectional area of the spinal cord at the level of maximum compression was measured preoperatively, with use of computer-assisted measurement of the spinal cord from the roentgenographic study (Bioquant IVa system; R and M Biometrics, Nashville, Tennessee), in the patients who had had a magnetic resonance imaging study or a computed tomography myelogram; the measurement could be obtained in sixty-three patients. The area of the spinal cord at the level of maximum compression was analyzed with respect to the preoperative and postoperative grade of myelopathy according to the scale of Nurick to determine if it had predictive value.

At the time of the latest follow-up, the severity of persistent pain as well as the functional status were assessed. A complete neurological examination was performed by one of us (S.E.E., H.H.B., or M.J.B.), and lateral roentgenograms were made. The criteria for fusion were trabecular bridging of bone as well as absence of motion as seen on roentgenograms made with the spine in flexion and extension.

Indications for Operative Intervention

Many of our patients had pain in the neck or the upper extremity, or both, as well as sensory symptoms or subjective weakness. The main indication for the operation, however, was evidence of myelopathy on physical examination and confirmation of compression of the cervical spinal cord on neuroroentgenographic studies. When myelopathy is diagnosed, we believe that operative decompression is warranted to prevent neurological deterioration and to improve function. Operative intervention for most of our patients was performed on an elective basis. The patients wore a soft cervical collar while awaiting the operation in order to minimize the risk of a minor injury that might aggravate the neurological condition.

Operative Technique

A standard Smith-Robinson approach to the anterior aspect of the cervical spine through a transverse incision was used, even for multilevel verterectomies. The exact procedure performed (a discectomy,

partial corpectomy, or subtotal corpectomy) was dictated by the extent of the abnormality and the number of levels involved. If a disc herniation with minimum osteophytic changes was the cause of the compression, a simple discectomy and Robinson-type grafting with bone from the iliac crest was performed. After 1989, we slightly altered our technique of discectomy and arhrodesis by burring the osseous end plates of the vertebrae to provide better surfaces for healing of the graft. If large osteophytes were present, a partial corpectomy or foraminotomy was performed with use of a high-speed diamond burr. A small posterior lip of bone was fashioned cephalad and caudad to prevent posterior migration of the graft. Small anterior lips were fashioned as well to minimize the risk of the graft slipping anteriorly. A Robinson-type iliac-crest bone graft of an appropriate size was then inserted.

If disc material, osteophytes, or an ossified posterior longitudinal ligament were present posterior to the vertebral body, then subtotal corpectomy was performed to decompress the spinal canal adequately and safely. First, the material was removed from the disc spaces with currettage and then the middle section of the body was excised so that only lateral shells of bone remained. Care was taken not to remove bone too far laterally in oder to avoid injury of the vertebral artery. The trough made in the vertebra was usually sixteen to eighteen millimeters in width, which provided decompression of the spinal canal and enough space for placement of the strut graft. Diamond burrs were used to thin the posterior shell of the vertebral body back to the posterior longitudinal ligament, after which it could be elevated off the ligament with use of tiny curets. If the posterior longitudinal ligament was intact and had not ossified, we did not remove it. The docking sites of the graft into the end vertebrae were sculpted with a burr to expose bleeding subchondral or cancellous bone. Anterior and posterior lips were fashioned to prevent migration of the graft. Skeletal traction was used for placement of the strut graft, and traction was increased when the graft was tapped into place. The strut graft was centered and then slightly countersunk within the docking site of each end vertebra. In a one-level subtotal corpectomy, an iliac-crest strut graft was used; in a two-level procedure, the surgeon chose a strut graft from either the iliac crest or the fibula; and in a three or four-level corpectomy, a fibular graft was used. All grafts were autogenous bone.

Intraoperative monitoring of the spinal cord with cortical evoked potentials was used for most of the corpectomy procedures. No patient had internal fixation. Postoperatively, a soft rubber drain was used and the head of the bed was elevated 20 to 30 degrees. All patients who had had a discectomy and an arthrodesis or a partical corpectomy and an arthrodesis wore a rigid head-cervical-thoracic orthosis posteperatively. Of the patients who had had a subtotal corpectomy, forty-four wore this tpye of orthosis and thirteen wore a halo vest. The choice of a brace or a halo ves was made on the basis of the bone quality, the intraoperative stability of the graft, and the personal preference of the attending surgeon.

Forty-five of the 108 patients had a standard Robinson anterior cervical discectomy and arthrodesis. One level was involved in fourteen patients; two levels, in fifteen; and three levels, in sixteen. Two patients had a partial corpectomy at one level, and four had a partial corpectomy at one level and a discectomy at one or two additional levels. Fifty-five patients had a subtotal corpectomy; it was performed at one level in eleven patients, at two levels in twenty two, at three levels in twenty-one, and at four levels in one, two other patients had a corpectomy at one level and a discectomy at another, and both had insertion of bone graft from the iliac crest. A strut graft from the iliac crest was used in nine-teen patients, who had a subtotal corpectomy, and a fibular strut graft was used in thirty-eight.

Statistical Analysis

The relationship between risk factors and outcomes was determined with use of multiple regression analysis. Specifically, we looked for an association between the preoperative severity of the myelopathy as well as the clinical outcome according to the scale of Nurick and the variables of age, duration of symptoms, sagittal area of the spinal canal at tle level of maximum compression, Pavlov ratio, and preoperative area of the spinal cord. Chi-square analysis was used to evaluate the association between pseudarthrosis and gender, history of smoking, type of operative procedure, number of operative levels, type of graft, and outcome with respect to pain. The Student t test was used to examine the association between age and the presence of a pseudarthrosis. Chi-square analysis was used to examine the relationship.

Results

Two patients died in the perioperative period; one had a myocardial infarction one week postoperatively, and the other had pulmonary failure from pneumonia approximately six weeks postoperatively. The remaining 106 patients were followed for at least two years. The twenty-four patients who had had no gait abnormality preoperatively had no change in gait postoperatively. Of the eighty-two patients who had had a preoperative gait abnormality, thirty-eight (46 per cent) had a normal gait, thirty-three (40 per cent) had an improvement in gait, six (7 per cent) had no chane, four (5 per cent) had an initial improvement and later deterioration, and one (1 per cent) had a worse gait. The nineteen patients who had had no motor weakness preoperatively had none postoperatively. Of the eighty-seven patients who had had a preoperative motor deficit, fifty-four (62 per cent) had complete motor recovery, twenty-six (30 per cent) had partial recovery, six (7 per cent) had no change, and one (1 per cent) had a worse deficit. Weakness from nerve-root compression at another level developed later in two patients. Of the eighty-nine patients who had had a sensory deficit preoperatively, forty-three had complete recovery, thirty-five had improved sensation, ten had no change, and one lost sensation.
A pseudarthrosis developed in sixteen patients. Thirteen of them had had an anterior cervical discectomy and arthrodesis (six had had a two-level and seven had had a three-level procedure). Two patients had non-union after a one-level subtotal vertebrectomy with insertion of a strut graft from the iliac crest. Of the thirty-eight patients who had a fibular strut graft, only one had a non-union; all others had a successful arthrodesis. Of the sixteen patients who had a pseudarthrosis, ten had neck pain and three had recurrent myelopathy that was attributed to the pseudarthrosis. Five of the ten patients who had a painful non-union had enough symptoms to warrant a revision operation. Moderate-to-severe pain at the time of follow-up was highly associated with the presence of a pseudarthrosis ($p<0.001$).

Chi-square analysis was used to compare the risks of pseudarthrosis associated with the different types of grafts. No significant difference was found, with the numbers available, between the rate of non-union associated with Robinson-type grafts and that associated with strut grafts from the iliac crest ($p>0.10$). The rate of union associated with fibular strut grafts (97 per cent) however, was significantly higher than that associated with Robinson - type grafts (71 per cent) ($p < 0002$). The rate of non-union in the patients, who had had a multilevel anterior cervical discectomy and arthrodesis was 42 per cent compared with 0 per cent in those who had had a one-level procedure ($p<0.002$). There were few cigarette smokers in our series, and smoking was not found to be associated with the development of a pseudarthrosis. Age was negatively correlated with the occurrence of a pseudarthrosis ($r = -0.24$, $p < 0.05$) - that is, older patients were more likely to have a solid fusion.

Of the eighty-nine patients who had had preoperative pain, sixty-one (69 per cent) had no pain, sixteen (18 per cent) had mild neck pain, five (6 per cent) had moderate neck pain, and one (1 per cent) had moderate radicular pain. Pain developed after a postoperative infection secondary to extrusion of the ilica-crest graft and esophageal perforation in one patient who had had no preoperative pain. Of the 106 patients who had been followed for at least two years, seventy-one had no functional impairment, fifteen had mild impairment of the ability to perform strenuous labor or to participate in sports, eight had moderate impairment (they could perform the activities of daily living but could not work), two had impairment of the ability to perform the activities of daily living, six had impairment of the ability to walk in the community, two were able to walk only about the house, and two were unable to walk. At the latest follow-up examination, the average grade according to the system of Nurick was 1.2 (range, 0.0 to 5.0).

Age was the only factor analyzed that was found to be associated with the preoperative grade according to the system of Nurick - that is, older patients tended to have more severe myelopathy before the operation. The strongest predictor of the postoperative grade of the myelopathy was the preoperative grade: better neurological function before the operation was correlated with a better neurological outcome postoperatively ($r = 0.64$, $p < 0.001$). In addition, after controlling for the preoperative grade of the myelopathy, we found that women had less improvement than men in terms of the postoperative grade (partial $r = 0.31$, $p < 0.01$).

The myelopathy recurred in five patients. Three of them had a pseudarthrosis with resultant formation of osteochondral spurs and recurrent compression of the spinal cord. One of the patients declined additional operative intervention. The other two had a revision operation (a posterior procedure in one and an anterior procedure in the other), with subsequent clinical improvement, Stenosis of the spinal canal at new levels with recurrent myelopathy developed in two patients; bot had another anterior decompression and arthrodesis. One of these two patients had improvement in motor stregnth and function. The neurological deterioration was halted in the other patient, but there was little improvement with respect to the myelopathy.

Six other patients needed an additional operative procedure for the treatment of disc herniation or spondylosis at adjacent levels, and one patient needed posterior stabilization because of subluxation caudad to the site of a long fusion.

Analysis of the Diameters of the Spinal Cord and the Canal

The normal sagittal diameter of the spinal canal was measured posterior to the vertebral body in order to exclude posterior osteophytes. The average value was 15.3 millimeters (range, 12.0 to 20.0 millimeters). The Pavlov ratio was 0.80 or less in sixty of the 105 patients for whom the measurements were made, and the average ratio was 0.78 (range, 0.54 to 1.10) for the entire group of 105 patients. The average sagittal diameter at the narrowest point of the spinal canal was 11.8 millimeters (range, 9.0 to 18.0 millimeters). With the numbers available, the Pavlov ratio and the sagittal diameter of the spinal canal at its narrowest point were not found to be associated with the preoperative or postoperative severity of the myelopathy as demonstrated by the grade according to the system of Nurick.

In the sixty-three patients for whom measurements were available, the average cross-sectional area of the spinal cord was 34.6 square millimeters, with a wide range from 8.9 to 110.9 square millimeters (median, 32.8 square millimeters). The area of the spinal cord also was not found to be associated with the preoperative or postoperative severity of the myelopathy.

Complications

The most severe complication was an increased deficit of the spinal cord that resulted in complete quadriplegia in one patient. The patient had had progressive quadriparesis and dysfunction of the sphincter because of a large disc herniation tracking up posterior to the vertebral body and causing severe compression of the spinal cord. A one-level anterior corpectomy of the sixth cervical vertebra was performed with use of an iliac-crest strut graft; the patient awoke after the operation with an increased deficit. Emergent neuroroentgenographic studies showed a swollen spinal cord with no hematoma, fracture, displacement of the graft, or other lesion that could be remedied by an operation. The patient was completely quadriplegic at the time of follow-up, approximately four years after the operation.

Postoperative obstruction of the upper airway due to edema required reintubation in three patients. One of these patients had pneumonia with subsequent respiratory failure and died approximately six weeks postoperatively. Four patients had an intraoperative leak of cerebrospinal fluid, which was successfully repaired with a fascial patch and lumbar drainage of the cerebro-spinal fluid in three patients. The remaining patient needed coverage with a muscle flap in order to seal the leak.

Six patients had complications related to the graft. Four of them had displacement of the strut graft necessitating operative revision. One patient had partial displacement of the strut graft, which was treated by changing the type of immobilization to a halo vest, and one had collapse of an osteoporotic iliac-crest strut graft, which was treated with operative revision to a fibular bone graft. Erosion of the esophagus and postoperative infection developed in one of he patients who had displacement of an iliac-crest strut graft. The patient was managed successfully with operative debridement and replacement of the graft, nasogastric suction, and systemic antibiotic therapy. Two of the six patients who had a complication related to the graft were initially managed with halo immobilization. None of the Robinson-type grafts collapsed or became displaced. A hematoma developed in two patients postoperatively; one hematoma drained spontaneously, and the other was treated with operative drainage, with no adverse sequalae. Of the twelve patients, who had at least one major complication, five had had operative intervention before the index procedure ($p = 0.005$). Of the six patients who had a complication related specifically to the graft, four had had a previous laminectomy ($p < 0.001$).

Minor complications included a hematoma at the donor site of the graft, which resolved; a fracture at the donor site of an iliac-crest graft, which was treated symptomatically; a delayed tibial stress fracture (after bone graft was obtained from the fibula), which healed after application of a splint; and an infection of the urinary tract in one patient and an infection at the site of a halo pin in another, which were both treated with antibiotic therapy.

Discussion

Operative treatment of cervical myelopathy has focused on decompression of the spinal cord to halt neurological deterioration and to promote recovery. Both anterior and posterior operative techniques have been used to decompress the canal, with varying rates of success. Theoretically, posterior laminectomy is technically less demanding and requires no healing of a bone graft. Problems with laminectomy have included postoperative instability, inadequate decompression of the spinal cord, persistent pain, and progression of the neurological deficit. Laminaplasty has been performed as an alternative to laminectomy in an attempt to avoid the destabilizing effects associated with removal of the lamina. Laminaplasty has limitations, however, as it is an indirect method of decompression, it results in some loss of motion, it is not recommended for patients who have cervical kyphosis, and it may not treat axial neck pain successfully. During the past twenty-five years, we have preferred to

approach the spine anteriorly when treating cervical myelopathy. Anterior decompression allows direct removal of the compressive abnormality, with stabilization obtained by anterior arthrodesis. The disadvantages include the technical challange of the procedure, the need for healing of a graft, and potential problems at adjacent levels.

One of us, in 1977, described seventeen patients who had moderate-to-severe myelopathy that was treated with anterior discectomy and arthrodesis. The patients had good neurological recovery, and many regained the ability to walk about the house or the community. However, the duration of follow-up ranged from six months to six years, and pain relief was not described in detail. Ebersold et al, in a study of thirty-three patients, noted very good early results after anterior discectomy and arthrodesis; some neurological deterioration occurred over time in six patients, but several of them had an additional diagnosis of multiple sclerosis, arteriovenous fistula, or poliomyelitis. No data on the outcome with respect to pain was described.

Other authors have reported the results of subtotal corpectomy and strut grafting for the treatment of cervical myelopathy. Bernard and Whitecloud reported good functional recovery and no non-unions after use of fibular grafts with a dovetail technique. Yonenobu et al and Okada et al reported the results of subtotal corpectomy and anterior arthrodesis for the treatment of spondylotic myelopathy. In both studies, there was a high rate of improvement in neurological function and few patients who had late deterioration. None of these studies, however, addressed the outcome with respect to pain. In a study by Saunders et al, in which forty patients who had spondylotic myelopathy were managed with subtotal corpectomy and use of a strut graft from the iliac crest or the fibula, the rate of neurological recovery was high and only two patients had deterioration over time. The rate of complications was 48 per cent, but it included minor, treatable complications such as hyperventilation and hyponatremia.

Our report is a retrospective review of the long-term results of anterior decompression and arthrodesis, performed at one institution by three surgeons who used consistent techniques, in patients, who had cervical spondylotic myelopathy. As other investigators have done, we attempted to identify the roentgenographic and clinical predictors of the preoperative and postoperative severity of the myelopathy. We noted a strong association between the severity of the myelophatpy preoperatively and that at the latest follow-up examination, an observation that was in agreement with the findings of Saunders et al. To our knowledge, gender has not been reported to be associated with the outcome of treatment of myelopathy, but our data suggested that men have more improvement, even after we controlled for the preoperative rating of severity. We believe that the more salient point of our results is that most patients, male or female, have substantial postoperative improvement.

The duration of symptoms; the sagittal area of the spinal canal at its narrowest point, as seen on plain roentgenograms; the Pavlof ratio; and the preoperative area of the spinal cord, as measured on cross-sectioal imaging studies, were not found to be associated with the severity of the myelopathy either preoperatively or postoperatively, with the numbers available. It is likely that plain roentgenograms do not reflect the true degree of compression of the spinal cord as sofd-disc herniation and even osteophytes cannot be visualized accurately. We were surprised that the area of the spinal cord had no predictive value, but the result may have been influenced by the fact that cross-sectional imaging data were available for only sixty-three of the 108 patients.

The improvement in motor strength, gait, and function as well as the reduction of sensory deficits was very high, with many patients returning to normal or nearly normal neurological function. One patient, however, had a catastrophic neurological outcome resulting in complete quadriplegia. The reason for the increased deficit was unclear, but it was believed to be related to intraoperative traction and hypotension occurring after the decompression, with resultant ischemia of the spinal cord.

Most of our patients had either axial or radicular pain in conjuction myelopathy. Although there is little information in the literature regarding the outcome with respect to pain for such patients, it has been our experience that anterior stabilization of the spondylotic segments results in sabstantial relief of neck pain. The long-term results in our study demonstrated no or only mild pain in seventy-seven (87 per cent) of the eighty-nine patients who had had pain preoperatively. Pseudarthrosis was associated with more pain postoperatively, a finding that we also reported in an earlier study on anterior discectomy and arthrodesis for the treatment of cervical radiculopathy. The risk factors for pseudarthrosis included the number of operative levels involved in an athrodesis performed with use of a Robinson-type horseshoe-shaped bone graft and the source of the bone graft (the iliac crest or the fibula). We believe that our technique, in which the entire cross-sectional surface of the fibular graft is centered into the end vertebrae, provides maximum stability and surface area for healing; the rate of union of autogenous fibular grafts inserted in this manner has continued to be extremely high. A younger age is also associated with a higher risk of pseudarthrosis. We can only postulate that younger, healthier patients may be more active and have more mobility in the neck, which results in a slightly less stable environment for the bone graft, but we have no data to support this hypothesis.

Six of the twelve patients who had a major complication had difficulties related to the strut graft. We believe that it is notable that four of the six patients in whom the strut graft dislodged or collapsed had had a previous multilevel cervical laminectomy. A compromised posterior column places an anterior strut graft at a substantially higher risk for displacement. A rigid two poster brace was used for four of the six patients who had a complication associated with the graft, and two of the four patients had had a previous laminectomy. Although a halo vest provides better immobilization than a brace, it does not prevent axial loading or all complications related to the graft. Alternative methods to minimize dislodgment of the graft include use of a plate anteriorly or posterior stabilization; we have used both of these medhods, but not in any of the patients in the present series.

Osteoporosis was another important factor related to complications involving the strut graft in our patients. No bone-densitometry data were available; however, on the basis of the, preoperative roentgenograms and the operative findings, we belive that four of the six patients who had a complication related to a strut graft had osteoporosis. If a patient has osteoporosis, there is some risk that the anterior part of the body of the inferior vertebra may fracture during axial loading of the strut graft when the patient assumes an upright posture.

Some investigators have thought that a cervical fusion increases biomechanical stress at the remaining levels and perhaps accelerates degenerative changes. The prevalence of symptomatic problems at adjacent disc levels in nine (8 per cent) of the 106 patients in our study is similar to that reported after anterior discectomy and arthrodesis procedures in patients who had cervical radiculopathy. It is impossible to determine from our data whether this finding represents the normal progression of degenerative changes or an acceleration of the changes because of the fused segments; we believe that symptomatic problems at the adjacent disc levels are most likely a combination of the two processes, which become clinically important in a relatively small percentage of patients.

The 5 per cent prevalence of recurrent myelopathy in our series was similar to, or better than, that reported in other studies. Compression of the spinal cord and recurrent myelopathy developed in two of our patients who had spondylosis at an adjacent level and in three patients who had a pseudarthrosis. Persistent motion at a spondylotic segment can result in an increase or a recurrence of chondro-osseous spurs, which can lead to static or dynamic compromise of the spinal canal. We recommend that roentgenograms with the spine in flexion and extension, tomography, or computed tomography with spinal reconstruction be made in order to look for a pseudarthrosis. Magnetic resonance imaging

studies or computed tomography myelograms should then be made in order to look for extrinsinc or intrinsic conditions that could explain the recurrent myelopathy.

In conclusion, our long-term study of the results of anterior decompression and arthrodesis for the treatment of cervical myelopathy demonstrated a high rate of improvement in neurological function or complete neurological recovery as well as substantial or complete relief of pain in most patients who had had preoperative pain. Functional improvement paralleled the neurological recovery. The most common major complications were related to the graft, and they occurred in patients who had had at least one previous operative procedure on the cervical spine. Multilevel anterior discectomy and arthrodesis procedues were associated with the highest rate of pseudarthrosis, and arthrodesis with an autogenous fibular strut graft was associated with the highest rate of success.

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Diagnosis and Treatment of Cervical Spine Injuries

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The management of cervical spine injuries is on one side an organizational and on the other side , a technical problem .

I would like to address a few issues which seem to be of importance in handling cervical spine injuries . These issues are the following :

- Primary assessment and imaging
- Classification of injuries
- The role of reduction
- The role of stabilization and results

a) Primary assessment :

The primary assessment starts at the accident scene . The patient has to be considered as unstable and as potentially or really tetraplegic . The vital signs (blood pressure , circulation and respiration) have to be monitored in order not to miss a multiple traumatized patient . A rough , but well aimed neurological examination needs to be done to have a bottom line for comparison .

If the patient can be cleared as having a cervical spine injury with neurological deficit or in combination with an additional trauma , a referral to a center should be considered . A simple primary x-ray evaluation may be done before the transfer and in case of dislocation an installation of a skull traction may be considered for possible reduction , since more than 70% of lower cervical spine injury can be reduced by traction only .

b) Imaging

The final imaging should include the whole cervical spine , AP , lateral and oblique . The cervico-thoracic junction should be clearly visible . Specific views may help (swimmer view) to present it better . The conventional tomography is still helpful but is mostly replaced by CT-scan with sagittal , or even 3 dimensional reconstruction . Although the CT-scan is not the imaging of choice in the middle and lower cervical spine , however , it is in the upper cervical spine . Specifically for injuries of the posterior elements , the CT-scan does not really give the appropriate information . Patients with neurological deficit may get an MRI or a myelo-CT . Pure discoligamentous injuries may be best appreciated by an MRI .

c) The imaging together with the history and clinical findings allow the classification of the injury :

The classification is organized in A , B , C Types with groups and subgroups . Conceptually the concept of compression injuries (= shortening = A – lesion , mostly located in the anterior vertebral body row) , distraction injuries (= lengthening = B.

lesions , predominately localized in the posterior tension banding system) and rotation injuries (= C lesions localized in both anterior and posterior column of the spine) .

The most frequent lesions , more than 70% , are lesions with a damage of the posterior tension banding system .

There is a clear relationship between neurological damage and the osteoligamentous injury when the spinal canal is compromised equal or more than 50% and some typical lesions have higher incidence of neurological deficit than others . The upper cervical spine injuries do only have a limited correlation with neurological deficit .

The neurological deficit is a combination of the primary injury to the spinal cord and the possible persistent mechanical compression . To give the patient a chance , the persistent mechanical compression should whenever possible be eliminated as soon as possible .

d) The role of reduction :

Reduction is the best decompression . It is an indirect decompression . 70% of cervical spine injuries can be reduced by traction alone without any manipulation . In locked injuries manipulation and the reverse movement of the injury may be done to obtain a reduced cervical spine . Very few cervical spine injuries are unreducible and requir open reduction , either from the back when the facet joins are locked or from the front . Whenever open reduction is aimed we have to keep in mind that disc material may be dislocated into the spinal canal during the reduction manoeuvre Therefore , an anterior reduction with a possible anterior decompression may be the choice .

e) Stabilization

There is an ongoing discussion whether the injuries should be treated where the major lesion is or whether there is a standard procedure . If we follow the rule of treating the injury where the major lesion is , the posterior stabilization would be the treatment of choice . The posterior fixation , however , is much more traumatic than the anterior surgery with more blood loss , less favorable fusion conditions and technically more difficult . In our experience most of the cervical spine injuries can be treated exclusively by anterior surgery . The plating techniques , first the Orozco plates and the further development with the cervical spine locking plate give enough stability for clinical use to limit surgery to the anterior approach which is atraumatic and basically blood less .

3D ANALYSIS OF THE SCOLIOTIC DEFORMITY

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I. Introduction - History:

Before the era of the XRays everybody dealing with spinal deformities was thinking in 3 dimensions. This was realized with molds built in various materials where finally the plaster of PARIS was the best.

Ingenious measurement and machineries were designed to draw and keep the shape of the back as precisely as possible in 3 dimensions, reproducing the real deformity. The drawing of the spine itself as it can be seen for example in the book of John SHAW (1824, London) demonstrate clearly that the apex of the deformity is lordotic with the length in between spinous processes much shorter than the length in between 2 vertebral bodies.

With the era of the XRay all these findings started to be forgotten. The picture of the skeleton given by these XRays was so attractive that physicians, surgeons, etc... took the wrong habit to think only in the plane of projection mainly given by the AP view and rarely with the sagittal view. The consequences of this type of thinking were some errors in the use of the instruments where the most stricking was the "flat back" syndrome created by thinking in only one dimension for lumbar spine deformities.

Robert Roaf and Sommerville in England, then in our country our own work, and Rene Perdriolle work with Henry Graft, Jerome Hecquet and myself in 1979, were the pioneers for 3D analysis.

II. Various methods exist to analyse and reproduce in 3D the spinal skeleton:

Our original choice was the model designed by Jerome Hecquet, Henry Graft and ourself and published (Rev. Chir. Ortho. 1983...) because of its simplicity, allowing prompt and attractive vizualisation of the spine either in a global or a more segmental aspect, either for the volumes or the maximum slope variation orientation or center of mass, etc... Its multiple possibilities were of great help in the approach of the 3D analysis of the scoliotic deformity especially with the top view of the spine probably the most impressive to understand the dimensions.

Mathematical model, surface reconstruction technic with CT Scan or those coming from regular orthogonal XRays including or not the finite elements methods are realized with numerization of these XRays by digitazation using various types of computer logicials, some of them using the center of rotation of each vertebra as the basic element, other using direct measurement of the axial rotation from more reference points on the Xray.

This finite element model allows us today to quantify almost completely the deformity and to approach simulating of orthopaedic or surgical correction inside the computer.

III Basic concepts and the reference planes

Are built from the gravity line of the body studied in a standing or sitting position. This is a postulate but nothing can be understood if we don't have this basis. This gravity line is determined by the orthogonal

axis centred from the "polygene of sustentation" of the body: meaning the center of the surface more or less circular or ellipsoidal representing the projection of the gravity line around both feets on the ground for standing or the frame both thigh and both ischium tuberosities for sitting.

From this line and the ground or sitting plane we can determine the x, y, z (coronal, horizontal and sagittal) planes basis of the 3D studies. This concept drive to the concept of 0 balance 1 where the gravity line of the body lies within the center of this surface allowing equal (=balanced) motion in all direction (front back, right left) in this plane. This drive to the concept of "conus of economy" where the body can stay balanced within this surface without no or with a minimum of muscle action and the "conus of maximum work" where the muscles are working at maximum to maintain balanced the body.

In addition this push to the concept of the pelvic vertebra where the entire pelvis must be considered like the last vertebra of the spine (because of the minimal mobility of the S.I. joints) with major consequence for the standing as for the sitting position and finally to the concept of the "cephalic vertebra" where the entire head is considered like the upper top "vertebra" of the axial skeleton with its particular mass and weight.

The last basic concept to be considered is the one of stability and instability, immediate or potential.

Immediate instability means that an abnormal motion beyond the physiology is demonstrated in any plane of reference by dynamic imaging (flexion, extension, ...)

Potential instability means no change is demonstrated by dynamic imaging, but because of the permanent malalignement, either a sudden trauma or progressive stresses lead to abnormal displacement.

It is why the 3 dimensional concept of the 3 columns of the spine is so important not only for bony and cartilaginous elements but also for ligaments, disc, capsules and muscles studied in the sagittal plane (F. Denis description), or in the horizontal plane (french anatomist description).

IV. 3D normal spine:

Seen from the coronal plane the spine is perfectly aligned with perfect symmetry between right and left side. It is the same for the horizontal plane where vertebrae do not demonstrate any axial rotation. But on the sagittal plane the normal spine is built with a succession of curvature with cervical lordosis followed by thoracic kyphosis and lumbar lordosis. The junction between these sagittal segmental curvature are very smooth and progressive leading to the harmonious sagittal contour of the human spine with apical zones the most away from the gravity line and the junctionnal zones in between the curves.

But the normality cannot be determined by only one angulation for these various segments. There is a rather wide range in the thoracic kyphosis and lumbar lordosis leading to normal variations: for example from 20° to 40° of thoracic kyphosis is considered as normal. These differences are related to ethnical and developpemental variations. The top view of such normal spine is particularly expressive for the harmony.

V. Dysharmony whatever the plane where its occurs determine the pathology:

A. **Pure sagittal deformity** is easrier to understand where nothing wrong exist in the coronal or horizontal plane.

*Regular: For example thoracic hyperkyphosis like in some Scheuermann disease realize a regular sagittal deformity with subsequent increase of lumbar and cervical hyperlordosis to compensate progressively and balance, the increase of thoracic kyphosis. On the contrary, thoracic regular hypokyphosis lead to a decrease of normal cervical and lumbar lordosis and push to create a flat back and in the major cases a kind of cervico thoracic and thoraco lumbar kyphosis.

Seen from a 3D point of view in general for the body thoracic hyperkyphosis is generally associated with increase of AP diameter of the chest with a more vertical orientation of the rib cage with less respiratory consequences and thoracic lordosis with a decrease of this diameter with more horizontal orientation of the rib cage with more respiratory compromise. Generally these regular purely sagittal changes never lead to instability.

*Angular: this means that the deformity always lying only in the sagittal plane is located at very few level, sometimes only one and create a sudden change in the alignment at the apical zone.

The 2 major consequences are: much more risk for instability and considerable variations in the compensation for the balance according to the amount of deformity and its location on the spine.

But if the lesion, trauma, congenital, infections, etc..., has destroyed the disc space with ligaments even if the correction a recreated a normal alignment even if the destroyed posterior elements are replaced by instrumentation and fusion, if the anterior fibrous empty space remains, with time, we will see sometimes stress fracture of the instrumentation and posterior fusion. This is 4D instability because the time may be considered like a fourth dimension.

For example finally the spondylolisthesis (mostly the congenital), it is a sagittal angular deformity where the "pelvic vertebra" (typical intercalary bone) will rotate in the sagittal plane in retroversion with major lumbo sacral kyphosis and subsequent compensatory hyperlordosis. It is why reduction when used must correct this lumbo-sacral malalignment more important than the slippage.

B. Pure coronal or pure horizontal deformities are almost never seen isolated because of the sagittal curvatures existing physiologically. Any displacement on the frontal or horizontal plane result in an obliquely oriented displacement and give automatic changes in the other direction so realize a dimensional deformity.

C. The best example of localized 3 dimensional deformity is given by **"rotatory dislocation of the spine"**

We describe this condition in 1972. We had observed that in some congenital or dystrophic conditions (like osteochondro dysplasia, neurofibromatosis, etc...) the 2 vertebrae and disc space located at the junction of 2 segmental curves each of them being in lordosis and rotating in an opposite direction, progressively dislocate in a kyphotic and rotating configuration realizing a scissoring effect around the spinal canal.

When we match the AP and lateral projection of the deformity given by the XRays, we can demonstrate that the apex of the kyphosis is exactly located at the junction of the 2 curves seen on

the AP projection. This phenomenon is progressing with time and especially clearly understandable when we have the opportunity to have a succession of XRays AP and lateral starting with a minimal deformation and ending with a considerable one as it can be found in some charts of neurofibromatosis patient treated only with brace or cast.

Neurological complications are often seen in such a condition because the apex of the kyphosis is very acute and the spinal cord is submitted to a scissoring and twisting effect over a very short segment. The roots are tightened in an opposite direction. But this phenomenon is progressive, so the neurological sign generally arise progressively and it is why we may anticipate a good effect of progressive traction leading to progressive untwisting and recovery of the neurological signs allowing to perform a circonferencial anterior and posterior fusion without the necessity of direct decompression if the spinal cord.

Approaching such a condition demonstrate also clearly that the anterior strut grafts are located neither into the frontal nor into the sagittal plane but are always obliquely aligned regarding the body axis.

D. Typical dysharmony in 3 dimensions: the scoliotic deformity demonstrate the torsion.

a/ As we have demonstrated, the basic structural scoliotic segment is represented by succession of vertebral units always located in extension or lordosis one from the next one with axial rotation of each vertebra of such segment always in the same direction. This start from one neutral vertebra (without axial rotation) and continue successively with increase axial rotation, passing through a maximum of axial rotation located at the apical vertebra of this segment and running down with decrease axial rotation always in the same direction to end at the next neutral vertebra.

Each vertebra, and this is well demonstrated with finite elements models, each part of one vertebra (because of the structural deformity of the bone), is successively located in a specific position with its proper/reference in the 3 dimensions. This means that one curve cannot be located in one plane There are an infinity of plane to localise one scoliotic segment and means that the XRays are only shadows giving the projection of the curve but not the reality of the curve.

This phenomenon characteristic of the scoliotic deformity is the torsion: displacement of each vertebra in the 3 dimensions running successively over all the vertebrae of the scoliotic curve from the neutral vertebra to the next neutral vertebra. This phenomenon for us is secondary to a rotatory movement which is thwarted by the orientation of the pelvis, of the shoulder and finally of the head.

This explain why in reality the Cobb angle measure mainly the "collapsing" of the spine. So a scoliotic spine is made by either multiple scoliotic structural segments or by only one scoliotic structural segment followed above and below by compensatory not structural segment. Each of these segments is linked to the next one by the junctionnal zone. This junctionnal zone represent either one disc space and its adjacent upper and lower vertebra or one vertebra with its adjacent upper and lower disc space or at maximum a group of two consecutive vertebrae. The middle with neutral axial rotation the adjacent one with opposite side axial rotation. Their arrangements are in a such a manner that they realize or approach to a balanced spine in 3D.

When some segment do not give sufficient motion to allow the head to reach again the gravity line, the spine become imbalanced either on the coronal or sagittal or horizontal plane.

b/ These concepts of apical zone and junctionnal zones are very important

If we measure the intervertebral rotation (that is the difference of axial rotation of 2 consecutive adjacent vertebrae) we can demonstrate that at the apical zone the difference is very little almost nothing but with the greatest amount of axial rotation.

On the contrary at the junctionnal zone the amount of axial rotation is minimum but the intervertebral rotation rate is maximum.

This means that the apical zone are the stiffest part of the curvature and the junctionnal zone the more mobile even the more unstable. This explain why the rotatory dislocation phenomenon can be so marked if this junctionnal zone happen with a dysplasic bone.

But in idiopathic scoliosis where the quality of the bone is normal, if such phenomenon do not occurs, the sudden change at the junctionnal zone in between two structural segments is evident, for example in double major curves the thoraco lumbar junction is frequently kyphotic or realize a flat back. The same thing exist at the junction in the double thoracic, etc...

This explain the so called "progressing kyphosis" above the Harrington instrumentation seen in the past.

The natural history of lumbar rotary dislocation in adult scoliosis with degenerative signs it is exactly the same mechanicism occurring sometimes at only one single level between L3 L4 for example or between L5 and the pelvic vertebra.

It is very important also for the instrumentation using the CD principle because if the strategy for the bone fixation of the instruments is not correctly applied when the rod is rotated, counter torsion may occurs in a wrong way and create decompensation. It is why it is necessary generally to overlap these junctional zones when structural curves with proper orientation of the instrumentation.

So for the apical zone the most rigid and if the discs spaces are not previously released, the correction from the posterior instrumentation give only a global "en bloc" displacement of this apical zone in the sagittal planes but very little correction for the axial rotation. But the consequence for the stability of the instrumentation is that it is a strategic point do have a strong fixation of the instruments at this apex especially on the convex side of a curve.

On the contrary the junctionnal zone is the most mobile and instable part with the minimum of axial rotation and the maximum of intervertebral rotation. The consequence for the posterior instrumentation is obvious:

- avoid to start or end the instrumentation on a vertebra located in this area if the rotation of the rod give o counter torsion on this vertebra going to increase the instability and especially the imbalance.

- But on the contrary include there junction into the fusion and instrumentation generally with reverse action of the instruments than the one working for the main curve.

This must be determined by the bending films on lateral and sagittal planes preoperatively with the local analysis of the specific mobility of the discs space located above and below the junctionnal vertebra especially for the lower lumbar spine when very few mobile segments remains, but also for the thoracolumbar spine when we do not want to fuse the lumbar curve entirely.

c/ Another basic deformity is sometimes encountered in scoliotic spine especially in the infantile group and with large progression can give some trouble to be understood, it is the "hyperrotatory kyphoscoliosis" with in reality the so called "paradoxal kyphosis", still corresponding to intervertebral lordosis but with a so marked axial rotation than the lateral scoliotic collapsing appears on the sagittal plane for the patient so looks kyphotic. This is rather specific for the infantile malignant group of scoliosis where generally exist a group of 3 or 4 apical vertebrae with very big axial rotation from the beginning. But this phenomenon can be observed also in a few cases of thoracic juvenile scoliosis with tremendous progression at puberty (for example 9° Cobb angle progression every month as we have seen in some cases).

Finally this phenomenon occurs also in some kyphosing scoliosis especially in the lumbar spine in late adulthood mixed with degenerative changes of the disc capsules, ligaments. The apical rotation is so big linked with the lateral tilting that fort the entire body the collapsing became antero posterior so in the sagittal plane so kyphotic. For these deformities the 3 columns horizontal concept is very important to be considered, it is like if the anterior column disappear because was ejected laterally and progressively backward from the gravity line so nothing hold the spine in the front so the collapsing occurs in kyphosis. It is why this type of paradoxal kyphosis can be corrected through anterior approach with detorsion devices after anterior release.

d/ This hyper rotatory type of scoliosis was at the base for us to understand and describe "the crank shaft phenomenon". This will introduce the fourth dimension: The time (phenomenons of the growth for the deformities in childhood, and of the degeneration for the deformities in the elderly).

For this "crankshaft phenomenon" we observe the progression of the deformity in spite of a solid posterior fusion done on an immature still distorted spine. The continuation of the growth on the anterior column of such scoliotic deformity when the vertebral bodies are in lordosis lateral tilting and axial rotation, this continue to increase the deformity exactly with the same mechanicism than a congenital spine anomaly with postero-lateral bar.

See from the top in 3D, it is evident and explain why the back not kyphotic initially became "kyphotic" after a so called posterior fusion because continuation of the anterior growth with the torsional phenomenon.

The only way to prevent that would have been to perform the anterior interbody fusion simultaneously with the posterior one.

Conclusion:

1) For pediatric spine the 3D analysis of any spinal deformity must be associated with the 4th dimension: evaluation of the time for remaining growth in order to built the strategy for the treatment. We can predict probably no change if growth is completed, possible change if not.

2) 3D analysis is based upon:

a/ - What are the goals to be reach
- Best balance as possible
- Best harmony for the deformities remaining after correction
- As close as possible of the "economic conus" for the function of the patient.

Notice: this do not means "best cobb angle" for the curve "the maximum correction for one curve is not always the optimum"

b/ Global analysis of the body looks for:

- The gravity line and planes of reference including top and bottom vertebra (pelvis most of the time) regarding the standing or sitting position. In both cases do not forgot to evaluate, the function and motion of the lower limbs (hip, knee and feet).

- The global shape of the spine seen from the front, back as well as sagittal.
For a similar coronal shape with single or double on multiple curves we may have various sagittal alignments, normal or lordo or kyphotic or flat and notice the segments which seem to be the most involved = thoracic, thoracolumbar, lumbar, lumbo sacral...

With this global analysis everything concerning balance or imbalance, function and motion active and passive will be analysed.

c/ Then segmental analysis is done mainly using standing XRay AP and lateral with specific bending XRay (right, left, front, back).

On this analysis it is necessary to determine the structural segments and the compensatory, the location for each segment: of the apical zones (disc or vertebra); of the junctionnal zones in order to precise the strategic points to be addressed by the treatment.

It is also necessary to evaluate the extend of the involved area to be treated and fused if surgical treatment is required but mainly to determine, the proper location of the end vertebra to be instrumented, the upper as well as the lower one in order that the discs spaces left free below the fusion must be balanced the best as possible in the 3 of the space to secure the best longevity as possible.

ADOLESCENT IDIOPATHIC SCOLIOSIS
EVOLUTION AND PRESENT CONCEPT OF POSTERIOR SURGERY

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The aim of the surgical treatment of scoliosis remain unchanged: to correct the deformity and to maintain the correction with a fusion.

Because of its proximity to the skin, the posterior column had been addressed more routinely.

In the early years, correction was obtained by external means: traction, plaster casts of different types for many weeks, and fusion was realised in the cast with autogenous iliac crest followed by a long post-operative period of external support. Correction was fair and some loss was observed. The trunk however was usually well balanced thanks to the adaptation of the fused area and the adjacent segments on the plaster cast.

In the 1960s, Harrington introduced the correction by internal distraction of the concavity with a rod. Lateral correction was improved, but sagittal contour and rotation were not corrected. Thoracic lordosis remain unchanged and, in the lumbar area, an iatrogenic kyphosis could be created. Because the links between the spine and the rods were only at the extremities of the curve, external support was still necessary. Lossof correction and the rate of pseudarthrasis were reduced but still significant.

Luque introduced a different concept based on segmental fixation with laminar wires on each vertebrae and approximation to concave and convex rod. This improved the stability of the correction but the sublaminar wires introduced a potential neurological risk and had a limited control of vertebral movement.

In the 1980, Cotrel and Dubousset developed the principe of posterior correction by a rotation manoeuvre of a solid bendable rod moved from lateral to sagittal. Vertebral fixation was provided by hooks at selected levels orientated to apply combined lateral and sagittal correccting forces. Correction and stability was improved allowing the suppression of external support, but the complexity of the surgery was increased. In some cases rotation manoeuvre in the thoracic area, led to over correction, and prolonged torsional forces on adjacent segments caused decompensation. However, the instrumentation allowed the application to the spine of a better knowledge of the 3D deformity and to learn from the first mistakes.

BIOMECHANICAL PRINCIPES
3D analysis of the deformity

Standard X-rays provides only a shadow of a single plane of the reality.
Software had been developed to reconstruct the spine from standart frontal and sagittal X-rays in standing position. It is possible to work with this reconstruction, turning around, looking from the top and measuring relative positions of each vertebrae. It is therefore possible to demonstrate that scoliotic deformities can be divided into segments connected with junctional zones.
The apical zone of a scoliosis is the segment of the spine which has moved into lordosis and torsion. It is the place of greatest axial vertebral rotation, but with the smallest intervertebal rotation. It is also the stiffest part of the deformity with, in adolescent, bulging disc towards the convexity.

The junctional zone is between two structural curves, or between a structural curve and a c compensatory curve. This zone, closer to midline, demostrate greater intervertebral mobility and intervertebral mobility and intervertebal rotation. It may be the place of a junctional kyphosis. Dynamic bending and particularly concave bending may show different kinds of behaviour n coupling movements. According to standing status, they may show no change, higher or lower neutral vertebra.

The efficient sagittal contour

It is well recognised now that restoration of the sagittal alignment is one of the most important key point of surgical treatment. Many failures such as flatback syndrome, junctional kyphosis, and early low back pain below a fusion were consequences of failure to restore the sagittal contour.

Sagittal posture is subject to variations affected by psychosocioeconomic factors. However each of us has a genetically determined efficient sagittal contour. Duval-Beaupere and al have shown that sagittal curvatures are correlated with a pelvic parameter: the "indicence" (angle defined by a perpendicular to the middle of the sacral plateau and a line between this point and centre of the femoral head). When the incidence is high, a balance spine needed a high lumbar lordosis and vice versa.

The optimal correction

For many years, surgical correction has been expressed in terms of Cobb angle correction. The increasing power of instrumentation with wide release has shown that maximum correction of the Cobb angle may unbalance the spine and fail to provide the best possible outcome.

The new "long bone" which is created in the fused area, must be as short as possible to preserve the maximum mobility. But at the same time, it must aim to approximate the spine to its most efficient contour, taking into account the stiffness of the main curve and the mobility of the adjacent segments. The spine must be well-balanced in the frontal plane and close to its ideal sagittal contour. The lenghth of the fusion should provide a harmonious progression between fused and unfused segments, with balanced mobility around a stable efficient position.

Considering those elements will be decided the choice of approach, the amount of release and the end limits of fusion. It is not possible to approach the two columns through the same incision. During one approach, the release of the instrumented column is done. Anterior instrumentation are supposed to provide better correction because of the removal of the discs (in scoliosis anterior column is longer than the posterior one) and segmental instrumentation. However for mobiles curves, the modern multiple hook, screw rod system provided comparative results. The advantage of anterior instrumentations could be the preservation of the back muscles. Disadvantage of large anterior approach could disappear by development of thoracoscopic surgery. But with stiffest deformities, the choice may demonstrate some difference. A stiff thoracic lordosis is generally associated with a junctional thoraco-lumbo kyphosis. A posterior instrumentation is unable to restore enough thoracic kyphosis and the instrumentation must extended beyond thoraco-lumbar junction to avoid unbalance. An anterior instrumentation can restore enough thoracic kyphosis with large anterior release to provide harmonious progression between fused thoracic part and unfused thoraco-lumbar junction.

More severe deformities over 80° stiffness in frontal plane and with fixed sagittal malalignment need release of both columns.

The mobilisation of the spine to the corrected position is resisted by 3D stiffness of the deformity. From a geometrical analysis, the ideal way to move a thoracic apical zone is from an axis posterior to the spine. On the opposite, correction via posterior rotation of a bended rod works fom an axis anterior

to the spine. The eccentric movement may increase resistance to correction and stiff curves creates torsional stresses on adjacent segments.

Rational of Colorado instrumentation is based on semi directed translation of stable vertebal grips.

Stable vertebral grips are realised via pedicular screw fixation rod pedicular hooks stabilised with staples. Each implant has a threated end post which allows connection to the rod at variable distance. This connection is provided by a clamp in which the end post has 4 degrees of freedom.

Steps of correction

1- Insertion of all vertebral grips: bilateral on the extremities, alternatively each side and each two or three vertebrae for intermediate.

2- Connection to the bended rods.

Rods are bended according to sagittal alignment. They can be connected at variable distance from the spine, and because of 4 degrees of freedom, both rods can be connected simultaneously.

3- Then the two rods are put in the sagittal plane allowing a first frontal realignment of the spine. But, spine is still "suspended" to the rods at variable distance from them.

4- Nuts are then progressively hightened going from one vertebrae to the other.

Thanks to be range of freedom on the connecting clamp, the spine moves to the rods following the way of minimum resistance.

At final locking the end post is perpendicular to the rods in the sagittal plane, but hooks can be fixed with any degree of rotation in the frontal plane. This allows them to stay in the best position on the vertebrae and at the same time, be connected to a straight rod in the frontal plane.

Bone grafting

The solidity of the new constructs avoids the need for external support in almost all cases. Long-term stability, however, needs a solid fusion, and meticulous decortication in still mandatory.

Additional autograft bone from the iliac crest is still the gold standard, but in adolescent idiopathic scoliosis, synthetic porous ceramic (BTCP-HA) provide good support for bone ingrowth in a decorticated environment, and avoid the morbidity of iliac crest harvesting.

Neurological control

Per-operative neurological complications are a major concern during surgical correction of spinal deformities. Stagnara wake up test have been the routinely reliable method of per-operative control, and remain the gold standard.
Electrophysiologic monitoring techniques provide continuous control of the spinal cord function, and early detection of reversible neural injury.

Sensory evoked potentiel are influenced by many factors (anaesthesia, temperature, blood pressure). Reliability can be improved by combining evaluation of the motor pathway.

However, their achievement and interpretation need well-trained and experienced technical help.

Blood salvage
The surgery of spinal deformities usually involves blood loss requiring transfusion.

The risks of homologous blood transfusion, particularly viral diseases had led to the development of different blood salvage techniques.

Pre-operative donation, per-operative control including positioning, meticulous surgical techique, anaesthesia, intra-operative reinjection using blood cell-saver.

Their combination avoid homologous transfusion in almost all cases of idiopathic scoliosis, even with combined approach.

Indications
More than the 45° Cobb angle indication depends on:

- Stage of maturation. Signification is not the same at beginning or end of growth spurt.
- The level of the curve. Thoracic lordo-scoliosis are more likely to the be operated while double major will balanced curves can well tolerated up to 60°.
- Preservation or perturbation of the sagittal contour is another important element in the discussion.
- Finally, psychological concern, risk and benefit of surgery must be widely discussed with the patient and the parents.

Except the severe thoracic curves where the traction is used to improve pulmonary function, no pre-operative treatment is necessary. Patient is allowed to stand up the next day without external support.

ADOLESCENT IDIOPATHIC SCOLIOSIS OUTCOME ANALYSIS OF SURGICAL TREATMENT

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The surgical treatment of Idiopathic Scoliosis has evolved significantly over the past 2 decades. The new era began with segmental fixation of Luque and a new generation of instrumentation pioneered by Cotrel and Dubousset. Today, varieties of surgical techniques are available to choose from and most of them provide excellent correction of the deformity. Along with improvements in spinal instrumentation, the results surgical treatment of Idiopathic Scoliosis have also improved.

The results of each surgical procedure should not only be judged by radiographic results but also by the clinical outcomes. More recently, the use of clinical outcome instruments to evaluate the results of surgical treatment of spinal disorders, has been emphasized. Different types of outcome instruments have been tested and among them is the outcome instrument developed by Scoliosis Research Society.

Factors affecting the outcomes in surgical treatment of AIS:

- Age
- Curve type
- Curve flexibility
- Technique of fusion
- Type of instrumentation
- Surgical approach (Ant. Vs Post.)
- Surgical complications

Curve correction: (meta - analysis) (Ref. 18)

* Posterior systems 48% to 67%
* Anterior systems 71% to 93%
* Minimal affect on thoracic sagittal balance
* No vertebral derotation

Cotrel - Duboussed Instrumentation: (Ref. 12)

76 Patients FU 6 years

Radiological Results: No curve progression in coronal plane
No progression in sagittal plane in 75 patients
All fused

Clinical Results: 38% mild pain.
Functional improvement 92%, Cosmetic improvement 97%

Anterior Vs Posterior approach:

Advantages of Anterior approach:
- Correction of hypokyphosis
- Less decompensation
- Better correction?

Results (Betz et al) - Thoracic curves	*Anterior*	*Posterior*
* Patients	76	100
* Coronal correction	58%	59%
* Sagittal correction of hypokyphosis (less than 20 degrees)	81%	40%
* Postoperative coronal balance	equal	equal
* Averalge Level saved distally	2.5	
* Selective fusion of the thoracic curve	97%	18%
* Pseudarthrosis	5%	1%
* Loss of correction more than 10 degrees	23%	12%
* Implant breakage	31%	1% (3.2 mm rod)

Results (Burton, Asher et al) - TL & L curves	*Anterior*	*Posterior*
* Patients	14	11
* Pre-op curve	52°	49°
* Post-op curve	10° (81%)	7° (86%)
* Mean length of fusion	4.0	9.8
* Function	5.0	4.8
* Pain	4.0	3.9
* Appearance	4.5	4.1
* SRS score	4.2	4.1

Functional Results

Haber et al Meta-analysis: (Ref. 9)
Patients appear to be more satisfied by the magnitude of curve correction rather than the percent of curve correction.

Patient's Perceptions (Function, Pain and Appearance): (Ref. 19)

168 Patients 72% completed the SRS Outcome instrument.
Females scored better in function after surgery and self-image after surgery.
TL & L curves better self image followed by KM V, KM I&II, and KM III&IV
Less pain in Caucasian patients and longer fusions (L1 to L3)
Almost all want to have the surgery again if reverting to preoperative status.

Complications:
- Pseudarthrosis
- Crankshaft phenomenon
- Curve increase and loss of correction
- Transitional poblems
- Infection

Surgical treatment of Idiopathic Scoliosis has evolved over the past two decades. Many factors influence the outcomes of surgical treatment. In most instances, with properly selected patients and appropriate technique one can expect an excellent outcome, both in curve correction and function.

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ABSTRACTS

Paper #1

SINGLE STAGE POSTERIOR VERTEBRECTOMY IN YOUNG CHILDREN FOR THE TREATMENT OF CONGENITAL KYPHOSIS AND SCOLISIS

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Historically the treatment for congenital spinal deformities consisted of observation, posterior or anterior fusion in situ and combinations of these Two stage (anterior and posterior) hemivertebrectomy has become more popular in the last decades because this operation provides an acute correction of the deformity. The need for surgical correction of congenital kyphotic and scoliotic deformities is appealing, but up to date no efficient method has been described. We have performed single stage posterior vertebrectomies in four patients with congenital deformities. The patients ages were (4, 4, 5, and 6), two patients had a congenital kyphosis (one Type I at T5-6, the other Type II at T12), the third and fourth patients had a fully segmented hemivertebra at L1 and a semisegmented hemivertebra at T12 respectively. In all patients the vertebrectomy was completed with a standart posterior approach, a compressive posterior instrumentation with rods and wires was applied to produce and maintain correction. A short segment (one level above-one below) posterior fusion was performed. Perioperative transfusion requirements were between 250 and 500 ml (375 cc average). The duration of the operation was between 160 and 300 minutes (215 minutes average). All patients were followed up with a fulltime TLSO for two months, day only bracing was prescribed till the end of the sixth month. In one case a minor ulcus at the end of a rod healed without further complications. The follow up period was between 13 and 6 months, (8,4 months average). The avarege corretion of the scoliotic and kyphotic curves was 38 degrees. There were no considerable loss of correction at the last controls. We presume that this technique can be applied to a wide spectrum of congenital spine deformities to obtain a balanced spine in young ages.

Paper #2

HEMIVERTEBRAE EXCISON IN THE SURGICAL TREATMENT OF PATIENTS WITH CONGENITAL SCOLIOSIS. A REVIEW OF 13 CASES IN 12 PATIENTS.

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Hemivertebrae are one of the most common causes of congenital scoliosis. The severity of the resultant scoliosis is related to the degree of growth potential. Braces are not effective and surgical treatment is frequently necessary if the curve increases. Two kinds of operations have been proposed convex growth arrest and excision of the hemivertebrae. Hemiepiphyseodesis of the convexity should be performed under the age of 5 years and the correction of the curve depends on the growth potential of the concavity. Excision of the hemivertebrae has some advantages it produces total correction of the deformity and there is a single level fusion. Thirteen cases of hemivertebrae resection in twelve patients have been reviewed. All patients were operated by a double approach under the same anesthetic. The minimum follow up was 1 year and the maximum 5 years (average 3 years). The age varied between 17 months and 5 years (average 3 years). Three hemivertebrae were located in the thoraco-lumbar region and the rest in the lumbar region. The preoperative curve degree varied between 30° and 46° (average 35°). The postoperative curve degree varied between 0° and 16° (average 6°). Correction was achieved by instrumentation of the two adjacent vertebrae (compression of the convexity). Pediatric Harrington instrumentation was used in 1 case, pediatric T.S.R.H. in 1 case and Baby C.D. in 11 cases. All patients wore a brace for a period of 6 months. Solid fusion was achieved in all cases. There were no neurologic complications. Hemivertebrae excision seems to be a valuble and safe procedure for the surgical treatment of congenital scoliosis.

Paper #3

COMBINED ANTERIOR-POSTERIOR CONVEX HEMIEPIPHYSIODESIS FOR CONGENITAL SCOLIOSIS

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INTRODUCTION: Progression of curve in congenital scoliosis is due to unbalanced vertebral growth, with the convexity outgrowing the concavity. Combined anterior and posterior convex hemiepiphysiodesis is known to be the optimum form of early surgical treatment for patients with some growth potential on the concavity at the site of the vertebral anomaly. Retrospective analysis was performed to see how predictable was growth potential and how sufficient was a convex growth arrest.

MATERIAL AND METHOD: Nine patients having congenital scoliosis without a significant kyphotic component (8 due to hemivertebra/e and 1 with unilateral unsegmented bar) are included. All had documented progression. The average age was 3+9 years (1.5-6) and mean follow-up was 4+4 years (2 to 6+9). The curve was thoracic in 6, thoracolumbar in 2 and lumbar in 1 and fusion was extended over the entire curve within the limits of Cobb angle. A subcutaneous Harrington rod was used in one patient and on average 5.7 vertebrae (2-8) were fused.

RESULTS: After an average follow-up of 4+4 years, a total correction of 12.8° (25.8%, 3°-27°) on average was calculated. So far curve progression was halted in all cases, in five it worked as a true epiphysiodesis and in four as an arthrodesis and fusion. There were no major early or late complications.

CONCLUSION: Early diagnosis is the key for optimal treatment in congenital scoliosis and convex anterior and posterior hemiepiphysiodesis is a safe and effective (for correction or stabilization) procedure in young children (especially < 5 years) with congenital scoliosis due to hemivertebra and with no kyphotic or lordotic component. Although our follow-up is short and all patients are still growing, many of them have a good chance to reach skeletal maturity without needing further surgery.

Paper #4

SURGICAL TREATMENT CONGENITAL SCOLIOSIS DUE TO FORMATION FAILURE

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Congenital spinal deformities in the thoraco-lumbar spine are mostly a mixture of failure of formation and segmentation combined with rib abnormalities. This study retrospectively analysed role of surgical management in patients with congenital scoliosis due to formation failure.

MATERIAL AND METHODS: Between 1987-1997, 42 consecutive patients with mean age 8,5 years with mean preop Cobb's angle 57,8° were operated in our Hospital. 25 patients had single hemivertebra, 17 patients had multiple hemivertebra and or bars. In 13 cases we perform anterior and posterior hemivertebrectomy. In 29 cases we perform combined anterior and posterior fusion with instrumentation.

RESULTS: At a follow up beyond 3 years the average Cobb angle is 48,9°. Scoliosis stabilised.

CONCLUSION: Hemivertebrectomy and anterior and posterior fusion combined with instrumentation is good method for stabilization of progression. Surgery should be done much earlier then ours patients.

Paper #5

KYPHECTOMY AND STABILISATION WITH VERTEBRAL SCREWS IN SPINE BIFIDA

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Extreme kyphotic deformities at the lumbar level are among the frequent problems in children with high level spina bifida. These children experience problems with sitting and standing balance along with decubiti at the apex of the deformity. Historically these problems were addressed by kyphectomy and rod-wire techniques which required long segment instrumentation. Beyond the perioperative problems caused by along incision these children's have to face a nonphysiological short thoracolumbar spine because of the long segment instrumentation and fusion at a young age. We operated on six patients between the ages of three and seven with a combination of pediatric sized vertebral screws, rods or plates, wires and transvers connectors. In all patients relatively short segment instrumentation (average 4, 8) was applied with satisfactory correction. Cast applications was limited to two months Skin slough was encountered in two patients and implant loosening at the cephalic side was revised in the first case. The follow up period was between 26-12 months. Generally the results of the operation were satisfactory and in all patients sitting balance was gained and the occurrence of apical decubiti was prevented. The short segment fusion potentially will avoid the development of a short spine but the risk of recurrence of the kyphotic deformity may remain.

Paper #6

SEGMENTAL SPINAL DYSGENESIS

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Segmental spinal dysgenesis is an uncommon congenital spinal defect characterized by localized segmental agenesis of the spine. Bony defects include significant focal canal stenosis, hypoplastic or absent vertebrae, subluxation of the spinal column, and instability. Associated anomalies are common. Progressive kyphosis is inevitable.

We present 4 cases of segmental spinal dysgenesis, who were operated on in the Division of Pediatric Neurosurgery at Marmara University Medical Center. The ages varied between one and five years. Distal neurologic deficits are presented in all cases. In order to realise an accurate visualization conventional radiographic techniques, three-dimensional computerized tomographic reconstruction and spinal MR were performed. These studies were repeated also in the postoperative period. The treatment was directed at the establishment and maintenance of spinal stability and arrest of the progressive kyphosis. It consisted of early arthrodesis, with or without anterior decompression of the chord.

Paper #7

LUMBAR SPINE FUSION IN THE TREATMENT OF DEGENERATIVE SPONDYLARTHROPATHY: A REVIEW OF 146 CASES

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Spondylosis, a generalised process that affects all levels of the spine, encompasses a sequence of progressive degenerative changes in the intervertebral disks, vertebral bodies, facet joints, and ligamentous structures. It occurs in a sequential fashion as the body and spine age. Instrumented spinal fusion is considered the standard treatment of spinal deformities such as scoliosis and instability resulting from trauma. Its use in degenerative conditions of the lumbar spine is still controversial. In this review, we report the outcome of 146 consecutive lumbar fusion with spinal instrumentation. Posterolateral interarticular process fusion with or without associated interbody fusion were the technique of fusion utilised. The follow-up period goes from 2 to 10 years. There were 71 males and 75 females. The indication for the operation was spondylolysis with and without olisthesis, degenerative disc disease and facet joint arthrosis, pain after prior laminectomy (failed back surgery), spinal stenosis and neurogenic claudication. The type of hardware, the level of fusion, associated laminectomy and interbody fusion, early and late complications, hardware failures, clinical and postoperative outcome are analysed. The evaluation of results and the score system utilised are reported. A review of the medical literature on the subject with special reference to the end results is summarised. With results quoted as excellent and good in 87,4% of the we believe that instrumented spinal fusion can be a gold standart treatment in well selected cases.

Paper #8

REVERSE LAMINOPLASTY FOR THE TREATMENT OF LUMBAR SPINAL STENOSIS. A NEW SURGICAL TECHNIQUE

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Narrowing of spinal canal diameter secondary to degenerative disease leads to neurological symptoms and signs, including neurogenic claudication. This process is diagnosed by CT and MRI and is treated by a variety of decompressive procedures. The presence of a posterior compression requires a posterior decompression. However, the occurrence of postlaminectomy instability, herniation of muscles toward the spinal cord, and fibrosis are the main laminectomy-related problems. To avoid such problems, 10 patients with spinal stenosis underwent a reverse laminoplasty. Following excision of laminae using high speed drill, yellow ligament and herniated disc were removed and laminae were replaced so that the cranial aspect was placed in caudal orientation, and caudal aspect in cranial orientation. In the last step, laminae were fixed by means of mini plates. Spinal stenosis were at L4-L5 in all cases.

The symptoms were totally relieved after operation and a regression in neurological deficits was obtained. Preoperative and postoperative spinal canal size was performed using CT scan. The spinal canal diameters showed and 78% enlargement in postoperative CT scans.

It is concluded that reverse laminoplasty is an effective and easy procedure, and provides a natural barrier against fibrosis and muscle herniation into the spinal canal.

Paper #9

EARLY RESULTS OF SURGICAL TREATMENT FOR DEGENERATIVE LUMBAR SPINAL STENOSIS

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Degenerative lumbar spinal stenosis is a major cause of low back and lower extremity discomfort and disability in the elderly. Because nonoperative therapy for this condition seldom results in long term improvement, surgical therapy in these patients has to be considered to improve their function and comfort.

PURPOSE: To analyse retrospectively our indications, preoperative evaluation protocol, surgical technique and early clinical results after decompressive surgery alone and combined with both instrumented and noninstrumented arthrodesis in degenerative lumbar spinal stenosis.

MATERIALS AND METHODS: Twenty-five patients (17 female and 8 male) with an average age of 62,8 years (range, 40-85 years) were evaluated. One level was decompressed in 7 patients, 2 levels in 7 patients, 3 levels in 4 patients, 4 levels in 4 patients and 5 levels in 3 patients. The extent of the decompression was determined mainly on clinical symptoms and the findings of MRI, dynamic myelography and myelo-CT. Only in 2 patients (8%) decompression alone was undertaken, the remaining majority (23/25,92%) had an instrumented arthrodesis (20/23,87%) or noninstrumented arthrodesis (3/23,13%). 7 patients (28%), who had spondylosis or degenerative sponylolisthesis, all had an arthrodesis and all except one were instrumented.

RESULTS: At final follow-up, mean 14.5 months (range, 6-96 months) postop, all patients were given an interview and underwent a physical and radiological examinations. Patients were evaluated regarding peri-and postoperative complications, reoperations, back pain, leg pain, numbness, abilitiy to perform daily activities, walking capacity, bladder function and satisfaction with surgery.

Despite the relative high percentage (32%) of peri-and early postoperative complications (deep wound infection in 2 patients and superficial wound infection in 1 patient, sterile wound drainage after bone allograft in 1 patient, dural tears in 2 patients and transient paralysis of nerve roots in 2 patients), all were successfully managed. No reoperation was noted during the follow-up period. The patient's satisfaction rate of 88% in the short term was remarkable high. Sciatica was the symptom most frequently relieved and back pain was the most frequently persisting symptom after operation.

CONCLUSION: Decompressive surgery with instrumented and noninstrumented arthrodesis for degenerative spinal stenosis appears to be beneficial, at least in the short term, for many patients in reducing pain and increasing function but is associated with a high rate of complications probably due to relatively advanced age and current comorbidities of the patients and mainly low lumbar location of the surgical field.

Paper #10

SURGICAL TECHNIQUE OF REDUCTION AND FIXATION OF LUMBAR SPONDYLOLISTHESIS

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The purpose of this paper was to focus upon the mechanism of surgical technique of reduction of lumbar spondylolisthesis in the prone position on the spine frame, which had been discussed by many authors in past.

MATERIALS & METHODS: Eleven patients of the 4th or 5th lumbar spondylolisthesis, either degenerative or displastic type, which showed more than 30% slip (30-80%) rate by Boxall method were operated upon by pedicle screwing and PLIF. Seven patients (mean age 33) were operated by what we call "lordosisization method" and the other four patients (mean age 45) were operated by new "lordosisization method" which was designed to force direct lever action upon the vertebral body distal to the slipped vertebra.

RESULTS: Correction rate of slip rate was 52.4% in the first group while 77.4% in the second group. Lordotic gain of slip angle was 17.1 degrees in the first group while 23.2 degrees in the second group. The difference was significant.

DISCUSSION: The mechanism of reduction was thought in general to be distraction and posterior translation-posterior rotation of the slipped vertebral body but we found actual mechanism was distraction and anterior translation - anterior rotation of the vertebral body distal to the slipped vertebra in the prone position on the spine frame. New 'lordosisization method' included the lever action maneuver to force the vertebral body into anterior translation - anterior rotation to reduce olisthesis.

CONCLUSION: New understanding of mechanism of reduction of spondylolisthesis proved to increase correction rate by using pedicle screwing on the spine frame.

Paper #11

"REINFORCEMENT OF THE POSTERIOR SPINAL LIGAMENTS AFTER DISCECTOMY"

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The last eight years, 65 patients who underwent discectomy for extruded disc hernia have been found during operation to suffer from laxity of the paraspinal and interspinal ligaments.

After the fenestration and the removal of disc material too strong sutures or wires have been passed, like "eight" around the basis of the processus spinosus and the spine became more tight.

Two of the patients are re-operated after one and half year for removal of the wires. Both wires have been found intact. The 63 patients have not complained for back pain after the fenestration in a follow-up time of five years.

Paper #12

INDICATIONS AND TECHNICAL ASPECTS OF LUMBAR POSTERIOR ENDOSCOPIC MICRODISCECTOMY: RESULTS OF A 18 MONTHS MULTICENTER STUDY

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Percutaneous lumbar discectomies remain somewhat controversial. Generally, there are limited indications for these approaches and very often they have not proven to be as effective as standard open surgery. Three years ago a new percutaneous procedure for lumbar disc surgery was described by K.T. Foley and M.M. Smith, the MicroEndoscopic Discectomy (MED). This technique allows the surgeon to address not only lumbar disc herniations, but also free fragments and symptomatic lateral recess bony stenosis, through a traditional posterior midline approach and using standard surgical instruments, by a small tubular retractor under endoscopic visualization.

MED can be performed under general or epidural anesthesia and the patient can be positioned in prone or lateral decubitus. A C-arm fluoroscope is necessary to control the exact lumbar level and obtain lateral images for the correct positioning of soft tissue sequential dilators. When the final tubular retractor is positioned and fixed to the table, the endoscope and a suction tube are inserted, beginning the standart surgical procedure for lumbar discectomy (ie. soft tissue removal, small laminotomy, flavectomy, nerve root retraction and disc removal). The result of surgery is a small incision, minor disruption of the paraspinous muscles and successful removal of disc.

The first preliminary MED series was presented by Foley and Smith in 1997. In Italy, a multicenter study has started on December 1997, when the first Author performed his first MED procedure. Actually, 112 patients were operated by the Italian study group with MED technique. The results and statistical analysis of the first 57 of them will be presented, with a mean follow-up of 13 months (min.6 - max. 18).

These preliminary clinical experiences with this technique show it to be at least as effective as open surgery, but much less painful with a shorter hospital stay and a quicker return to activity.

Paper #13

LAPARASCOPIC L5-S1 ARTHRODESIS: 20 CASES WITH A DOUBLE BARREL INSTRUMENTATION

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L5-S1 interbody fusion have a high rate of success. The use of endoscopy optimize this less aggressive technique but cage positioning is sometimes difficult.

OBJECTIVES: To optimize cage positioning, we use an airtight double barrel device. This is the first clinical series investigating this instrumentation for L5-S1 fusion.

METHODS: Twenty patients (15 females, 5 males) suffering from chronic low back pain underwent anterior interbody stabilization via laparoscopic approach, usually through two 10 mm portals, one 5mm portal and one 30mm portal. All patients underwent 2 Sofamor Danek LT titanium cages (length: 20 or 26 mm; diameter: 12/16 mm). The long axis of the cages was in a straight AP direction and the two cages parallel centered on the midline of L5-S1. The conical cages restored the normal height of disc via annular distraction and lordotic shape. All patients had a MRI before surgery to appreciate location of vessels bifurcation, and results were evaluated by Prolo's score and X-rays.

RESULTS: The overall morbidity of the procedure was very low. No septic or neurologic complications occurred, no retrograde ejaculation, no major vascular, digestive or urinary injuries were detected. One haematoma on iliac crest harvesting site needed a debridement. The settling of the double barrel needed safe manipulation of the vascular anatomy to allow cage insertion. A minimal exposure of 32 mm for two 12/16 mm cages was necessary. A Kirshner pin was inserted in L5 vertebra to retract left iliac vein and right iliac artery, to avoid vessels injuries. The 2 cages were strictly parallel and in the AP direction in all cases. In 4 patients, one out of two cages was less deep than the opposite (one to two mm) but the fusion was achieved after 10 months: no case of implant migration, no significant subsidence or pseudarthrosis. Prolo's score was improved: economic status from 2,6 to 4,3 and functional status from 2,5 to 4,4.

DISCUSSION: This preliminary study of 20 patients illustrates the fact that endoscopic technique using a double barrel can be effectively applied without per-operative vascular, neurological or visceral injuries. The double barrel allows a better mechanical positioning of the cages and is as safe as single barrel device.

Paper #14

PERCUTANEOUS ENDOSCOPIC DISCECTOMY

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OBJECTIVE: The purpose of this study is to show an easy, safety and efficient way of percutaneous micro-decompressive endoscopic spinal discectomy with laser or coaglothermo discoplasty procedure for 50 patients.

MATERIALS AND METHODS: Uncomplicated herniated disc combined with pain in the back or leg. Pain that is not responding to conventional treatment such as physical therapy, traction, bed rest, exercises and medications given for at least 6 weeks with positive CT scan, MRI or myelogram CT or discogram for disc herniation.

RESULTS: The preliminary results of percutaneous discectomy has been improved since the laser or the thermo-coagulation was added to the treatment of the lesion. There has been no significant post-operative complications. Some patients have residual pain in terms of infrequent radiculopathy or loss of sensation. On average, patients returned to their usual activities in three weeks time.

CONCLUSION: Microdecompressive percutaneous endoscopic spinal discectomy with added laser or thermodiscoplasty is an easy, safe and effective measure to treat herniated disc of the lumbar spine. Therefore, we are improving and promoting the advantages and clinical results of minimally invasive spinal discectomy for disc disease as compared to open laminectomy.

Paper #15

ANTERIOR LUMBAR INTERBODY FUSION WITH THREADED ALLOGRAFT BONE DOWEL VIA A LAPAROSCOPIC APPROACH

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PURPOSE: To analyze and evaluate the learning curve experience with lumbar transperitoneal laparoscopic discectomy and interbody fusion.

METHODS: 27 patients (range age 19 to 70) underwent laparoscopic anterior transperitoneal lumbar interbody fusion at the L4-5 and/or L5-S1 disc spaces. The procedure is performed with CO2 insufflation to enable visualization through a 10 mm endoscope. Four portals are generally required for one level and seven for two levels. The technique involves approaching the lumbar spine via a laparoscopic transperitoneal route. The intervertebral space is then enlarged using serial distractors and at maximal distraction the disc space is then reamed and tapped. A dowel is then placed into the intervertebral disk space. The diagnoses were posterior lumbar pseudarthroses in 7 pts, degenerative disc disease with discogenic pain in 20 pts, and 8 pts, also had foraminal stenosis. Threaded cortical allograft bone dowels were used in 26 patients and non-threaded iliac crest dowel in 1 case.

SIGNIFICANCE: After the correct and precise identification of the anatomical source of pain (MRI, discography), disc replacement from the front with bone and fusion may be the best surgical option. Advances in imaging studies and in surgical techniques have permitted the development of minimally invasive spinal surgery with the result of less surgical injury to the patient, less blood loss, shorter length of hospitalization and quicker rehabilitation and work return.

RESULTS: The mean length of hospital stay was 3,40 days (range 1-7 days). Ambulation began at the first postoperative day. 47 allograft bone dowels and 1 autogenous bone dowel were placed. Average estimated blood loss was 160cc (range: 120-400 cc). The average operative time was 190 min. for one level and 370 min. for two levels. The patient with non-threaded dowel had slight anterior displacement without the necessity of reoperation. There was six laparoscopic procedures that required conversion to open procedures. Four of them occurred when two level exposure was attempted. The causes for conversions were; iliac vein tear in two cases, iliac vein anomaly in one case and intraperitoneal adhesions due to previous surgeries in three cases. One patient developed a non-union and required posterior fusion and instrumentation. There was one allograft bone dowel collapse with no clinical significance.

DISCUSSION: Laparoscopic L4-5 and L5-S1 anterior lumbar interbody fusion may represent a viable and safe option for patients with a symptomatic spinal motion segment. This approach decrease duration of hospital stay, recovery time, morbidity and is potentially less expensive than open surgery for anterior lumbar spinal fusion.

Paper #16

HOW SHOULD THE THORACOLUMBER BURST VERTEBRAL FRACTURES BE TREATED? CONSERVATIVELY OR SURGICALLY.

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The treatment of thoracolumbar burst fractures is controversial since the criteria of stability for that fractures are not clear. There are many conflicting conclusions about the choice of treatment. In our prospective study we tried to determine the factors that effect the results of our treatment both clinically and radiologically.

17 conservatively and 17 surgically treated patients with thoracolumbar burst fractures whose average age were 45 years (26-47) and who were averagely followed for 26.5 months (12-37) were examined prospectively. All the ptients had two column fractures and all of them were neurologically intact. The radiological and clinical results of both groups were analysed statistically with Mann-Whitney U test.

There were no statistical difference between the levels of burst fractures for each group. The values of local kyphosis angle (LKA), sagittal index (SI), anterior vertebral height (AVH) and posterior vertebral height (PVH) before and after the treatment of both groups are statistically compared. There were no statistically meaningful difference between the values of LKA, SI, AVH and PVH before the treatment while the values of same criteria showed a meaningful difference after the treatment between the surgically and coservatively treated group. There were also no difference between the rates of canal encroachment (CE) before the treatment between two groups. But the canal remodelation rate was higher in surgically treated group. The amount of CE did not effect the result of treatment.

Denis scales are used to evaluate the working and pain status of our patients. There was no statistical difference between two study groups both for working status and pain status at the end of follow-up period.

As a results we conclude that: 1- Radiological image of vertebral column worsens during the conservative treatment in comparison to surgical treatment and it is possible to restore the alignment by operative treatment. 2- CE is not a determining factor for the method of treatment and its rate does not effect the final result. But its remodelation rate is higher in surgical treatment. 3- Conservative treatment can be expected as an alternative treatment for the treatment of thoracolumbar burst fractures and factors such as patients age, social activities, medical status, economic cost and surgeon's experience should be taken in consideration for the determination of method of treatment.

Paper #17

KANEDA DEVICE APPLICATIONS IN THE TREATMENT OF THORACOLUMBAR FRACTURES

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The excision of posterior half of the vertebral body along with the retropulsed bony fragments and filling the gap with an appropriate bone graft is the treatment of choice in certain burst fractures. Internal fixation with Kaneda device after that decompression is a reliable method in most of the patients with that type of fractures. It gives sufficient stabilization and allows early mobilisation without any external support. Evaluated in this study are the results of 39 patients (25 male, 14 female) with burst fractures who were treated by anterior decompression and internal fixation with Kaneda device between 17/6/1994 and 26/2/1999. Mean age of the patients at operation was 27.2 (16-45). Fractured vertebra level was T12 in 8 (%20.5) L1 in 20 (%51.3), L2 in 8 (%20.5) and L3 in 3 (%7.7) patients. Mean preoperative canal compromise was %38.2 (%16-60). Twenty-six tricortical iliac autografts, 11 fibular allografts and 1 fibular autograft were used after decompression. Patientsl mean sagittal index was 33° (13-48) preoperatively and 12° (-1, -28) postoperatively. Seventeen of the patients were neurologically intact at admission, while 4 patients were in Frankel B, 6 patients in Frankel C and 12 patients in Frankel D. No neurological deterioration occurred due to operations and mean advance in Frankel grades of patients with neurological problems was 1.3 (0-2) postoperatively. Complications included postoperative scoliosis in 11 patients, screw placement problems in 5 patients. Mean postoperative scoliosis angle was 4.2° (0-19). Six (%3.8) screws were found to penetrate inter-vertebral discs and 1 screw was within the canal with an eccentric location. The patient with screw within the canal reoperated next day and the screw placement was corrected without any neurological damage. No infection occurred in any patients.

Paper #18

THE SURGICAL TREATMENT OF THROCOLUMBAR VERTEBRA FRACTURES AND IT'S RESULTS.

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The number and scale of injuries is increasing day by day, causing more and more vertebra fractures. However, the advancements in medicine and technology enable us to analyze and cure these fractures much better than we used to. In this study, the surgical treatment and results of thoracolumbar vertebra fractures (TVF) are presented.

Out of the 38 cases brought to our clinic between 1991 and 1998 due to TVF, 30 cases, of whom 15 were male and 15 were female, were analyzed. In all cases posterior spinal fusion (PSF) were performed with the use of autografts in addition to posterior spinal instrumentation (PSE). The average age at the time of surgery was 33.6 years (range, 17-65 years). Falling from height (22 cases) and traffic accidents were the most common causes of injuries. Of the 36 TVF seen in 30 cases, 25 were burst fractures, 5 were compression fractures, and 6 were fracture-dislocations. In addition to TVF, in 15 cases additional skeletal system lesions were present. In all cases transpedicular fixation, screw-hook combinations, and sublaminar wiring the choice of surgical technique. The average duration of follow-up was 35.6 months (range, 8-84 months). Preoperatively 6 cases were Frankel A, 1 case was Frankel D, and 23 cases were Frankel E. No neurological deterioration or improvement was seen in postoperative period. Long term follow-up revealed solid fusion in all 30 cases.

Today, for the treatment of unstable TVF, we recommend the surgical treatment. We believe that, in patients who are neurologically intact with no deterioration and in patients with complete lesions PSF with PSE will serve as an adequate and satisfying method of treatment.

Paper #19

THE BIOMECHANICAL INVESTIGATION OF THE EFFECT OF ADDITIONAL TRANSPEDICULAR FIXATION OF THE FRACTURED VERTEBRAE ON STABILITY IN BURST FRACTURES (A calf Spine Model)

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One of the most common traumatic lesions that result in an incomplete neurological deficit is unstable burst fractures of the spine. Posterior spinal instumentation for thoracolumbar trauma is well-established and documented treatment modality. After Harrington introduced posterior spinal instrumentation for most unstable thoracolumbar spine fractures, it has been the most commonly applied method of stabilisation and fusion. Posterior spinal instrumentation uses the well-known and familiar technique of posterior midline exposure. The basic technique involves routine posterior spinal exposure and screw placement into the pedicle 1 level above and 1 level below to the injured level with, if possible, an additional screw placement into the pedicle at the injured level.

The purpose of this study is to investigate whether additional transpedicular screw fixation of the injured vertebra could increase the stability of posterior fixation.

Biomechanical tests were performed on fresh lumbar spines from calves. Ten fresh calf spine segments, each containing three motion segments, were obtained and anterior corpectomy at the middle vertebra of each segments was performed. Posterior spinal instrumentation was applied to all of them. In the first group, screws were placed into the pedicle 1 level above and 1 level below the corpectomy level. In the second group of five calf spine segments, additional transpedicular fixations were obtained at the corpectomy level. Stability of these two group was tested by applying axial compressive loads. The results were evaluated statistically.

We found that screw placement at the injury level did not provide an additional stability of the posterior stabilization of the vertebrae.

Paper #20

THE RESULTS OF ANTERIOR SURGERY FOR BURST FRACTURES OF THE THORACOLUMBAR SPINE

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Between 1992 and 1998, 36 patients with thoracolumbar burst fractures were treated by anterior surgery. 20 patients were male and 16 patients were female and mean age was 30.6 years. Mean follow-up was 12 months. The fracture levels were between T9 and L4. Fractures were classified according to Denis. Our surgical indications were; progressive neurological deficit, anterior vertebral height loss > 50%, Sagittal Index > 25° and canal involvement > 60%. Anterior decompression with strut graft and anterior instrumentation were performed in all patients. Tricortical iliac autograft (18 cases), fibular allograft (5 cases) and Harms cage (13 cases) were used. We used Kaneda anterior spinal system (10 cases) and Synergy spinal system (26 cases). All patients were evaluated pre and postoperatively with CT scan.

No neurological deterioration, major thoracoabdominal complication or implant failure was seen. Sagittal contour was restored in all cases. The overall clinical results were satisfactory with the relief of clinical symptoms and neurological recovery with solid union.

Upon this review, we concluded that when appropriate indications are considered, anterior decompression, strut grafting and instrumentation is a safe and effective method in the treatment of unstable thoracolumbar burst fractures.

Paper #21

FLEXION-DISTRACTION INJURIES COMBINED WITH FRACTURES OF THE VERTEBRAL BODY

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INTRODUCTION: Spinal injuries are considered to be isolated injuries in most of the widely used classifications for fractures. However some of these injuries involve combined mechanisms which may remain unrecognized and lead to increased morbidity and inappropriate treatment. One of these is the flexion-distraction injury with anterior (compression) or anterior and middle column (burst) failure. Transvers axis of the flexion moment remains close to the posterior wall of the vertebral body, thus resulting in transvers disruption of the posterior column and compression or burst fracture of the vertebral body. Initial evaluation may result in conservative treatment for a simple compression fracture or anterior decompression surgery for a burst fracture but further evaluation of the posterior elements by oblique radiographs and MRI may demonstrate a ligamentous or bony distraction injury.

PATIENTS AND METHODS: 14 patients with flexion-distraction injury and vertebral body fracture underwent surgical treatment. The mean age was 26.5 (16-40) years. Five had anterior column failure and nine had anterior and middle column failure. Patients with anterior column lesion had posterior instrumentation and fusion only. Patients with both column failure had first posterior instrumentation and then anterior decompression and fusion. Seven patients in the second group had accompanying neurologic deficit. Dural tear was noted in four patients during the posterior procedure. We had no implant failure or loss of correction at the end of an average follow-up of 16 months.

CONCLUSION: Proper evaluation of the posterior elements is utmost important for the diagnosis of flexion-distraction injuries with fractures of the vertebral body. When the diagnosis is made treatment should start with a posterior procedure.

Paper #22

NON-OPERATIVE MANAGEMENT OF STABLE THORACOLUMBAR BURST FRACTURES WITH TLSO

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In thoracolumbar vertebral fractures with incomplete neurologic deficit and in fractures involving all three columns, the role of surgical stabilization is well established. However, in the neurologically intact patient the advantages of operative treatment become less clear. The purpose of this retrospective study is to analyze the efficacy of extension bracing in a carefully selected group of patients with burst fractures of the thoracolumbar spine.

Nineteen neurologically intact patients with burst fractures at the thoracolumbar junction were treated with an average duration of one month of bed rest and ambulation in a total contact orthosis for six months. No attempt was made to reduce the deformity. Selection criteria excluded patients with posterior column disruption wich was determined by the existence of more than 30 degrees of kyphosis at the fracture site, more than 50% anterior loss of vertebral height, widening of adjacent spinous processes, facet or pars interarticularis fracture and subluxation as well as more than one thoracolumbar fracture and any sign of deteriorating neurologic function. Hospital stay averaged ten days. Follow-up averaged 32 months. Mean kyphosis was 17 degrees at time of injury and 22 at last follow-up work and pain scales were used for subjective evaluation. At follow-up 15 patients rated their pain as little or none. Sixteen patients had little or no restriction of activity. Follow-up CT scans obtained in 8 patients showed significant resorption of retropulsed bone. No deterioration of neurologic function developed in any patient. In patients with intact posterior elements and thoracolumbar burst fractures, conservative management in a total contact TLSO can lead to satisfactory functional result. The authors attribute the good results of non-operative management to the exclusion of patients with posterior column disruption.

Paper #23

CARBONIUM FIBER CAGES IN THE SURGICAL TREATMENT OF SPONDYLOLISTHESIS

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The main goals of surgical treatment in spondylolisthesis are: pain relief, restoration of sagittal plane alignment and correction of postural deformity. In 1943 Cloward first described the Postero-Lateral Interbody Fusion (PLIF) in 122 patients with spondylolisthesis. PLIF maintains disc height, protects the nerve roots and restores weight-bearing to the anterior structures and immobilizes the unstable degenerated intervertebral disc space. The carbon fiber-reinforced polymer implant proposed by Brantigan (1991) separates the mechanical and biologic function of PLIF. Carbon cages provide immediate mechanical stability of the spinal segment treated, protecting the bone graft from mechanical stress. It minimizes the bone graft harvesting. It is thus possible to reduce complications in the donor site, widely described in the literature. From 1993 through 1997 at the Division for Spinal Surgery of the Catholic University in Rome, Italy, 18 patients with spondylolisthesis were treated by means of Carbonium Fiber Cages combined with VSP plates. VSP plates, first described by A. Steffee in 1986, are particularly indicated in the treatment and reduction of spondylolisthesis because of their great capability to be contoured for anatomic positioning. Steffee plates permit rigid and permanent stabilization of the spine, enhance graft consolidation and fusion and restore the sagittal plane alignment. Mean age was 41 years, 6 patients were female, 12 males. Mean slippage was 40%. Mean follow-up was 2 years ranging, from 1 year to five years. All patients but 5 underwent postoperative clinical and X-ray examination and CT-scan (coronal, sagittal and axial view) 6 months and one year after surgery in order to check the positioning of the cages and the bony fusion. In all patients but three we observed pain relief, good reduction of the slippage (70-100%), permanent restoration of sagittal plane alignment and correction of postural deformity. In one patient low back pain increased after operation making it necessary to remove the VSP implant but not the carbon cages. In another patient breakage of two screws was observed after a serious car accident. No other major complications were observed. In conclusion Brantigan carbonium fiber-reinforced polymer cages combined with Steffee VSP system has proved to provide a stable reduction and fusion and symptomatic relief in most of the patients surgically treated for spondylolisthesis.

Paper #24

PRELIMINARY REPORT OF THE USE OF MORPHOGENETIC RECOMBINANT HUMAN PROTEIN (rhBMP-2) FOR PRODUCING POSTEROLATERAL BONY ARTHRODESIS IN HUMAN SUBJECT

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MATERIAL: Seven patients are reported. Age: 35 to 65. Follow up: 6 months. Sex: 6 females, 1 male. All had instability and pain in the lumbar spine. All had posterolateral application of BMP-2 in one posterolateral gutter, on the other side, autogenous bone graft. All had GDLH Titanium Instrumentation. Clinical controls with X-Rays, and tomograms were done immediately, pre op., post op., six weeks, three months, and six months. All were interpreted by three independent observers.

RESULTS: At three months, the side with autogenous bone was reported with 43% with fusion, and other side with BMP-2, 86% fused. At six months both sides were 100% fused with diminution of pain of 80%. All neurological signs and symptoms had disappeared.

COMPLICATIONS: There was one trans operative complication, a broken pedicle.

Paper #25

POSTERIOR LUMBAR INTERBODY FUSION ENHANCED WITH RAMPS AND CAGES: A REVLEW OF 60 CASES.

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The success of an interbody fusion is limited by mechanical and biologic deficiencies of the donor bone. The use of cages provides an implant, which is designed to meet the mechanical requirements of postero lateral interbody fusion. It replaces the donor bone with autologous bone, best possible bone for healing. Their main role is to seperate the mechanical and biologic functions of postero lateral interbody fusion offering a protection for the graft during the consolidation process. Furthermore, a lesser quantity of bone graft is necessary and is harvested from the bone collected from the resected laminae.

We report a 1 to 6 years follow-up results for 60 consecutive patients. There were 16 males (mean age 41,2 years) and 44 female patients (mean age 44,6 years). Indications included postsurgical failed backs, spondylolisthesis and spondylarthropathies. The same surgeon operated all cases. The implants achieved successful fusion in all of the followed patients. Complications, which occurred in this series, included one transient radicular involvement, which resolved after modifying a malpositioned screw, 1 screw breakage with reoperation, one displaced ramp with reoperation from an anterior approach. Clinical results were quoted as excellent in 41/60, good in 6/60, and poor in 3/60, although in one case, the poor result was not attributable to objective identifiable problems related to the surgical procedure but rather with a person involved in a worker's compensation claim. This surgical procedure is very satisfactory as to the results achieved but it must be stressed that good patient's selection and a high degree of surgical expertise are needed to carry it out.

Paper #26

A.L.I.F. WITH SCREWING CAGES

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The evolution of the spine surgery in the last years has allowed a progressive less agressivity of the surgical technics.

The application of the "minimal invasive technics" to the anterior reconstruction of the lumbar-sacral spine are the example of a correct philosophy according to the biomechanical, biological and anatomical point of view. However its limitations impose a critical view to its use as exclusive technics.

The authors referring to the strategy of the different anterior approach of the lumbar-sacral spine, present their indications for isolated A.L.I.F. and A.L.I.F. with transpedicular instrumentation associated as well as the respective counter-indications.

The authors present their casuistics of the last $3\ ^{1}/_{2}$ years commenting on the clinical results of the use of the screwing cages.

Paper #27

SPONDYLOLISTHESIS: A COMPARISON OF 3 SURGICAL APPROACHES

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PURPOSE OF THE STUDY: The purpose of our report is to assess the validity of three methods of the surgical treatment of spondylolisthesis: 1) posterior fusion in situ, 2) transpedicular screw reduction, stabilisation and posterolateral fusion, 3) transpedicular screw reduction, stabilisation, posterolateral fusion and posterior interbody fusion.

MATERIAL AND METHODS:
Between 1992-1997, 43 patients with mean age was 23 years were divided into three group:
Group I- 6 patients with grade I spondylolisthesis received, in situ posterior fusion
Group II- 16 patients received, laminectomy, nerve root decompression, reduction, stabilization with transpedicular screw fixation and posterolateral fusion.
Group III- 21 patients received, laminectomy, nerve root decompression, reduction, stabilization, transpedicular screw fixation with posterolateral and posterior interbody fusion.

RESULTS: At a follow-up beyond 2 years. For the patients in group I there was a good fusion and stabilisation, occasional low back pain in 1 case mainly with activity and disapearing with rest. In group II there was 6 implant failure with pseudoarthrosis, 6 loss of reduction. In group III there was good clinical and radiological results.

CONCLUSION: Transpedicular reduction and stabilisation combined with posterolateral and posterior interbody fusion represent the most physiological and biomechanically correct procedure in the treatmet of spondylolisthesis. Posterior interbody fusion improved clinical and radiological result.

Paper #28

LONG-TERM RESULTS OF INSTRUMENTATION SURGERY FOR SPINAL DEFORMITY PATIENTS - 20 YEARS OR MORE AFTER SURGERY, IN PATIENTS OVER THIRTY YEARS OF AGE

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PURPOSE: Long term results of instrumentation surgery for spinal deformity patients 20 years or more after surgery, in patients over 30 years of age, were reviewed.

MATERIALS AND METHODS: One hundred seventy five patients were selected for this study. The patients age was over thirty years old with a minimum follow-up of ten years after surgery. One hundred thirty seven were female with mean age was 37,3 years old, mean follow-up period was 20.4 years and thirty eight were male with mean age was 36.2 years old, mean follow-up period was 19 years. Final spinal instrumentation fusion with posterior procedures which included one stage HI, H-W, Luque, CD were performed on 123 patients. Anterior fusion, including the Dwyer method and Zielke method was performed on 20 patients. Questionnaire consisted of several items: back pain, occupation, marriage, delivery, ADL, sport sactivity, cosmesis, self-consciousness, and subjective satisfaction.

RESULTS AND DISCUSSION: Posterior fusion was performed 83%, anterior procedure was 16%. Of 137 female patients, 88 patients (64%) were married and 71 patients gave birth to their children. Of the 175 patients, 41% were no pain, 57% were as Stage II or Stage III and 2% as Stage IV. Of 175 patients, 108 patients (62%) were selfconscious to some extent about the residual back deformity, and 22 patients (13%) objected to the operative scar.
Almost all of the patients complained of no ADL disability, except for difficulty in seeing backward in 35%, finger-floor distance of over 20 cm in 25%, and difficulty in putting socks on in 16% of the patients. Of 175 patients, 127 patients (73%) were satisfied with the result of the operation for the control of spinal deformity, improvement in cosmesis, and increase in physical and social activity. Six patients (%3) were dissatisfied for the reason of remaining deformity and occurrence of back pain. It is necessary for patients to follow-up longer periods.

Paper #29

LATE RESULTS OF LUMBAR CLOSING WEDGE OSTEOTOMY EGG-SHELL IN ANKYLOSING SPONDYLITIS

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PURPOSE OF THE STUDY: To evaluate the long term clinical and radiological results of closing wedge lumbar decompression osteotomy in ankylosing spondylitis.
Lumbar closing wedge osteotomy was performed for fourteen AS (13 male. 1 female) with a mean of 68° (32-104°) kyphotic deformity and a mean of 29.3 cm (7.5-41.5) sagittal axial deviation.
Mean correction was 34° (26-48°), sagittal axial deviation was decreased to 9 cm (1.7-18) cm, while 13.9 cm (7-28 cm) increase in length was achieved and all patients became able to look forward.
After mean 35 months (18-56) follow up, total kyphotic deformity was calculated to be 48° (38-63°) while there was 10.3 cm (4.1-21.6 cm) increase in sagittal axial deviation and a decrease of 4 cm (2-8 cm) in length, 2.5° (0-10°) loss of correction.

CONCLUSION: Although some loss of correction occured, we conclude that the results are satisfactory and longstanding.

Paper #30

LUMBOSACRAL SAGITTAL PLANE ANALYSIS IN PATIENTS WITH DEVELOPMENTAL DISLOCATION OF THE HIP JOINT AFTER TOTAL HIP REPLACEMENT

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It is well known that patients with sigh-dislocated hips (DDH) have altered physiologic standing balance and lumbopelvic relationships due to increased lumbosacral lordosis. These relations are of interest because these patients are prone to increased incidence of degenerative spinal problems.

Our treatment protocol for high DDH in an adult patient includes restoration normal hip biomechanics by means of a total hip arthroplasty with shortening of the femur and placing the acetabular cup in the true acetabulum. Hypotethically these patients should have beneficial effect of normal hip joints on their posture. Therefore, we evaluated Crowe 3 and 4 hips on standing lateral radiograms in order to investigate the corrective effect of restoring normal hip mechanics on the sagittal alignment of the lumbosacral spine. 11 patient with a minimum follow-up of two years fulfilled the criteria. All of them were female and the mean age was 45.5 years. At the time of presentation, mean Sacral Slope was 45.18°, mean total lordosis from L1 to S1 of ¯66.81° and, L1 to L5 was ¯53.09° These parameters were found 44.27° for Sacral Slope, ¯60.09 for L1-S1 lordosis and ¯53.18° for L1-L5 lordosis at the last follow-up. Statistical analysis revealed no significant changes before and after the follow-up.

Eventualy we concluded that the deformed sagittal alignment of the adult patients presenting with high-dislocated hips is already structural. Restoration of hip joint mechanics with a total hip prosthesis has no significant effect in short-term period.

Paper #31

SEQUENTIAL-SIMULTANEOUS RECONSTRUCTION OF SAGITTAL PLANE DEFORMITIES OF THORACOLUMBAR SPINE: A PROCEDURAL MODIFICATION

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PURPOSE: This study was designed to evaluate and introduce a procedural modification in the treatment of severe sagittal plane deformities requiring simultaneous posterior column shortening and anterior column lengthening.

MATERIALS AND METHODS: Twenty consecutive patients (12 male, 8 female), average age 33 years (range, 12-65 years) were studied. Twelve had posttraumatic hyperkyphosis, two Schuermann's, two degenerative disorders, and one each metastatic cancer, achondroplasia, spondyloepiphyseal dysplasia, and idiopathic scoliosis salvage. Twelve had an average of 1.8 surgical procedures previously. The indications in all cases were pain and/or deformity.

PROCEDURE: In the prone position, implant anchors were placed, decompression or osteotomy as needed done, and cantilever foundations placed at one end. Following temporary wound closure with additional adhesive barrier drapes, the patient was positioned in the true lateral decubitis position, discectomy or corpectomy performed, and re-exposure posterior with cantilever correction done. Finally structural grafting was done anteriorly.

RESULTS: There was one deep infection, in a patient who had had previous deep wound infection, one pseudoarthrosis with implant failure requiring revision, and three patients with pain that was relieved by implant removal. The average blood loss was 2152 cc (range, 750 to 4000 cc), length of operation was 649 minutes (range, 390 to 855 minutes), and hospital stay was 9.5 days. The mean preoperative 41 degree angle of sagittal plane deformity was improved to 7 degrees. One patient died of metastatic cancer, one was lost to follow-up at 12 months (when he was satisfactory), five were operated in the last two years, and minimum follow-up of 24 months was available on the remaining 13. The mean correction loss at follow-up was 1.6 degrees. The overall pain, function and appearance scale (5 worst, 15 best) was improved from 7 to 11 ($p=0.007$), and all were satisfied or very satisfied with the results.

CONCLUSION: The sequential-simultaneous approach for the correction of severe kyphosis can be done safely and effectively. It affords the advantages of easier position for posterior surgery and an operation which can be performed by one team. However the operating time is longer.

Paper #32

INCIDENTAL DUROTOMY: A SPINAL SURGERY COMPLICATION?

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INTRODUCTION: Dura mater tear is a common but undesirable intraoperative event. Although its occurence is used as a basis for litigation, the clinical relevance of the event is debated.

PURPOSE: The purpose of this study is to analyze the incidence, treatment and associated morbidity of dural tears.

MATERIAL AND METHODS: A retrospective review of 2144 patients who underwent spinal surgical procedures at one institution was performed. Demographic data, diagnosis, type of procedure, mechanism, treatment and evolution were recorded.

RESULTS: Dural tears were identified in 73 pts. (49.3% male) with an average of 60.2 yrs. (16-83 yrs.). 38.4% of the 73 pts. had prior (1-6) surgery. Durotomy occurred at the time of surgery in 65 (3.0% of 2144 spinal surgeries) of the 73 pts: 36 (3.1%) of 1175 laminectomies; 2 (1.0%) of 205 fusion without instrumentation; 10 (2.0%) of 502 fusion with instrumentation; 17 (8.1%) of 209 revision surgeries. Durotomy occurred prior to surgery in 9 of 73 pts. (during myelography in 8 pts. and during epidural steroid injection in 1 pt.).

68 of the 73 pts. had dural tears recognized at the time of surgery (Group 1) and the remaining 5 (Group 2) had tears identified subsequent to the primary surgery (average interval: 13.58 mths; range 0.5-72 mths).

Dural tears were repaired at the time of primary surgery in 67 pts. of group 1. This consisted of direct suturing of the defect in all cases; fibrin patch was used in 17 repairs, fibrin glue in 17; fat graft in 5 and muscle graft in 5 pts. The fascia and skin were closed using running double sutures.

2 pts. of group 2 presented with headache, 2 with neurologic deficit and 1 with CSF leak. 3 pts. were diagnosed with dural tears on MRI, 1 on CT and 1 patient had a CSF leak. All 5 pts. of this group had pseudomeningoceles which were confirmed during surgery. Repair consisted of suturing of the defect in all cases; fibrin patch was used in 2 repairs; fascial graft in 1 and muscle graft in 1 pts. The fascia and skin were closed using running double sutures.

Follow-up data was available for 71 pts. 5 of these had headache at initial follow-up which 3 had unrepaired durotomies. These 3 pts. had resolution of headaches after repair. The other 2 pts. resolved spontaneously. In group 1, complications were; superficial wound infection (1); deep wound infection (4) and meningitis (1) (this patient had durotomy unrepaired at the primary surgery). In group 2, 1 of the 5 patients had deep wound infection. The total incidence of deep wound infection in these 73 patients was 6.8%.

18 pts. had subsequent radiologic testing and/or surgery for unrelated problems and none had arachnoiditis. Most recent follow-up after durotomy was at an average of 10.7 mths (range 0-138 mths).

DISCUSSION: Incidental durotomy was associated with increased risk of deep infection compared to the general risk with spine surgery (based upon prior studies by the same authors). Revision cases may be associated with a higher risk of durotomy due to the complexity of surgery.

CONCLUSION: CSF cutaneous fistulae and pseudomeningoceles are uncommon sequelae of spinal surgery. They may be associated with an increased risk of wound infection (attributed to intraoperative dura mater tears in our series). There were no long term complications.

Paper #33

DURAL TEARS ASSOCIATED WITH LUMBAR SPINE SURGERY, MANAGEMENT AND LONG TERM OUTCOME

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Despite the frequency of spinal surgery and the concomitant incidence of dural tears, little has been written regarding the long term results of primarily repaired dural tears. The author represents his experience in managament of 33 cases of dural as a complication in lumbar spine surgery performed for a variety of diagnosis from 1992 to 1998.

Cases were analysed for the causes of injury, method of management, short and long term consequences and management of post operative complications.

All cases were recognised and repaired primarily at the time of surgery.

The most common causes of injury were encountered with cases of recurrent lumbar disc surgery, tight spinal canal.

Different surgical techniques were used for the repair of the dura. Immediate postoperative morbidity in the form of new neurological deficits, 4 cases of urine retention, 4 cases of leg pain 2, all this sequelae resolved spontaneously with follow up, 3 cases of C.S.F. leakage were treated conservatively, the three cases were dry within 2-3 weeks. As a long term follow up 2 cases of pseudomeningocele were encountered 3 and 4 months postoperatively were treated surgically and one case of arachnoiditis represented 6 months postoperatively with back pain and persistent leg pain.

Conclusion: Incidental dural tears is a complication of spinal surgery. Great care should be taken to avoid dural trauma especially with tight spinal stenosis, recurrent surgery and with spinal instrumentation. Careful and meticulous dural repair using different surgical technique should be used to avoid short and long term morbidity of dural tears.

Paper #34

THE USE OF TRANSPEDICULAR DECANCELLATION OSTEOTOMY IN THE TREATMENT OF VARIOUS SPINAL DEPORMITIES

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Transpedicular decancellation osteotomy is used in the correction of varius spinal deformity. 23 Patients are treated with this method. Patients are grouped in three main groups.

Scoliosis (4 patients), Kyphosis (13 patients) and Failed back epidural fibrosis (6 patients) Kyphosis patients were also in five groups, Adult kyphosis (1 patient), kongenital kyphosis (2 patients), Sequela of Pott's disease (3 patients), Ankylosing spondylitis (4 patients), postraumatic kyphdsis (2 patients).

Each group evaluated seperately. In scoliosis group the amount of mean segmental correction was 41 degrees. In kyphosis group the amount of correction was 45 degrees and in the epidural fibrosis group it was 32 degrees.

In the epidural fibrosis the amount of correction not the primary aim of the procedure and the main aim was the relaxation of the streched durae, and those patients healed uneventfully.

As a result this procedure can be performed in the treatment of different spinal deformities.

Paper #35

THE QUESTIONAIRE EVALUATION OF SCOLIOSIS SURGERY OUTCOME. MINIMUM FIVE YEARS FOLLOW UP.

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In the years 1986-1992 a total number of 228 patients have been operated on because of the idiopathic adolescent scoliosis. They were the first ones in Eastern Europe operated with the use of CD. instrumentation. The aim of the work was to assess the final outcome of the surgery as seen by the patient in his own subjective way. A modified questionnaire of Conolly has been sent to all the 228 patients. There were 150 returns of correctly filled in questionnaires, 33 patients were lost because of change of the address and the fate of remaining 45 was unknown.

The questionnaire is presented in details and the answers given by the patients are discussed. The patients were asked about their job or education status, back pain, the use of medicamentation, ability to stand, sit and walk for different time, sport activities, self-service, driving a car, shopping, social contacts, trips and holidays, marriage status, having children and delivery, remarks on their back shape, necessity of special type of clothes, general health status, whether the aim of the operation was achieved and if they would accept the operation again knowing its result. The last two question, maybe most important ones, were answered? "no" by only 8% and 2% of patients respectively. The majority of them were pleased with their life status and appreciated the surgery outcome. On the other hand 44% used special type of clothes to hide the residual back deformity. The authors find it interesting to compare the subjective patient's self-evaluation with objective results including radiological assessment. This is going to be a subject of another publication.

Paper #36

SPINAL SAGITTAL IMBALANCE SYNDROMES

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INTRODUCTION: Sagittal deformities of the spine may affect the cervical, cervico-thoracic, thoracic, thoraco-lumbar, lumbar and/or lumbosacral region. It can originate in any of these areas and can be limited to a region of the spine or affect the overall alignment and balance. Several etiologies may cause sagittal imbalance, a classic clinical example of which is the "flatback" syndrome.

The etiology as well as the spinal location of the disorder is mandatory to perform the appropriate treatment for these type of deformities. A classification system was established for this purpose.

MATERIALS AND METHODS: 60 consecutive patients with rigid symptomatic sagittal deformity of the spine and imbalance were treated surgically. A retrospective chart and radiograph review was performed. Pre and Post-Operative Radiographic measurement of regional and global kyphosis and lordosis, balance, apical kyphosis and lordosis, anterior and posterior translation from the plumbline was obtained. Diagnoses included: pseudarthrosis (5 patients); ankylosis spondylitis (5 patients), distraction instrumentation in the lumbar spine (16 patients); anterior compression instrumentation in the lumbar spine (1 patient); post-laminectomy Kyphosis and Hypolordosis (11 patients), Scheuerman's Kyphosis (4 pts); congenital (1 pts.); Idiopathic Hyperlordosis (1 pt.); post-traumatic Kyphosis (5 pts.); multiple level degenerative disc disease lumbar hypolordosis (7 pts.); Pathologic Fracture Kyphosis (metabolic disease fracture 1 pt.; tumor 2 pts.); neuromuscular (1 patients); Adult Idiopathic Scoliosis (5 patients)

RESULTS: Average follow-up was 27 months (Range, 24-48). This study group included 19 males and 41 females with an average age 49 years old, (Range, 20-81).

The treatment performed were: posterior spine fusion in 6 cases, posterior spinal fusion and PLIF in 3 cases, posterior lumbar decancellation osteotomy in 19 pts., combined anterior/posterior fusion in 31 patients, and anterior spinal fusion in one case.

The preoperative sagittal plane decompensation averaged 11 cm (Range, 2 tom 35 cm) and was to corrected to average 2 cm (Range, 0 to 12 cm). Preoperative lumbar lordosis averaged -5 degrees (Range, 40 to -25 degrees). Postoperative lumbar lordosis averaged -58 degrees (Range, -30 to -85 degrees). The average correction was 58 degrees (Range, 40-75). The postoperative thoracic Kyphosis was 36 degrees (Range, 20-50) and the postoperative lumbar lordosis was 55 degrees (Range 35-75). Complications included 4 deep wound infections, 5 junctional kyphosis, 2 hardware failure, 2 pleural effusion, 2 patients treated with osteotomy decancellation required decompression, 1 patient treated with osteotomy had a non-union, and other patient with the same treatment had instrumentation failure.

DISCUSSION AND CONCLUSION: The patient with a fixed sagittal decompensated deformity presents a difficult orthopaedic challange. The etiology as well as the location of the disorder is mandatory to perform the appropriate treatment and correction of these type of deformities. A classification system was established to provide a systematic approach to the diagnosis and management of these deformities. It has been expanded into an algorithm form.

Paper #37

SPINE SURGERY IN THE ELDERLY PATIENTS

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Spinal surgery can be challenging especially in elderly patients as they may have additional risk factors such as osteoporosis, cardiopulmanary problems or relative malnutrition. This study was conducted to determine the outcome of spinal surgery in the elderly patients.
Retrospective analysis of patients aged 60 or above and operated by a single surgeon between 1993 and 1998 for spinal disease was completed. There were 10 males and 9 females and the age at the time of the operation averaged 66.3 (60-72). The indication for surgery was infection in 8 (42.1%), trauma in 8 (42.1), tumor in 2 (10.6%), and spondylolisthesis in 1 (5.2%) of the patients. Anterior surgery was performed in 4 (21%), posterior surgery in 5 (27%) and anterior-posterior in 10 (52%) (simultaneous or sequential one stage: 8 (42.1%), two stage: 2 (10.5%) of the cases.

Preoperative evaluation revealed that 10 (52.6%) patients had cardiovascular, 1 (5.2%) had pulmonary problems, 5 (26.3%) had diabetes mellitus and 9 (47.3%) patients had neurological impairment. Total time for operation and blood transfusion averaged 4 hours (2 hours 15 minutes-6 hours 30 minutes) and 3 units, respectively. Mean hospitalization period was 12.3 (6-29) days. Preoperatively, major vessel injury, incidental duratomy or any major complications was not observed. Minor cardiovascular problems (arrhythmia, hypertension) was observed in 5 (26%) patients. Neurological status did not change in 2 (10.4%) while improved in 7 (36.8%) and one patient (5.2%) developed drop foot postoperatively. Three major complications (15.7%) (pneumotharox: 1, drop foot: 1 and pulmonary insufficiency: 1) and 9 (47.3%) minor complications in the first two weeks postoperatively were observed. During the follow-up one patient developed deep wound infection and the instrumentation was removed. One patient died from myocardial infarction in the 10th postoperative day.

In spite of increased associated complication rates, spinal surgery in the elderly leads to satisfactory results with proper patient care.

Paper #38

RESULTS OF OPERATIVE TREATMENT OF SCHEUERMANN DISEASE

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Scheuermann's Kyphosis -also known as Juvenil kyphosis and spinal osteochondrosis- is one of the most common throcacic and thoracolumbar structural kyphosis which may efficiently be treated and of which progression may be stopped by conservative treatment method. Nevertheless, pain and cosmetic appearance of deformity refer to orhopaedist to choose surgical modalities.

32 Scheuermann's kyphosis patients have been treated surgically between years 1991 and 1997 in our Clinic. 23 of cases were male, whereas 9 consisted of females. The average age of patients is 16,4 yrs. and average follow up period is 5 years and 2 months.

In 23 cases posterior instrumentation posterior fusion, in 6 cases, anterior release posterior instrumentation posterior fusion, in 3 cases one or two level posterior wedge osteotomi posterior instrumentation posterior fusion were performed.

Preoperatively, average kyphosis angle using Cobb method was 73 degrees and average postoperative correction was 34 degrees. Correction loss was measured 3,2 (0-17) in 1 year and 5 months and 3,8 (0-17) in 5 years and 2 months follow up radiographic controls.

Due to dislodgment of upper end vertebrae hooks in 3 patients, and pull-out of lower vertebrae screws in 2 patients, these cases were later operated for revision. Kyphosis developed below distal end of instrumentation in one case, fusion and instrumentation were extended 2 levels below the previous distal end.

According to follow-up results; correction loss was in higher rates during the 1st year and was rarely observed after the 2nd year. Besides, posterior instrumentation posterior fusion were observed as to be sufficient for skeletal immature cases, however, mature cases would need additional anterior release and some of them would need posterior wedge osteotomy. Fusion and instrumentation must extend all wedged vertebrae to the first square vertebra.

Paper #39

TB SPINE - COMPARISON OF THE CHANGES IN 3 DECADES AND THE IMPLICATIONS TO THE SPINE SURGEONS

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TB spine is an important disease for the spine surgeons in the developing and the underdeveloped countries. In the past 20 years, treatment of joint and spine involvement by TB bacilli has been greatly changed by the introduction of anti-TB chemotherapy and surgery. Hodgson was honored to describe the radical debridement of the infectious foci of the vertebral body via anterior approach. This principle has been adopted in our hospital since the early 60th.

Three retrospective studies were conducted to analyze the operated cases of TB spine in the duration, 1960-79, 1980-89 and 1990-present, by the different staffs in the same groups. During these periods, there were drastic changes in the socio-economical and medical care systems in Taiwan. In the 60th and 70th, the numbers of operative cases in all age group swere 3 to 5 per month. Obvious kyphotic deformity was common, because many children were affected. While in the 80th, the operative cases decreased, and the child involvement was only occasionally. In the 90th, the number decreased to only 5 cases per year, and child was virtually not affected. The reasons of these changes are due to improvement of economic and nutritional conditions among the people, better medical care system and the wide acceptance of vaccination since the early 70th. Recently, some modifications of operative procedures are noted: such as the approach side was decided by the findings in MRI or CT scan; further placement of the internal implants was considered in some cases for better stabilization and/or prevention of deformity.

However, the positive rate of bacterial culture was still low, which suggested that better diagnostic method must be introduced. Although TB spine is in the declining, infections due to other pyogenic bacilli and fungi seem on the rise. This will be more grave due to longevity in the society, abuse of steroids and antibiotics, and the increasing positive HIV cases. The spine surgeons should be more careful to diagnose and to find out the real causative pathogens in the cases of spine infection.

Paper #40

TUBERCULOUS SPONDYLITIS CLASSIFICATION AND TREATMENT

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New theraphy methods and approaches have still reported for tuberculous spondylitis. But the best method is not clear on the patient basis.
Fourty-eight patients that have minimum a year follow-up were retrospectively evaluated.
A classification was used for choosing of the surgical method:

TYPE 1:
A- The lesion located in the vertebra, no disc degeneration, no collaps, no abscess, no neurologic deficit.
B- Frank abscess formation, no disc degeneration, no collaps, no neurologic deficit,

TYPE 2:
Frank abscess formation, disc degeneration, collaps is exist. Neurologic deficit may exist. Sagittal index<20°. No instability.

TYPE 3: Deformity and instability is exist. Sagittal index>20°.
TREATMENT FOR:

TYPE 1: A: Only antituberculous chemotherapy is enough.
B: Drainage of abscess and debridement is enough.

TYPE 2: Anterior debridement and fusion is necessary. In the existence of neurologic deficit decompression should be added. Strut cortical graft is used for fusion.

TYPE 3: In addition to anterior debridement and fusion, correction of deformity and internal fixation is necessary. Stabilisation can performed anteriorly or posteriorly. We prefer anterior strut grafting and posterior instrumentation and fusion after two weeks.
İn that study group who were treated in according to the classification scheme explained above, any major complication had happened. The most common complication that had been observed in type-2 patients is local kyphosis which was maximum 8 degrees. That complication was not cause any serious problem. Any of these patients needed surgical correction. Any neurologic deterioration was observed.

Paper #41

ANTERIOR SURGICAL PROCEDURES IN THE TREATMENT OF SPINAL TUBERCULOSIS. LONG TERM RESULTS.

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Anterior debridement, decompession, anterior instrumentation and chemotherapy are one of the most recommended treatment method for the vertebral tuberculosis. The aim of this study is to evaluate the long-term clinical results of our cases with vertebral tuberculosis treated by anterior debridement, anterior instrumentation and chemotherapy.

Twenty-two patients with adequate long-term follow-up treated in Dokuz Eylül University Department of Orthopaedics and Traumatology between 1991-1996 were taken into the study. There were 13 male and 9 female and average age was 43.4 (10-70). The anatomical region of the lesion was thoracal in 10, lumbar in 8 and thoracolumbar junction in 4 cases. Radiological investigations revealed involvement of more than two vertebral segments in 3 cases (13.6%), and cold abscess formation in 13 cases (59%). Seven patients (31.8%) had neurological impairment preoperatively. Chemotherapy was given preoperatively for an average of 87 days (5 days-10 months). Chemotherapy was continued postoperatively to complete nine months. Instrumentation was not used in three cases. Autologous rib grafts were used in 12 cases and autologous three cortical iliac grafts were used in 10 cases. Mean follow-up was 4.4 years (2-7.5 years). Three cases were found to be dead at the latest follow-up because of reasons other than tuberculosis. Seven patients with neurological impairment recovered fully in an average of 8 months. Complete fusion was achieved. It was complete in all but one cases. One case required reoperation for implant failure. No reactivation of the disease, implant failure and neurological impairment was observed in all the others.

Primary anterior surgical procedures, debridement and anterior instrumentation combined with chemotherapy must be taken into the consideration especially in cases with neurological impairment and destruction in osseous structures.

Paper #42

COMPARISON OF THE ONE STAGE ANTERIOR DEBRIDEMENT COMBINED WITH ANTERIOR INSTRUMENTATION AND 2 STAGE - ANTERIOR DEBRIDEMENT AND POSTERIOR INSTRUMENTATION IN ACTIVE TUBERCULOUS SPONDYLITIS

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PURPOSE OF THE STUDY: To compare the result of one stage anterior debridement combined with strut bone graft and anterior instrumentation with 2 stage operation - primarily anterior debridement combined with bone graft and secondarily posterior instrumentation in active tuberculous spondylitis.

MATERIALS AND METHODS: 21 cases of one stage group and 17 cases of two stage group were compared regarding recurrence of infection, change of kyphotic angle, duration of hospitalization and medical cost, etc. Follow-up period was averaged 27 months (range: 12-48 months)

RESULTS: With respect to the duration of hospitalization, 2 stage group was averaged 58 days (range 43 - 108 days), one stage group was averaged 29 days (range 21 - 47 days). Medical cost of one stage group was cheaper than that of two stage group by 30% on an average. Changes of kyphotic angle of both group were not significant (2 stage group 2°, one stage group 3°). There was no case of recurrent infection in both group.

CONCLUSION: Compared with two stage group, one stage group showed better result with respect to medical cost and duration of hospitalization. It is considered that one stage operation is a better operative method if a patient does not have poor general condition or inappropriate medical situation for anterior instrumentation.

Paper #43

SURGICAL TREATMENT OF THE THORACOLUMBAR SPINE TUBERCULOSIS

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From 1994 to 1998 30 patients were treated by surgical intervention. 18 patients were male and 12 patients were female and mean age was 36,2 years. Mean follow-up was 26 months (at least 12 months). 8 patients had only anterior drainage and 22 patients had anterior radical debridement and fusion and posterior instrumentation and fusion. Posterior instrumentation was used only in patients who had had anterior radical debridement. All patients had one year continued triple drug therapy. Before the operation CT and MRI evaluation of the whole spine were done. 8 patients had had neurological deficits preoperatively in various severity, 6 of which resolved completely. In 19 cases thoracolumbar region and 6 cases thoracal region and in 5 cases lumbar area were involved.

No implant failure and no fracture of the strut graft were seen. Late infection was developed at the side of posterior instrumenttion. In one patient reactivation was seen and he was reoperated.

As a result of anterior radical debridement and fusion with posterior instrumentation and fusion was the most effective treatment choice.

Paper #44

AN ALGORHYTM FOR THE TREATMENT OF SPINAL TUBERCULOSIS AND LONG TERM RESULTS

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55 patients with the diagnosis of spinal tuberculosis were treated between 1988 and 1999. Mean follow up time was 6 years and 2 months. 4 different treatment protocols were used with different indications in different types of cases.

Group I. Conservative treatment (6 pts)
Group II. Single stage posterior instrumentation and fusion. (21 pts)
Group III. Anterior debridement - fusion and posterior or anterior instrumentation (17 pts)
Group IV. Radical debridement (11 pts)

Indications and results of the treatment methods were considered as a different concept and different indications were used in selection of the type of treatment method in each group. This established treatment algorhytm consisted of following parameters:

. Number of involved segments
. Presence or amount of abscess
. Neurological involvement
. Affected region

Mean loss of correction was 2.6 degrees and 2.8 3.1, 2.4 and 2 in groups respectively. There is no statistical difference between groups according to the ANOVA test.

More than five years of results showed that late results were not changed and solid fusion was seen in all patients.

Paper #45

PRIMARY AND SECONDARY FUSION IN LUMBAR MICRODISCECTOMY

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This is a follow-up study of 92 patients (males (m) 54 cases (59%), mean age (ma) 42 years (y) [18-79 y], females (f) 38 cases (41%) ma 45 y [21-77], average follow-up time 112 weeks (w) [28-212 w,] treated between August 1994 and June 1998. They were selected from a total 467 cases treated surgically for lumbar disc disease. The study evaluated the outcome of a minimally invasive, microsurgical interbody fusion for lumbar nerve root entrapment and concomitant instability using disc cages only. Fifty-one cases were treated with primary fusion at the time of the initial microdiscectomy. Forty cases (62% males ma 37 y, 38% females ma 41 y, [21-73 y], for instability and nerve root entrapment and 11 cases of instability without entrapment (male 82% ma 34 y, 18% females ma 38 y). Forty-one cases of secondary fusion (males 52% ma 57 y, [30-76], females 48% ma 50 y [33-76], after previous back surgery were done. The indication criteria for operation of instability and nerve root entrapment were presence of I. failure of conservative treatment II. Positive straight (or reversed) leg raising test (SLR) III. Loss of reflex of power IV. Correlating radiological nerve root entrapment V. Clinical instability signs (pain on up-righting, instability catch) VI. Monosegmental radiological instability signs (disc height / water content loss, retrolisthesis, horizontal traction spurs, flexion extension translation > 2 mm. For the 11 cases without nerve root entrapment criteria I., V. and VI. were used as well as VII. Positive response to 14 days lumbar immobilization cast or monosegmental facet joint osteorthritis responding to local infiltration.

An outcome comparison of primary versus secondary fusion reveals the favorable results of 85% resolution of lower back pain (LBP) and 96% of resolution and non-recurrence of radicular pain (RP) in primary fusion in the presence of monosegmental lumbar disc disease causing nerve root entrapment and signs of instability. Similarly favorable results were obtained in repeat discectomy cases having combined cartilaginous and fibrotic nerve root entrapment treated with secondary interbody fusion with 76% resolution of LBP and 88% resolution and non-recurrence of RP. The results show the very favorable outcome of LBP in microdiscectomy with primary fusion and seem to suggest that the fibrotic process in failed disc surgery is maintained or significantly affected by concomitant instability, which can be successfully treated, halted or even reversed by lumbar interbody fusion using disc cages only. A minimally invasive approach attempting maximal preservation of anatomical stabilizing structures, an optimal and detailed microsurgical nerve root decompression or neurolysis was used in this series.

Paper #46

SURGICAL TREATMENT OF ADULT L5 SPONDYLOLISIS USING MORSCHER HOOK SCREW: FIVE YEAR RESULTS

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The treatment of spondylolisis and other minor forms of spondylolisthesis is usually conservative. Only when symptoms persist in spite of conservative treatment surgery may be indicated.
This is a retrospective and critical analysis of adult 15 cases of L5 spondylolisis associated with symptoms of nerve root involvement. We analyse the results of vertebral stabilisation using Morscher hook screw and bone grafting.

We include 15 patients with mean age of 37 years 6 months. Fourteen patients had back and sciatica pain, another complained of chronic back pain. These symptoms did not respond to medical treatment. Isthmic lysis was located at L5 level bilateraly. Radiological investigations revealed 13 spondylolisthesis stage I, a multifocal disc pathology and a L4/L5 instability.
All these patients underwent Morsher hook screw stabilisation associated to discectomy (8 cases) and nerve release (3 cases). 11 cases had a posterolateral bone grafting and 4 cases had bone grafts at the isthmus. Average follow-up was of 5 years 1 month. Mean post-operative cast immobilisation was 3 months.

According to Prolo score, 6 were very satisfied, 8 satisfied and one disappointed by their results. Mean radiological consolidation was obtained after 4 months in isthmic graft and in 3,5 months in posterolateral graft. We report 3 early complications that resolved in the three months post-operatively. Four patients underwent removal of the hook screws: 3 because of implant loosening, one because of painful mechanical problems.

Morscher implants have been described for intra-segmental stabilisation with 70 to 90% success rate particularly in young patients. Because of the associated spondylolisis, spondylolisthesis, slipped disc and instability, we have adopted a new surgical technique: Morscher hook screw stabilised inter-segmental bone graft associated to the treatment of the secondary pathology. This simple and less invasive technique led to satisfactory functional and radiological results.

Paper #47

BIOMECHANICAL COMPARISON OF METHODS USED IN THE FIXATION OF PARS INTERARTICULARIS DEFECT

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The pars interarticularis defect is generally found to be the underlying pathology in spondylohisthesis cases below 50 years of age and in spondilolysis. In young patients, unresponsive to conservative treatment and without disc degeneration, direct repair of pars defect is generally recommended. Buck screw, Morscher hook-screw, Scott wiring, annd monosegmenter pedicular screw-sublaminar hook methods are widely used for the repair of pars defect. In this study, we compared the Buck screw with monosegmenter pedicular screw-sublaminar hook method biomechanically.

The last two segments of 14 calf spine was used. Two-milimetre defect was made with power-saw in pars-interarticularis of the proximal segment. For the repair, Buck screw was used in 7 specimens (group A), and pedicular screw-sublaminar hook method in 7 (group B). Motion in the defect was recorded under axial compression, flexion, extension, and lateral bending.

In axial compression, the motion in the defect in group A was greater than group B, and this was found to be statistically significant. In all other bending moments, the motion was greater in group B. The difference between two groups was not statistically significant in flexion and bending towards the extensiometer site, whereas was significant in extension and opposite side bending.

Biomechanical testing in this study showed us that, compared with the pedicular screw-sublaminar hook method, the fixation stability of the Buck screw was greater in two moments, smaller in axial compression and similar in the other moments. As a result, we concluded that, the pedicular screw-sublaminar hook method could be used as a fixation method for repair of pars defect.

Paper #48

PDN (PROSTHETIC DISC NUCLEUS) IS THIS "SOLUTION" FOR FAILED BACK SURGERY

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STUDY DESIGN: Retrospective study on 170 patients who were re-operated for failed back surgery from 1990 till 1997.

OBJECTIVE: To investigate the aetiology of failed back surgery as a result of inadequate assessment and how much the disc degeneration plays a role in the failed back surgery and whether to avoid the ultimate spinal fusion in failed back surgery.

METHODS: Patients were classified into two groups as: patient with recurrent discs, patient who had their disc as extruded discs, patient who had their disc as extruded discs or sequestered ones. Both patient groups were evaluated clinically and radiologically: (X-rays, C.T., M.R.I. study).

CONCLUSION: Repeated laminectomy without associated fusion is an adequate treatment for recurrent disc herniation, in the absence of spinal instability or other indication for fusion. 21% of patients undergoing a second operation due to failed back surgery are still complaining of residual back pain and radiculopathy in particular to patients with extruded or sequestered disc considering these patients as good candidates for PDN (prosthetic disc nucleus) replacement is considered to be most preferable in patients with degenerative disc and collapsing of the vertebrae or in patients with acute sequestered disc. Since October 1997, we have done implant on 16 patients. So far after preliminary evaluation, we can say that PDN still a new procedure, the results are promising and need to be evaluated after long term follow-up.

Paper #49

COMPLICATIONS OF TRANSPEDICULAR SCREW FIXATION IN DEGENERATIVE SPONDYLOLISTHESIS

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The complication of 161 inserted pedicle screws performed by one surgeon to treat 32 patients with degenerative spondylolisthesis were reviewed. The different implant systems used included Alıcı instrument (n=14), Synergy (n=11), CD (n=5), Isola (n=2). The most common intraoperative problem was screw misplacement (4 screw misplacement in 3 patients). Nerve root impingement occurred in one patient. The postoperative complications were deep infection (one patient), screw bending (one patient) and screw loosening (one patient). The conclusion is that pedicle screw fixation has an acceptable complication rate in degenerative spondylolisthesis.

Paper #50

SURGICAL MANAGEMENT OF SPONDYLOPTOSIS

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PURPOSE: Gaines procedure for the treatment of spondyloptosis and high grades of lysthesis is a staged L5 resection with reduction and fusion of L4 onto S1. Other methods of treatment include fusion in situ, and decompression and fusion (posterolateral and/or anterior, single or double staged).

MATERIALS AND METHODS: One 20 years-old boy and 18 years-old girl with the established diagnosis of spondyloptosis underwent surgery. The boy had a previous failed post, fusion in-situ operation. The girl underwent a two stage operation; in the first stage, the vertebral body of L5 along with the L4-5 and L5-S1 discs were resected by an anterior approach, in the second stage, performed through a posterior approach the loose posterior elements, articular processes and pedicles of L5 were excised and the body of L4 was reduced onto S1 and stabilized by transpedicular instrumentation. The boy underwent anterior discectomy followed by anterior interbody fusion of L5 and S1. The second stage operation included posterior instrumentation of L3-L4-L5 and S1.

RESULTS: Percentage of slip decreased significantly in both (100% to 24%; 100% to 40%). Progression of slip despite the posterior fusion in situ in the boy resumed. Clinical improvement was recorded in both as the decrease in the weakness and numbness of the legs. Sagittal rotation decreased also.

CONCLUSION: Surgery is indicated in spondyloptosis and in high grades of lysthesis with the risk of progression. Posterior fusion in situ among the other treatment modalities was shown to be insufficient in the prevention of potential progression of the deformity. Unacceptably high complication rates of reduction and nonreduction procedures made anterior approaches essential. Especially the Gaines procedure seems to solve the problem of high incidence of L5 root deficits in patients with spondyloptosis.

Paper #51

THE RESULTS OF SURGICAL TREATMENT OF SPONDYLOLISTHESIS: A MINUMUM TWO YEAR FOLLOW-UP

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This study has been conducted in order to investigate the results of surgical treatment of spondylolisthesis in adults. Surgical treatment of spondylolisthesis includes decompression, reduction, fusion and instrumentation or the combination thereof and is indicated when the conservative treatment fails or should the slip progress.

From 1993 to 1997, 16 adult patients with symptomatic spondylolisthesis who underwent surgical treatment and has been followed for at least 2 years, were included to the study. There were 12 women and 4 men and the mean age was 47.5 (33-63) years. Follow-up after the operation averaged 43 months (2-6 years). Five patient presented with low-back pain while 11 presented with both low-back and leg pain. Roentgenographic analysis revealed L5 slip in 8, L4 in 6 and L3 in 2 of the patients; 10 of them were grade I, 5 grade II and 1 was grade III. Decompression, fusion and instrumentation was performed in all while reduction in only 9 of the patients in addition. Postoperative bracing for 3 months with a TLSO was used for the cases to whom L3-L4 and L4-L5 fusion was performed and TLSO with a leg extension was preferred for the cases whom L5-S1 fusion was performed.

Mean hospitalization period is 7 days (5-10). Roentgenograhic analysis revealed that posterolateral osseous union was obtained in 15 patients bilaterally but in 1 of them fusion was unilateral. There was no pseudoarthrosis or progression of slip during the follow-up. One patient developed drop foot after the operation and did not recover during the follow-up period.

At the last follow-up, all of the patients declared that they felt about 90% relief of the pain. Again all of the patients except the one who developed neurological deficit, expressed full satisfaction and said that they could suggest to any other patient to undergo this kind of surgery.

Its our impression that, the addition of instrumentation to decompression and fusion seems to improve fusion rates and permits early mobilization and results in long term patient satisfaction.

Paper #52

POSTERIOR DECOMPRESSION AND FUSION WITH LATERAL MASS PLATE FIXATION FOR THE TREATMENT OF CERVICAL STENOSIS MULTILEVEL MYELORADICULOPATHY

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PURPOSE: To evaluate posterior decompression with fusion and lateral mass plate fixation as the surgical treatment of patients with severe cervical stenosis and myeloradiculopathy.

METHODS: A retrospective review of 24 patients with myeloradiculopathy due to cervical stenosis treated with posterior cervical decompression, lateral mass plate fixation, and local bone graft fusion was performed. All patients had multilevel cervical myeloradiculopathy. Follow-up was possible over a mean time of 18 months (range, 12-30). The average number of levels fused was 2.4 (range, 1-4). Myelopathy was graded according to Nurik's classification. Pain, motor and sensory function were assessed by better, worse, or same scale. Decompression was evaluated by post-operative MRI. Fusion was determined by anterior-posterior, lateral radiographic examination and tomograms if clinically indicated. Complications were also reviewed.

RESULTS: Post-operatively, 10% improved two grades of the Nurik's classification, 63% improved one grade, and 27% remained stable without worsening of their myelopathy. No patients showed worsening of their motor or sensory function with 45% and 73% showing motor and sensory improvements respectively. All patients experienced pain improvement Successful fusion occurred in all patients at an average of 3.4 months (range, 2-5). Post-operative MRI scan was available for ten patients and showed satisfactory spinal cord decompression with posterior cord translation. Complication included one superficial infection and two screws loosening not requiring revision. No patient required additional anterior surgery, or further posterior surgery.

DISCUSSION: Posterior decompression with stabilization and fusion results in effective decompression of the cord and clinical improvement. Lateral mass plate and local bone graft resulted in successful fusion. Complications were minimal. This procedure is a viable alternative to anterior cervical decompression and fusion in this group of patients.

Paper #53

RESULTS OF 6 POSTERIOR ATLOIDO AXIAL ARTHRODESIS USING APOFIX SYSTEM FOR DEGENERATIVE UNILATERAL C_1 C_2 ARTHROSIS.

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We report the results of C1C2 arthrodesis for unilateral arthrosis degeneration. All patients, 4 females and 2 males, presented severe neck and radicular (Arnold) pain. All had failure of complete medical treatment (immobilization, antiinflammatory, sedative and scopic C1C2 infiltration). There were no neurological deficit.

All patients were operated by the same surgeon. We used a posterior approach, C1C2 montage with 2 Apofix grips and iliac bone graft. There were no intra or post operative complication.
Fusion occured in all cases. All patients were radicular pain free but 3 patients still presented some cervical pain.

In conclusion, posterior arthrodesis is a good teachnique for severe arthrosis of C1C2 joint in case of failure of conservative treatment.

Paper #54

CERVICAL SPINAL INJURY IN ELDERLY

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Cervical spine fractures in the elderly is seen with a relatively high frequency. Aged people are more prone to falls and motor vehicle accidents and as their population is increasing steadily in most parts of the world the prevalence of this problem are expected to increase progressively. Due to pre-existing senile osteoporosis and associated medical problems there is higher rate of morbidity and mortality in this group of patients.

Over a 16 years period, 335 patients with cervical spine fracture were treated in our centre. Among them twenty patients (6%) were 65 years of age and older (73 yr.). In this study, clinical features, treatment, and outcome of these patients is retrospectively analysed. There were five (25%) patients admitted with complete cord lesion (Frankel Grade A), and 15 patients with Frankel Grade B through E. In one patient immobilisation was done by Halo device. The others were treated by collar. In seven patients reduction were achieved by traction and then immobilisation was done by collar. In one patient due to late instability non-union posterior fusion (Halifax) was done four months later. Of five patients with complete cord injury four died within first two weeks and the fifth after two months. Patients with incomplete cord injury have had favourable results.

Although the elderly with complete cord injury have a very poor prognosis for survival. Those with incomplete cord lesion may be treated successfully. Halo device is the method of choice for external immobilisation in the cervical spine fractures. However in elderly when the Halo device is not indicated or can not be tolerated, cervical collar can be a good alternative especially when optimal reduction is achieved. Posterior cervical fusion may be reserved for the cases of non-union after external immobilisation.

Paper #55

FRACTURE PATTERNS AND ARCHITECTURE OF THE AXIS. A pQCT ANALYSIS.

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PURPOSE: The purpose of the present study is to analyze 77 cases of odontoid fractures and to correlate fracture patterns to strength and architecture of the axis.

MATERIAL-METHODS: Our hypothesis of odontoid pattern fracture was tested in the lab using ten fresh human axis specimens. pQCT studies of all specimens was performed. The medical records of the 77 patients admitted in our department from Jan. 1970 to Dec. 1997, were analyzed. There were 45 men and 32 women of a mean age of 45,9 years old. Road traffic accident was the main cause of their injuires (61,26%). Associated injuires were found in 36 patients (46,75%), 24 of them in the spine. Sixteen patients (20.78%) had neurological signs, but only in 6 patients (7,8%) this was due to the lesion of the dens. The fractures were classified according to Roy-Camille classification, 34 being anterior oblique, 32 horizontal and 10 posterior oblique. One patient had an avulsion fracture of the tip of the dens. Sixty-nine patients were treated conservatively and 8 patients surgically by C1-C2 posterior fusion. The mean follow up period was 13,4 yrs (1 to 25 yrs). Ten patients developed a pseudarthrosis (12,98%).

RESULTS: At follow up of 58 patients from the conservative treated group (5 died and 6 were lost) 48% of them had an excellent result (union of the fracture in an anatomic position, without complains), 38% had a satisfactory result (union of the fracture with occasional complains) and 14% had a fair result (pseudarthrosis, malunion, severe restriction of movements, local pain). One patient with C1-C2 fusion was reoperated because the graft was absorbed. Pseudarthrosis was related to many factors. Among the factors involved in the appearance of pseudarthrosis, the site and the line of the fracture, were of great importance. Fractures through the neck are prone to pseudarthrosis as well as the horizontal type. Horizontal fractures proximal to the base of the odontoid process and not in vicinity with the -cancelous- body of the Axis, showed a tentancy to pseudarthroris. The line of the fracture depends on the vector of the applied force and on the architecture of the axis and its 3-D variaton of strength.

CONCLUSIONS: A careful analysis of our cases and the understanding of the anatomy, the distribution of the cortical bone and the mechanical properties of the axis allowed us to introduce a new classification. We distinguish four types (A,B,C,D) with two subgroups of type C (C1, C2). The propagation of the fracture line into the body of the axis depends not only on the vector of the applied force but also on the architectural characteristics of the bone at this area and on the density and pattern of axis trabeculae at certain points.

Paper #56

CERVICAL SPINE OF SOCCER PLAYER: A BIOMECHANICAL STUDY IN COMPARISON WITH MRI

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Recurrent minor trauma may lead to degenerative changes in the cervical spine, that is a common feature of soccer. Cervical spine degeneration is assessed biomechanically. A dynamometer is developed and normalized work and power and average moment was measured in flexion and extension in active (n=15) and veteran (n=15) soccer players. Angular motion was calculated from conventional x-ray pictures. Degenerative changes were assessed by x-ray and magnetic resonance (MR). All results were compared to age-matched controls (n=15 and n=13, respectively). Dynamometric measurements revealed a significant (p=0.01) difference in normalized work between active and veteran soccer players. Spondylotic changes were more severe in veterans that played soccer more than 10 years in a semi-professional level when compared to active soccer players and to their age-matched controls (p=0.04). Spondylotic anteroposterior diameter and intersegmental angle of C2-C3 decreased significantly (p=0.02) in veterans. MR changes were obvious with increasing age, however, the significance remained at the p= 0.06 level. A relation between the cross-sectional area of spinalis cervicalis and semispinalis cervicalis muscles and work, power and average moment could not be established. Dynamic MR revealed disc bulging in an active soccer player that presented normal findings in conventional MR. These results suggest that soccer is give rise to degeneration in the cervical spine due to recurrent trauma.

Paper #57

SURGICAL MANAGEMENT FOR LOWER CERVICAL SPINE (C3-C7) INJURIES

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The general principles of surgical management in lower cervical spine injuries are to improve and/or protect the patient's neurologic function while establishing a normally aligned, stable, yet mobile and painless spine.

PURPOSE: To analyse retrospectively our indications, preoperative evaulation protocol, surgical technique (anterior-posterior) and clinical results for lower cervical spine (C3-C7) injuries.

MATERIALS AND METHODS: 15 patients (13 male and 2 female) with an average age of 33 years (range, 11-56 years) were evaluated. All patients were examined clinically for neurologic deficits and radiographically by using ap, lat and oblique views X-rays, CT-scan and MRI to detect preoperatively the major direction of instability and to plan for the surgical approach and technique. All were isolated injuries except one with a concomitant T10-T11 lateral flexion injury. Eleven of the patients were injured in motor vehicle accidents, two by diving accidents, and two by falling from height. Seven of the 15 patients (40%) had root lesions, 4 of 15 (26%) were intact neurologically, 2 of 15 (13%) had complete neurologic injuries, 2 of 15 (13%) incomplete ncurologic lesions. Concerning the operative technique, 5 patients underwent a posterior wiring procedure with bone graft supplementation, 4 patients combined anterior-posterior plate fixation and fusion, 2 patients anterior fusion without instrumentation combined with posterior plate fixation and fusion, 2 patients anterior plating and fusion and 2 patients posterior plating and fusion. Autologous iliac crest was used for graft in all cases. Postoperatively all patients were immobilizied in a Philadelphia collar maximum for 12 weeks.

RESULTS: Mean follow-up was 34 months (range, 8-79 months). Follow-up included a review of hospital records, a review and measurements of all available radiographs including follow-up radiographs and a clinical examination. All 15 patients fused and radiogrhaps did not show graft or mesh dislodgement or malunion. Mean time to fusion was 3 months (range, 1.5-4.5 months). At follow-up no patient had any late deterioration of neurologic status. All patients with incomplete cord injuries and root symptoms improved neurologically and no patient with a complete spinal cord lesion have any useful motor function in tle lower extremities. None of 6 patients with an anterior plate complained of a tickling sensation in their throat. 13 patients (86%) had no neck pain. As complications, one loose anterior screw which had to be removed and one superficial wound infection which cleared with oral antibiotics, were encountered. In one patient with a posterior plate fixation and fusion there was a slight loss of lordosis when comparing the immediate postop X-rays with that at the time of follow-up.

CONCLUSION: Careful preoperative assessment of the mechanism of injury as well as the resulting bony and ligamentous injury are essentials to guide treatment. The decision to use an anterior or posterior or combined anterior-posterior surgical approach depends on location and degree of bony and ligamentous instability and the presence or absence of neural compression.

Paper #58

THREE STAGE (POSTERIOR - ANTERIOR - POSTERIOR) REDUCTION OF LATE, UNTREATED DISRACTIVE FLEXION INJURIES OF THE LOWER CERVICAL SPINE

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INTRODUCTION: Flexion and distraction are the usual mechanisms in traumatic lesions of the lower cervical spine. Treatment by reduction and internal fixation of such injuries is easy in the early stage, but it becomes quite problematic in case of late presentation. Reduction is then impossible due to fibrous tissue and callus formation both anteriorly and posteriorly, which should be released for reduction. For this reason a combined, three-stage surgery (posterior release, anterior release and fusion and then posterior instrumentation and fusion) is performed for such late presented, untreated cases.

PATIENTS: This procedure has been performed in three patients aged between 30 and 65. The level of injury was C7-T1 in one and C6-C7 in two. The period between the injury and presentation was 14 (12-16) weeks on average. Two patients had iliac bone graft and one titanium mesh cage for anterior fusion. Anterior and posterior cervical plates was used and anatomic reduction and fusion were achieved in all three patients.

CONCLUSION: Combined, three-stage surgery provides a safe and effective reduction, stabilization and fusion in patients who present late and untreated after dislocation of the cervical spine.

Paper #59

PRIMARY SACRAL TUMORS: FEATURES PREDICTIVE OF MALIGNANCY.

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A retrospective review of 52 patients with 35 malignant and 17 benign primary sacrococcygeal tumors treted between 1965-1996 was undertaken to find out some characteristic features predictive of malignancy. Medical charts, imaging studies, along with operative and pathologic reports, were used to discern the age, sex, prodromal and neurologic symptoms of the patients, and size (largest diameter), location (cranio-caudal, antero-posterior, and midline-lateral location, most proximal and most distal level of involvement, and epicenter of lesion defined by vertebra), and extension of the tumor (extension into anterior, posterior, proximal and/or distal-lateral directions). Univariate and multivariate tests were performed using Statistix 4. 1İ 1994 and NCSS 1997İ Statistical Software.

Patients with malignant tumors were older in age (p=0.0012, Student's t-test), and particularly, an age of ≥ 50 years was predictive for malignancy (p=0.0068, Fisher's exact test). All tumors occurred in men 50 years were malignant and mostly chordomas. Metastases were rare at presentation and mainly due to ewing's sarcomas, especially if the patients age was below 20 years. Prodromal symptoms ≥ 1 year were predictive for chordoma (p=0.0002, chi-square). Furthermore, the presence of neurological symptoms were predictive for a malignant or giant cell tumor (p=0.0009, chi-square). Furthermore, bowel, urinary and/or sexual dysfunction were frequently related to a chordoma. Malignant tumors were larger in size (p=0.022, Student's t-test). Likewise, lesions bigger than 10 cm were mostly malignant. Chordomas and teratomas were significantly lower located in the sacrum (p=0.0000, Kruskal-Wallis) and closer to the midline than all other tumors, excluding giant cell tumors (p=0.0002, Kruskal-Wallis). However, on multivariate analysis the only significant factor predictive of malignancy was the presence of extension of tumor into more directions (p=0.0000)

In conclusion demographic features and symptoms of the patient, together with the patho-anatomic appearance of the tumor on imaging studies provides helpful knowledge about the nature of primary lesions of the sacrum.

Paper #60

RESULTS OF SURGICAL TREATMENT FOR THE PRIMARY TUMORS OF SACRUM

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INTRODUCTION: In countries where oriental philosophy of life is encountered, patients cannot tolerate severe neurologic deficits. The surgeon experiences the dilemma between a patient's life and functions. Marginal resection and radiotherapy may be an answer to this problem.

MATERIAL/METHOD: Though quite seldom found, tumors of the sacrum are very difficult to treat. Most of the malignancies found here are chordomas and their only treatment is wide resection. Giant cell tumors are also frequently located here and when in big sizes, they are very complicated to treat. Between 1980-1997, 29 tumors of the sacrum have been treated surgically at our department. The mean age of the patients is 23 years. The mean follow-up is 61 months. Three 3 of the tumors had sacroiliac joint invasion ten of them are chordoma and 9 of them are giant cell tumor. The longest follow-up (15 years) belongs to a patient who is the only one to be treated by radiotherapy alone. The status of the patient is CDF (continious disease free). In 4 patients, nerve roots below S2 have been sacrificed. Severe neurologic deficits resulted. These patients live now with psychologic compromise. In 10 cases we added adjuvant radiotherapy and marginal resections. In this group, soft tissue defect in the retroperitoneum has been covered with silicon mammary prosthesis to protect the viscera against radiotherapy. 2 of these patients, both of which have chondrosarcoma, have relapsed after 1.5 years and treated with wide resection sacrificing the nerve roots below S2.

CONCLUSION: The success of therapy depends on surgical technique. For small tumors below S3, wide resection is the preferred treatment modality. For bigger and relatively aggressive tumors, marginal resection may be chosen. When the neoplasm is radiosensitive, nerve roots can be spared. If the upper nerve roots are invaded by the tumor, the surgeon can feel very condemned by sacrificing them.

Paper #61

CHONDROBLASTOMA OF THE LUMBAR SPINE: CASE REPORT AND LITERATURE REVIEW

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This is a case report of a fifty-four-year old patient with chondroblastoma of 5th lumbar vertebrae, a location that has never been reported. The clinical presentation, radiological features and clinical progress after repeated surgery and irradiation are described in detail. The literature on spinal chondroblastoma is reviewed.

Paper #62

SURGICAL STABILIZATION OF SPINAL METASTASES: OUR EXPERIENCE IN 53 CASES

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Instability of the spine consequent to the spread of a primary tumor is a serious complication in oncologic patients. The main objectives of the surgical treatment should be the decompression of the nervous structures (achieved with a somatectomy or a wide laminectomy) and the instrumented stabilization of the spine, in order to prevent new deficits and alleviate the pain.

The experience of our Spinal Unit since 1990 is reported. We have selected for a surgical treatment 53 patients. The intervention was proposed to the patients with intractable pain based on the spinal instability and/or with incipient or recent appearance of neurological deficits. The metastases were generally from adenocarcinoma. The spinal localization was at cervical level in 8 patients, at thoracic level in 28 patients, and at lumbar level in 17 patients. The surgical strategies were different in consideration of the different tract of the spine involved. At cervical level we preferred to use the anterior approach (6 cases) instead of the posterior approach (2 cases). At dorsal and lumbar level (45 cases) we performed a wide laminectomy and we utilized a posterior stabilization with different system (39 Cotrel-Dubousset); only in 1 patient with a single thoracic metastasis we performed a somal tectomy and applied a Lift VB plus Z-plate through a transthoracic approach.

The results must be analyzed in the context of the fact that the surgery is palliative. We observed an immediate relieve of pain in the majority of cases and, in many cases, an improvement of neurological status. The residual life of these patients depended on the aggressivity of the primary tumor but, in any case, the quality of life was ameliorated.

We conclude that the spine stability achieve by the operation permits early mobilization, and reduces post-operative complications. We are convinced that the accurate selection of the patients and the appropriate choice of the instrumentation are essential to optimize the results.

Paper #63

POSTERIOR DISTRACTION SPONDYLODESIS AND CONCAV CHEST WALL PLASTIC FOR THE TREATMENT OF STIFF THORACIC SCOLIOSIS

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PURPOSE OF THE STUDY: The operative treatment of scoliosis involves correction and stabilization of the curve as well as horizontalization of the endvertebra. In the past it has been shown that cosmetic results are of major importance for the patients with scoliotic deformities. In stiff thoracic curves real derotation and reduction of the rib hump cannot be achieved by derotation procedures. Also VDS did not provide satisfactory results. In this study we present a new technique for the correction of stiff thoracic curves using a posterior distraction spondylodesis combined with rib osteotomies on the concavity of the curve.

MATERIALS AND METHODS: Between 1991 and 1993 we have treated 117 patients with stiff thoracic scoliosis with the CTP (concave chest wall plastic) - method. A standard posterior approach was chosen. A threaded distraction rod (7mm) was connected with pedicle screws at the lower and pedicle hooks on the upper and of the curve. The ribs were detached from the costotransverse junction and elevated so that the distraction rod was positioned below the ribs. During a wake-up test posterior distraction was performed.

RESULTS: There was an average correction of Cobb's angle at the thoracic curve between 62° and 98°. The average achieved elevation of the rib valley on the concavity was 4 cm. Also improvement of anterior chest deformities on the opposite side was noted. We did not observe any neurogical complications. 2 patients had a pneumothorax in the postoperative period which resolved without residual dysfunction. In the long term follow up we did not observe any pulmonary problems in our patients.

CONCLUSION: The concave chest wall plastic provided a significant release for correction of deformities in the frontal as well as in the sagittal plane. The cosmetic appearance is superior to the results seen in anterior or simple posterior derotation techniques. Rib hump resection or residual thoracic asymmetry can be avoided in almost all patients. We recommend this procedure for a treatment of stiff thoracic scoliosis, especially with an existing rib hump.

Paper #64

THORACIC ANTERIOR INSTRUMENTATION FOR THORACIC IDIOPATIC SCOLIOSIS

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INTRODUCTION: Thoracic Idiopathic Scoliosis produces major deformities of the thoracic cage. Early detection in growing patients possesses a problem of treatment. Treatment with braces is questionable. Conventional surgical treatment represents major surgery with all its consequences. Minimal invasive surgery represents a new approach for treating flexible thoracic curves either in growing children or young adults. This technique is a great advance in the treatment of this pathology: Minimal scar, minimal blood loose, minimal rehabilitation and hospitalization, minimal number or surgical vertebrae with maximum correction.

MATERIAL: This is a preliminary report of the first 18 patients done with this technique: Sex: 10 females and 8 males. Age:13 to 16 yrs. Ave. 14.2. Deformity pre op. 56° to 30° Cobb, Ave. 44°. Deformity post op 25° to 12° Cobb, Ave. 16°. Number of discs removed: 7 to 3, Ave. 4.7 discs. Number of vertebrae corrected: 8 to 4, Ave. 5.4 Operating time: 3 1/2 to 5 1/4 hrs. Ave. 4 hrs. Blood loss: 300 cc to 75 Ave. 120 cc Hospital stay: 7 to 2 days, Ave. 4 days.

COMPLICATION: In the 18 reported cases, none. Two other cases were scheduled for Thoracic Instrumentation, but were cancelled in surgery for technical problems.

Paper #65

IMPORTANCE OF MEASURING THE INTERVERTEBRAL ROTATION IN ESTIMATION OF LUMBAR SCOLIOSIS REDUCTION

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PURPOSE OF THE STUDY: Intervertebral rotation is the basis of structural scoliosis. Correcting this failing should be the aim of surgical treatment. We have compaired three different surgical techniques.

MATERIAL AND METHODS: Measuring the vertebral rotation can be done with a computed tomography (CT) cut, but must take into consideration the frontal and sagittal tilt. The reference axis is always the same as far as the patient is concerned, but the measurement varies according to the patient's position on the X-ray table. However, the reference axis is not the same before and after operation, therefore measurements pre-and post-are not comparable. For the purposes of measurement, the intervertebral rotation (ΔR) is the difference between the rotation angles of two consecutive vertebrae, and is a measure relatively independent of the position of the patient in space. Three groups, each with 5 lumbar scoliosis patients with Cobb's angle of on average 45° at T11-L3 were studied. All the files contained standing anterior-posterior (AP) and lateral films plus multi-leveled CT scans, pre-and post-operative. The correction was obtained by rotation of the convex rod in group 1 (CD technique), by bending in situ in group 2, and by simultaneous bending and rotation of the convex screws in group 3 (an innovative method).

RESULTS: The average intervertebral rotation of the apex for all groups before surgery was 3.9°. That of the upper end vertebrae was 10° and that of the lower end vertebrae was 8.1°. In all groups the most important correction was at the end vertebrae, where the intervertebral rotation is the most serious. The average correction of the intervertebral rotation was 15% for group 1, 35% for group 2 and 54% for group 3.

CONCLUSION: ΔR is a good way of controlling correction independent of all reference axis. It confirms the displacement "en bloc" of the spine without large de-torsion during the rotation maneouvre of the rod. The bending in situ combined with rotation of the implants around the rod causes the rotation axis to change several times. This technique creates a mesurable de-torsion of the spine instead of assuming that de-rotation happens automatically.

Paper #66

ANTERIOR SURGICAL CORRECTION AND INSTRUMENTATION OF ADOLESCENT IDIOPATHIC SCOLIOSIS

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INTRODUCTION: The purpose in the surgical treatment for adolescent idiopathic scoliosis (AIS) is to obtain a balanced spine over pelvis in coronal and sagittal planes while fusing the least possible number of levels. Anterior instrumentation has the advantage of better control of the deformity in the sagittal plane and shorter fusion area but instrumentation kyphosis and implant failure have been a serious problem with Dwyer and Zielke instrumentation. Here we present the early clinical and radiologic results of anterior surgery with new solid instruments for AIS patients.

MATERIALS AND METHODS: A total number of 15 AIS patients (2 male, 13 female) underwent anterior instrumentation and fusion. The average age was 15.7 (13-19) years and average follow-up was 12 (6-18) months. Three patients had Synergy and 12 had Moss Miami instrumentation. Furthermore, 13 patients had structural mesh cage (Harms) for one or more disc spaces. All patients were mobilized on the second postoperative day and given a TLSO for 3 to 6 months. 4 patients had thoracal, 8 had thoracolumbar and 3 had lumbar curves.

RESULTS: The highest and lowest level of instrumentation were T4 and L4 respectively. The average number of levels instrumented was 6.2 (4-9). 13 patients had mesh cages for the distal one to three levels of instrumentation. The instrumented area showed an 82% (47-100) correction. The global angles of thoracic kyphosis and lumbar lordosis were restored. There was no significant complication.

CONCLUSION: With the new solid instrumentation sytstems anterior surgery and instrumentation becomes a good alternative for especially thoracolumbar and lumbar curves. A perfect coronal and sagittal plane correction and balance can be obtained while ending up with a smaller fusion area compared to posterior surgery. Intervertebral discs may be removed at the thoracic levels to compress and provide the thoracic kyphosis but more importantly lumbar lordosis may be restored by using either mesh cages or structural grafts to preserve disc heights.

Paper #67

COMPARISONS OF ANTERIOR AND POSTERIOR INSTRUMENTATION FOR KING I SCOLIOSIS

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King I scoliosis denotes that the curvature is greater in the lumbar region in the idiopathic scoliosis. The surgical correction and instrumentation can be either anterior or posterior in the cases with mild curve. While in the cases with larger single or double major curves, combined approach may be necessary.

In the early cases, Zielke's VDS was adopted for curvature with Cobb angle between 40 to 80 degree. In the flexible spine, the correction rate was 80% in average. The axial corection was also remarkable. The combined instrumentation in the severe cases achieved good sagittal alignment due to some pertained resilience of the instrumented segments. The problems were over-correction, potential kyphogenic effect during surgery, or later, during follow-up, rod breakage might happen.

The newer implants were stiffer, which could reduce the possibility of rod breakage in the cases of anterior placement. For the posterior instrumentation, pedicle screw insertion and further rod rotation is the rule. The initial results suggested that the correction by both approaches in the frontal plane is the same, 50 to 60%, while it seems to be better in the axial plane-by the anterior instrumentation. Combined instrumentation is also possible by the new implants.

Papar #68

EARLY RESULTS OF OUR "COLORADO" SPINAL INSTRUMENTATION

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Eighteen patients with idiopathic scoliosis were operated using "Colorado" spinal instrumentation system at SSK Okmeydanı Hospital Orthopedics and Traumatology Clinic between December 13, 1996 and December 31, 1998. The mean age of the patients was 16.6(12-24). There were 9 male and 9 female patients. The mean time of follow up was 13.7 months (2-26). 11 patients had thoracic, 6 patients had thoraco-lumbar 1 patient had a double thoracic curve. There was one rod migration at the convex side and one rod slippage from the upper hooks No other complications were seen.

Paper #69

A NEW APPROACH TO SCOLIOSIS

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Despite the advantages that new derotation based systems brought there still is debate going on about the treatment of especially adolescent idiopathic scoliosis. Problems like decompensation, junctional kyphosis, and insufficient sagittal plane alignment bring out new proposals. We now are using a technique and system, Ibnt-i Sina Spinal System (IBS), which we think is able to overcome these problems. It makes use of sublaminar wires, hooks, screws, and rods for correction. The main difference is that the major corrective force is the controlled simultaneous translation force on all segments of the curve. On the retrospective of 25 patients treated with this system we have seen that besides dealing good with decompensation and junctional kyphosis problems, the technique was superior in sagittal plane adjustments mainly in carrying the normal kyphosis to its physiologic location. IBS had provided great ease and success in treatment of especially lordotic rigid curves. We have not encountered any neurologic injury or instument failure. Clinical patterns will take place in this presentatien.

Paper #70

SHORT SEGMENT ANTERIOR SURGERY FOR THORACOLUMBAR/LUMBAR IDIOPATHIC SCOLIOSIS

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INTRODUCTION: The advantages of anterior surgery for thoracolumbar/lumbar idiopathic scoliosis includes maximum motion segment preservation and improved transverse plane correction. The uncertainties include patient selection criteria, instrumentated vertebrae selection, and alignment at and below the lowest instrumented vertebra. The purpose for this study is to determine the safety and efficacy of short segment surgery based on the principles of complete 360 degrees discectomy and realignment, maximum quantities of compressed non-structural bone graft, and single 6.35 mm rod/6.35 mm screw instrumentation.

MATERIALS AND METHODS: From 1993 through 1996, 15 consecutive patients (12 females, 3 males), index patient included, average age 15 years, 2 months (range, 12 6 to 25 8) were treated. Average operation time was 399 minutes, estimated blood loss was 745 cc, and hospital stay, including day of surgery, 8.6 days. Average vertebra instrumented was 4 (range, 3-5). Lowest instrumented vertebra was 2.6. The lowest instrumented vertebra was the lower end vertebra in 9 patients and one above the lower end vertebra in 6 patients. The full 9th or 10th rib was grafted in all patients: 9 patients had 1, and 1 patient had 2 nonadjacent rib grafts in addition; and 5 patients had non-structural allograft in addition. Follow-up averaged 2 years, 11 months (range, 2 0 to 4 8).

RESULTS: Complications occured in 2 patients; intercostal neuralgia which resulted after suture removal on 3rd postoperative day, and a broken lower instrumented vertebra screw with some position loss. Preoperative, postoperative and latest follow-up deformity measurements were as follows. Coronal plane balance; 32mm, 27mm, 9mm. Thoracolumbar/lumbar (TL/L) Cobb (%correction); 52 degrees, 10 degrees (81%), 19 degrees (63%). Instrumented TL/L Cobb; 45 degrees, 0 degrees (%100), 4 degrees (%90). Thoracic (T) Cobb; (n=11), 36 degrees, 30 degrees (17%), 27 degrees (25%). Lowest instrumented vertebra (LIV) tilt; 27 degrees, -3 degrees (111%), -1 degrees (96%). One vertebra below LIV tilt; 29.6 degrees (79%), 8 degrees (72). Sagittal plane instrumented levels (normal=7); -3, -7, -2 degrees. LIV extension (normal=-10)- -12, -7, -15 degrees. LIV flexion/extension change vs instrumented sagittal plane angular change (preop to latest), cc -654 $p<0.02$. Preoperative and latest angle of trunk inclination; T (n=9), 7 a

CONCLUSION: The technique is safe and effective with coronal plane correction equal to recent single or dual series, transverse plane and sagittal plane results better than other single rod series, and universal patient satisfaction.

Paper #71

LUMBAR PEDICLE SCREWS VERSUS HOOKS IN KING TYPE II ADOLESCENT IDIOPATHIC SCOLIOSIS

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The authors reviewed 246 adolescent idiopathic scoliosis patient underwent posterior spinal instrumentation between November 1990 and December 1998. Forty-nine patients (mean age 13.8 years; 39 female, 10 male; average follow-up period 48.4 months) classified as King Type II curves with selective thoracic fusion operation were included in the study. Of 49 patients, distal end of fusion area was instrumented with lamina hooks alone (H) in 15 and pedicle screws in 35. At average 48.4 months, pedicle screws improved horizontalization of lowest instrumented vertebra (with lesser residual tilt), and of first free lumbar vertebra below instrumentation (76% versus 34%), had better overal spontaneous correction of lumbar curve (64% versus 39%), and had better centralization of fusion mass above sacrum (2 coronal decompensation versus 4, and 0 sagital decompensation versus 3). These results are attributed to improved stability and mediolateral moment arm of pedicle screws, and less damage to functi onal and anatomical structures. Pedicle screws serve for better maintenance of uninstrumented spine below King type II curves.

Paper #72

NEW TECHNIQUE - TRANSVERSE PROCESS STABILISATION IN THE SURGICAL TREATMENT OF SCOLIOSIS

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If we ignore the high neurological risk of the segmental spinal instrumentation, it is known to be superior to all the other techniques.

This is the starting point of the technique I have developed. In this technique, transverse processes of the thoracal 1-10 vertebrates were used. The wire's cutting the bone was stopped by using wires together with rectangular plates. Maximum correction effect was provided by lengthening the power arm by means of stabilising each thoracal vertebra from both sides. The completeness of the power effect was provided by tying the wires on both sides with each other. A large area was gained for fusion on the posterior. The most important advantage was that neurological risk was overcome since there was no contact with the spinal cord. This method can be used in combination with screw, hook, Luque and Drummond. It does not require stabilisation during the post-op. 30 cases were operated using this technique between the years 1994 and 1998. 10 were male, 20 female and the youngest was 10 and the oldest 26 years old. Of these, 7 had neuromuscular, 4 congenital and 19 idiopathic scoliosis. The scoliosis angle was measured as 40 minimum and 130 degrees maximum, and the kyphosis angle was measured to be between 14 and 90 degrees. In 4 cases, posterior intervention was carried out after anterior loosening. No neurological deficits were encoutered due to this technique in any cases.

In the paper, depending on the early post-op results, the history of the developmental process, its recent stage and its applicability have been presented for discussion.

Paper #73

ONE DECADE EXPERIENCE WITH CD METHOD

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The first CD operation was performed in our hospital by Dr. Chopin in 1986, and continued next few years. Since 1988, we have started to work self - directing. Over this period 200 CD interventions have been performed on different spine patology, mostly on idiopathic scoliosis.

In this study, 60 cases of scoliosis have been analised on juvenile and adolescent age. The youngest operated patient was 11 years old, the oldest one 23 years old. The female patients predominated with 55 cases, only 5 male. The localisation of scoliosis was on thoracic region in 28 cases, thoracic and lumbar in 23, thoraco-lumbar in 8, and lumbar in 1 patient.

The greatest curve was 153 degrees by Cobb, the least was 40 degrees. With standart CD operative technics average achieved correction was 64%, the greatest correction was 80%, and the least 12%. The loss of correction of few degrees was recorded in mostly of the patients after verticalisation during the early postoperatively months.

Greater loss of correction was noticed at two patients, due to broken operative material on it's lower part, and they had to be reoperated.

There was not any infection or neurologic disorder.

As a conclusion, in this moment CD method is the best method in correction of idiopathic scoliosis and other spine patology, which give an opportunity for treedimensional correction and solid fixation.

Paper #74

LONG TERM EFFECTS OF SUBLAMINAR WIRING IN IMMATURE PIGS: AN EXPERIMENTAL STUDY.

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PURPOSE: An experimental model to observe long term effects of sublaminar wiring when performed in a growing child.

MATERIALS AND METHAD: One level sublaminar wiring operation was performed to ten newborn pigs under general anesthesia. After one year when all the pigs got to mature age, they were sacrified. We dissected the spinal medulla at the same level of the wires and the specimens were sent to pathology department to observe the histopathologic effects of the wires. We also searched for the ATP'ase level in these tissues.

RESULTS: Histopathologic results showed no difference between the wired segment and the control group which was dissected from the normal areas. ATP'ase levels were also normal.

CONCLUSION: Sublaminar wiring is a safe method when performed in a growing child.

Paper #75

DOES TRANSVERSE APEX COINCIDE WITH REGIONAL OR GLOBAL APEX LEVELS IN ADOLESCENT IDIOPATHIC SCOLIOSIS (AIS)

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PURPOSE: To identify the regional and global apices of curves in (AIS) and compare the levels of those with the most rotated vertebral levels on CT scans.

METHODS: Thirty-four structural curves of 26 consecutive patients scheduled for surgery for thoracic or thoracolumbar (TL) scoliosis were prospectively analysed with standing AP X-rays, and CT scans covering the curve apices and pelves. Curves were type 1 in one, tpye 2 in eight, type 3 in twelve, type 4 in two, type 5 in one and TL in two patients. Thoracic and lumbar curves were evaluated seperately for all type 2 curves. Vertebral rotations were normalised by the rotation of the pelves. The most rotated vertebral (or disc) levels (rotational apex) were compared to the regional and global apex levels (vertebra or disc) of the corresponding curves seperately.

RESULTS: Regional and global apices were at he same level in 16 curves (47.1%), within half a level in another 16 curves (47.1%), and the regional apex was one level highher in 2 curves. Comparison of transverse apex levels with regional and global apex levels can be seen on Table 1.

Rotational apex	-2.0	-1.5	-1.0	-0.5	0.0	+0.5	-1.0	+1.5	95% confidence limits
Regional apex	0	0	2	6	10	8	8	0	-1.00/+1.01
Global apex	1	0	0	7	12	6	7	1	-1.19/+1.04

Table 1: Frequency table for the comparison of the rotational apex with regional and global apex levels. (-) signs indicate higher, (+) signs indicate lower rotational apex.

Discussion: Correct identification of the apex of the scoliotic curves may be very important in decision making for certain modalities of surgical treatment in AIS. This study demonstrated that the regional or global apex of a given curve is the most rotated level in only a minority of the curves. The most rotated level may be as far as two levels from the global apex and one level from the regional apex. Recognition of this discrepancy may be critical in planning surgical treatment for idiopathic scoliosis.

Paper #76

EFFECTS OF ANTERIOR RELEASE ON CORRECTIONS IN CORONAL AND TRANSVERSE PLANES IN THE SURGICAL TREATMENT OF THORACIC ADOLESCENT IDIOPATHIC SCOLIOSIS

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PURPOSE: To identify the additional correction in coronal and transverse (ie.rotation) planes provided by anterior release and fusion in a group of patients who underwent posterior fusion and instrumentation for thoracic adolescent idiopathic scoliosis (AIS).

PATIENTS AND METHODS: Pre-operative and immediate post-operative X-rays and CT scans of twenty-four consecutive patients who underwent surgical treatment for thoracic AIS were retrospectively, analysed for this study. Patients were divided into two groups according to the type of surgery as group 1; only posterior surgery (15 patients; 3 boys, 12 girsl; average age 14) and group 2; anterior release and posterior surgery (9 patients; 4 boys 5 girls; average age 13). Groups were compared for the pre and post-operative magnitudes, as well as the corrections obtained in coronal (Cobb) and transverse (apical rotation) plane deformities.

RESULTS: Can be seen in Table 1.

	Preop Cobb (deg)	Postop Cobb (deg)	Correct. (%)	Preop rotation (deg)	Postos rotation (deg)	Correction (%)
G 1	54 (40-66)	18 (4-32)	67	17 (7-30)	15 (6-24)	~~15~~ 11.7
G 2	64 (50-102)	15 (3-34)	77	16 (10-26)	13 (6-23)	~~16~~ 18.7
P	0.048	0.194	0.073	0.411	0.446	0.861

Table 1: Comparison of pre and post-operative deformities and the corrections obtained (Mann-Whitney U-test)

DISCUSSION: In the frontal plane, the rate of correction obtained in this study is comparable to similar studies in the literature. Although the deformities in group 2 were significantly larger, the addition of anterior surgery provides a substantial increase in the amount of correction. For transverse plane deformity, posterior instrumentation yields only a negligible amount of correction, which is not parallel to the correction in the frontal plane, and is not sensitivi to the addition of anterior surgery. Rotational corrections obtained in both groups appear to be inferior compared to most of the similar studies. The cause of this difference may be the measurement of apical rotations in our study using CT thereby eliminating the residual pelvic rotation.

CONCLUSIONS: Posterior instrumentation is associated with a substantial rate of correction of the coroal plane deformity in AIS, which can further be augnmented by the adition of anterior surgery Transverse plane deformity, however, appears not be corrected significantly, andis not sensitive to the addition of anterior surgery in our hands.

Paper #77

THE PREVENTIVE EFFECT OF SUBLAMINAR WIRING TO HOOK DISLODGMENT

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Alucu spinal instrumentation (A3/A4) technique was utilized for the operative treatment of scoliosis for our 1st series. Our 2nd series were operated by the same technique followed by sublaminar wiring (SW) in order to prevent hook dislodgement and screw pull-out in the lower and upper end of instrumentation. We compared both series and studied the role SW in stabilization.

Series were created among your previousiy operated idiopatic King Type 2 and 3 scoliosis. Selection criterion were based on at least 2 years of follow-up periods and no early complications. Cases were then divided into 2 groups:A: Operated with A3/A4 B: Operated with A3/A4 SW

The 1st series consist of 50 randomly selected cases from Group A, whereas the 2nd series consist of same from Group B. Only upper instrumentation was compared for similarity of the evaluation.

1st Series: We used pedicular hook in the concave side and claw (pedicular hook and transvers hook) in the convex side of the upper vertebra. Mean Cobb angle was 57 & 61616;. Mean follow-up period was 4 years and 1 month. In the final evaluation, dislocation of minimum 1 hook was determined for 9 cases (18%).

2nd Series: Additionally to the 1st series procedure one/two level SW was applied to the upper vertebrae. The subliminar wires were fixed bilaterally to the rods. Mean Cobb angle was 64 & 61616;. Mean follow-up period was 3 years and 4 months. In the final evaluation, dislocation of minimum 1 hook was determined for 4 cases (8%).

Hook dislocation rate for 1st and 2nd series is 9/4. As a conclusion additional stabilization through SW, significantly contributed to increase this rate.

As SW prolonged the operation by 15 minutes, resulted in no neurological damage in our series, and most significantly decreased hook dislocation by %66, it was predicted to be an efficient method.

Paper #78

THE COSTOPLASTY AND CDI. AUGNMENTATION OF THE COSMETIC RESULT.

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ABSTRACT: After twelve years of experience with CD. instrumentation in scoliosis the authors introduced costoplasty to improve the cosmetic result of the scoliosis fusion. The subperiosteal rib resection is done through the same midline skin incision after blunt dissection of the paraspinal muscles. Usually five or six ribs are resected on the convex side and the length of removed fragment is ca 2.5 cm. The bone material from the rib is used as a graft, but in all cases but one there was a need to harvest more bone from the iliac ala. The costoplasty was performed in 35 patients with thoracic scoliosis where the hump was the main issue for the patient. There were no complications related to the rib resection, the operation time was slightly longer (20 minutes, approximately) and the blood loss was not marked. The postoperative recovery was uneventful in all patients although most of them had curves over 80 degrees. All the patients began spontaneous breathing about 15 min after the operation, one required ventilator support for six hours. The ambulation was allowed on the third postoperative day. All the patients required the same type and dose of medicamentation postoperatively as the group without costoplasty. The authors canclude that the costoplasty is an importaht and valuble addition to the spinal instrumentation that improves the shape of the back. It may be performed safehy in carefully selected patients especially without respiratory impairment but severe cosmetic deficit.

Paper #79

FRONTAL AND SAGITTAL BALANCE ANALYSIS OF LATE ONSET IDIOPATHIC SCOLIOSIS TREATED WITH TSRH

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STUDY DESIGN: A retrospective assesment of the effectiveness of Texas Scottish Rite Hospital (TSRH) instrumentation in late onset idiopathic scoliosis.

OBJECTIVE: Investigation of the effect of TSRH instrumentation on correction of the frontal and sagittal planes and that of derotation maneuvre on trunk balanca.

SUMMARY OF BACKGROUND DATA: As scoliotic curve is a rotational deformity, derotation maneuvre was used as the corrective factor, but recent studies demonstrated spinal imbalance and decompensation problems in patients treated with this method. TSRH instrumentation, being a modification of Cotrel - dubousset (CD) instrumentation, is a more effective system with its rigidity and locking mechanism.

MEDHODS: This study evaluates 217 late onset idiopathic scoliosis patients surgically treated with TSRH instrumentation from September 1991 to November 1996 with a minimum 2 years follow up. Preoperative and postoperative Cobb angles in the frontal plane and thoracal kyposis and lumbar lordosis angles in the sagittal plane are measured. For balanca analysis, lateral trunk shift (LT), shift of head (SH) and shift of stable vertebra (SS) are measured radiologically. Last control was done in November 1998 and correction loss, infection and other complications documented.

RESULTS: Mean age of the patients was 14.8±2.3 and mean follow-up period 43.8± 19.5 months. When all the patients were included, preoperative mean Cobb angles of major curves in the frontal plane was 59.1±20.7, Major curves that were corrected by 34.8±20.5 % in the bending radiograms were corrected by 58.9±19.5% postoperatively were achieved by 58.9±19.5% correction postoperatively. Also postoperative kyphosis angle and lumbar lordosis angles were 31.4±11.6 and 30.6±10.9 respectively. Postoperatively, a statistically significant correction was obtained in LT, SA and SS values. Secondary curves were corrected by 62.1±30.9% and no secondary new curves occurred postoperatively. Decompensation and imbalance problems were noted in 10.1% of the patients. At the last control, 6.4°±6.2° of correction loss was recorded in major curves in the frontal plane.

CONCLUSION: It is established that high correction rates can be obtained in scoliotic curves with TSRH instrumentation. Any undue effect wasn't observed in uninstrumentated lumbar curves and thoracic sagittal contours of the hypokyphotic patients. It is also empasized that this instrumentation system causes minimal imbalance problems and with proper preoperative planning high correction rates can be achieved.

Poster #1

RADICAL RESECTION OF PEDIATRIC SPINAL CORD ASTROCYTOMAS

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The optimal treatment of pediatric spinal cord astrocytomas is surgery followed by radiotherapy. Since the first clinical symptom in this pathology is scoliosis and torticollis, most of those cases are not evaluated further. This leeds to the late diagnosis and involvement of multiple segments of the spinal cord, which makes the removal very difficult.

Between the years 1992-1997 6 spinal cord astrocytoma cases were operated on in Marmara University, Institute of Neurological Sciences, Division of Pediatric Neurosurgery. The ages varried between 2 and 12 years. They all presented with vertebral colon deformity and neurological deficit. They were evaluated with spinal MR and SEP. An osteoplastic laminectomy and gross total resection were performed in all cases with no mortality and morbidity. During their follow-up no reccurence was observed.

Poster #2

ANTERIOR DECOMPRESSION AND ANTERIOR INSTRUMANTATION IN THE MANAGEMENT OF THOROCOLUMBAL FRACTURES

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The clinical data cited have shown that anterior decompression and stabilization does play a significant role in the treatment of thorocolumbal fractures.

In general, those patients with more than 20° local kyphosis and more than 50% canal compromise can be treated in this manner.

From 1995 to 1998 42 patients who had thorocolumbal fractures were managed operatively at 19 Mayıs University Hospital, one patient had T8 fractures, two at T9, two at T11, twelve at T12, fifteen at L1, ten at L2 fractures.

We had used Anterior Alıcı Spinal System (A.A.S.S.). Postoperative sagittal index were in physiologic limits in 40 (95%) patients threated with A.A.S.S. None of the patients had iatrogenic neurological deficit after anterior decompression. The neurological function 13 of the 20 patients improved by at least one grade.

We concluded that anterior decompression, strut graft and fixation with A.A.S.S. in patients who had a fracture thorocolumbal spine yielded good radiograph and functional results.

Poster #3

TREATMENT OF VERTEBRAL TUTERCULOSIS BY ANTERIOR APPROACH

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This study was conducted in order to evaluate the clinical and radiological results of the patients treated with surgery and chemotherapy with the anterior approach in vertebral tuberculosis and to compare these results with those in literature obtained using various methods of treatment.

Our stduy was carried out on 7 patients with vertebral tuberculosis applying to Erciyes University Medical Hospital. Their mean age was 43.4 years (18-62). Three patients out of 7 were male and 4 female. The development place of the disease was thoracal and lumber regions. All patients were applied anterior debridment, spinal instrumentation and bone grafting to and then the treatment was completed with chemotherapy. External support was used in all patients.

The mean follow-up period was 56 months (39-91). The occurence of fusion was seen in the controls after 6 month follow-up period. The angle of kyphose was found to be 26.1° (13°-75°) and 11.1° (2°-50°) preoperatively and postoperatively, respectively.

The correction loss was 2.3°. Three patients who could not perform their daily activities were able to fulfil their daily activities after the treatment.

It was concluded that in the treatment of vertebral tuberculosis, fusion and drug chemotherapy associated with anterior debridment and spinal instrumentation is an efficient method of treatment.

Poster #4

SURGICAL TREATMENT OF SPONDYLOLSIS

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The primary pathology in spondylolsis is a defect at pars interarticularis. Back pain usually respond to conservative treatment but not resolved totally. Heavy physical activity cause serious pain. The diagnosis is easy but sometimes it may be overlooked. Direct and oblique radiograms and CT scan are enough for diagnosis. MRI should be performed for suspected disc disease or existence of neurologic deficit. The lesion mostly seen on L-5 vertebra. Surgical treatment is the method of choice for radical treatment.

Between 1992-1997 eighteen patients (13 male, 5 female) were treated with surgically. The mean age was 24 (17-32), and the mean follow-up was 2.4 (1-5) years. All the patients have back pain continued at least one year and conservative treatment (NSAIDs, brace, exercise etc). was instated. The pseudoartrosis site was curetted and grafted at the operation. Fixation was achieved with two transpedicular screws and two infralaminar hooks. Compression was instuted between the hooks and the screws. The facet joints, interspinos ligaments and spinos process were left intact at the time of the operations. All the lesions located at L-5 vertebra. In two cases that have dysplastic lamina and spina bifida L5-S1 fusion was instuted and in a case that has the same dysplastic changes L4-S1 fusion was preferred. The patients were examined periodically with every three months. The results were evaluated at the end of the first year. All the patients satisfied with the procedure at that time. The most commonly seen complications that observed in surgical treatment of spondylolysis are pseudoarthrosis, implant failure and continuation of pain. Infection and pseudoartrosis was observed in a case in that group. The implant was removed and L5-S1 fusion was applied. The implants were removed after two years in all the cases and controlled for pseudoarthrosis and affected the result in a positive way. Surgical treatment of spondylolysis is not clear. But the pain that affect normal daily life or proffession or in the existence of neurologic deficit, surgery is the choice of treatment. Especially for young patients, surgical treatment should be adviced because in that patients, spondylolysis may cause spondylolysthesis in the future.

Poster #5

TREATMENT OF DEGENERATIVE LUMBAR SPINAL STENOSIS BY DECOMPRESSIVE LAMINECTOMY, AND POSTERIOR INSTRUMENTATION

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The purpose of this study is to evaluate the patients satisfaction operated because of lumbar spinal stenosis, by decompressive laminectomy, and posterolateral fusion and posterior instrumentation in view of pain relief, walking distance and need for any external support.

Eleven patients, whose had the procedure of decompressive laminectomy, posterolateral fusion and instrumentation between the years of May 1997-June 1998, because of degenerative lumbar spinal stenosis.

The mean age at the time of surgical intervention was 62.8 (45-77) years. The average duration of symptoms preoperatively was 8 (4-13) years.

In all cases, walking distance was diminished when compared with the previous years. Seven patients had complained of being unable to do even their daily home activities. The other 4 patients stated that their walking distance without low back pain was under 500 meters before the operation.

On CT scans, the examination criteria was anteroposterior diameter of spinal channel in the most stenosed level. This value was 9.1 mm (7-11) in average.

Decompressive laminectomy was performed in one level in 2, in two levels in 5, in three levels in 3, and four levels in one patient. The mean follow-up period was 13.8 months.

At the last follow-up, walking distance has incresead for 8 patients and it was 2000 mt. without pain in avreage. Among 11 patients, low back pain was eliminated in 6, decrease in 2, same in two, and increased in one case. One patient who paind had increased, needed to use crutches for walking.

It is concluded that decompressive laminectomy, posterolateral fusion and posterior instrumentation is a good choice of procedure for multilevel degenerative spinal stenosis.

Poster #6

THE CORRELATION BETWEEN THE CANAL COMPROMISE AND THE INCREASE IN INTERPEDICULAR DISTANCE (IPD) IN THE BURST FRACTURES OF TORACOLUMBAR VERTEBRAE

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In order to evaluate the corelation between the canal compromise in the burst fractures of thoracolomber vertebrae and increase in interpedicular distance retrospective study was done on 202 burst fracture of 178 patients. Percentage of canal compromise was measured from the CT sections by Willen method. And interpedicular distance which was the distance between the inner cortex of the pedicules was measured by using AP plane X-ray of the vertebrae. Statistical correlation was evaluated.

The result was that there was a correlation between the IIPD and canal compromise which can be explained by radial divergence of the corpus under the axial loading.

We concluted that IPD must be closed. It must be closed after the direct or indirect decompression for mechanical and neurological stability. Application of transpedicular screw to the burst vertebra might be a method for the closure of IPD. But the surgeon has to connect the screw inserted to the burst vertebra to the rods after the decompression. So current spinal systems must be modified.

Poster #7

TRANSPEDICULAR FIXATION FOR THE TREATMENT OF DEGENERATIVE SPONDYLOLISTHESIS IN ADULTS

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PURPOSE OF THE AIM OF THE STUDY: is to analyze the fusion rate and clinical success rate in adult patients undergoing surgical treatment for symptomatic degenerative spondylolisthesis. A postoperative questionnaire and grading scale for the clinical results and radiological criteria for the fusion were used.

MATERIAL AND METHODS: In our Clinic, between January 1993 and January 1995 10 patients with degenerative spondylolisthesis were treated with Transpedicular Fixation and posterolateral fusion. Mean age of the patients is 47.2 years and mean follow up is 50.2 months. In terms of classification according to Meyerding; Eight patients are in grade 1 and two patients are in Grade 2. Lysthesis were present in L4-L5 for eight patients and L5-S1 for 2 cases. Decompression and posterolateral fusion were applied six cases and insitu posterolateral fusion to four cases.

RESULTS: A Grading scale, consisting of return to work or prior level of activity, solid fusion and need to medication were used for the results. Eight of the patients had excellent and good results and two patients had poor results two of the poor results was observed in patients with only insitu fusion..

CONCLUSION: An instrumented posterolateral arthrodesis in combination with a decompression procedure results in a high rate of fusion and satisfactory clinical success in patients with degenerative spondylolisthesis. Continuation of low back pain, instability and root compression after a appropriate duration of conservative measures is the indication for the surgical treatment of degenerative spondylolisthehis.

Poster #8

OPERATIVE TREATMENT OF ADOLESCENT IDIOPATHIC SCOLIOSIS WITH POSTERIOR DEROTATION SYSTEMS

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Scoliosus is the most frequently seen vertebral deformity defined as, lateral deviations together with vertebral rotation occurring with structural border dispositions on the sagittal plane, three dimensional disruption of the spine.

Idiopathic scoliosis, which is the most common form, is divided into three according to the age of the patient when it is first diagnosed; infantile juvenile and adolescent.

We explored the three dimensional repair potential by evaluating the posterior derotation results that we have practiced in scoliosis surgery since 1992. Between 1992 March and 1997 June in Ankara Numune Hospital 2nd Orthopedics clinic, 38 patients who have diagnosed as adolescent idiopathic scoliosis were treated by posterior derotation systems. Twenty-three were females and 15 males: Their medial age was 14.1 (11-18 y) 5 patients extracted from the study because of their discontinue to update follow-up. Thirty-three patients remained are examined median 23.5 months (6-53). The patients classified according to King classification with evaluation of their preoperative graphics. One patient typ 1 (%3). 12 Type 2 (%36), 13 type 3 (%39), 5 type 4 (%15) and 2 were type 5 (%6).

We made posteroanterior, lateral roentgenograms with the patient standing, posteroanterior right and left bending graphics with the patient in supine positions and measured curves according to Cobb's method.

The patients control evaluations were on 1, 3, 6, 12, 18 and 24 months after surgery. The percentile of correction were %63.6 (35-90.9 on frontal thoracal plane and 14.1 % (0-39) on the sagittal thoracal plane. Before the surgery kyphosis on thoracolomber junction determined in 8 patients and continued after the operation in 3 of them.

The method that should be chosen in treatment of idiopathic scoliosis must provide correction in every three planes because of its disruption in all frontal, sagittal and axial planes. Our aim is to evaluate the surperior ways and disadvantages of surgical management with posterior derotation system in idiopathic scoliosis.

Poster #9

MANAGEMENT OF A NEGLECTED T9-10 FRACTURE DISLOCATION WITH POSTERIOR INSTRUMENTATION AND FUSION

A. Cılız, M. A. Tümöz, A. Dayıcan, S. Portakal, B. Bahadır

Ankara Numune Hospital 2nd Orthopaedics and Traumatology Clinics, Ankara, Turkey

Fracture-dislocations are probably the most unstable of all the fractures in thorocolumbar spine and associated with spina canal injuries.

The lack of anatomic stabilizators will cause significant postural deformities in a nontreated fracture dislocation that include local kyphosis and posttraumatic scoliosis because of deforming forces.

We treated a 29 years ol female who has a neglected T9-10 fracture dislocation with posterior instrumentation and fusion. She had a history of a fall from approximately 3 meters height and no history of treatment. Because of indefinable back pain she had an 18 to 20 days bad rest. After the pain became more tolerable she mobilized with using crutches.

Because of continued back pain and the deformity that her parents recognized on the back she was taken to Ankara Numune Hospital approximately 2 months later from the accident and hospitalized on 18.12.1997 in 2nd Orthopedic Clinics. Physical examination revealed local kyphotic and scoliotic deformities that was easily recognized with inspection.

There were no neurologic deficits except partial loose of lower leg force especially dorsiflexion of feet. We measured her scoliotic and kyphotic deformity according to Cobb's method in her posteroanterior and lateral graphics and get the results of 32 degrees and 50 degrees respectively.

The patient was operated in 23.12.1997 with posterior instrumentation and posterior fusion with iliac crest grefts. After the operation the measurements were repeated and found 15 degrees in coronal 35 degrees in sagittal plane with the correction rates %53, %30 respectively.

We believe that a delay of two months will get the procedure of correcting the deformity more dangerous. So at the operation our first aim was having a stable spine. We avoid of forceful manipulation for correction. There are few reports of fracture dislocation of spine in the literature. What ever our follow up was short, approximately 14 months, we decided to report this interesting case as a case report.

Poster #10

THE SURGICAL TREATMENT OF TARLOV CYSTS

S. Naderi, K. Yücesoy, H. Özeri, N. Arda

Dokuz Eylül, University, School of Medicine, Department of Neurosurgery, İzmir, Turkey

The Spina perineural cysts (Tarlov cyst) arises between the aracnoid and outer surface of piamater, and they involve the sacral nerve roots typically. The most of these cysts are asymptomatic, and usually discovered incidentally. Uf the cyst cause significant syptoms, surgical excision is necessary.

We presented a 46 years old women with L5 and S1 Tarlov cysts had operated because of neurological syptoms and signs. The surgical indications and techniques were discussed with the light of literatur.

Poster #11

THE PRESERVATION OF BONY STRUCTURE OF SPINAL CANAL DURING SURGERY OF SPINAL LESIONS BY LAMINOTOMY

K. Yücesoy, S. Naderi, H. Özer, N. Yücer, N. Arda, T. Mertol

Dokuz Eylül, University, School of Medicine, Department of Neurosurgery, İzmir, Turkey

The destruction of spinal canal integrity, particularly in pediatric patients, may cause a spinal deformity, epidural fibrosis, and the risk of spinal cord trauma. The replacement of aimed lamina after spinal procedure and its fixation using mini plates decreases these problems.

Eight patients with different pathologies (3 split cord malformation, 2 intraspinal lipoma, 2 intramedullary tumar, and intradural arachnoid cyst) underwent a laminoplasty. A total of 23 laminae were replaced using this method. No surgical complication was observed. It is concluded that spinal canal reconstuction by laminotomy is a safe and easy method.

Poster #12

TRACE ELEMENTS IN SPINAL FUSION PATIENTS

M. H. Tatari, H. İşlekel, E. Altekin, S. Göçen, C. Özcan

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The purpose of the study is to evaluate the preoperative and postoperative values of trace elements (Mg, Cu, Zn) among the spinal fusion patients.
Magnesium, copper and zinc blood values of 32 patients, with a mean age of 28.31, on the preoperative, immediate postoperative, first and third postoperative days, were evaluated. The operative time, intraoperative blood loss, total intaoperative blood andn flauid replacement, the number of the levels fused and the type of antibiotic used for prophylaxis in the postoperative period were recorded. In 22 patients postori or fusion, in 7 anterior fusion, 3 both procedures were performed in the same session. Among all patients, the mean operative time was 240 minutes,; the mean intraoperative blood loss was 1969 cc. and the mean blood replacement was 1823 cc.

Postoperative immediate hypomagnesemia occured in 28 (87.5%) of the patients, copper decrease in 25 (78%) and and zinc decrease in 19 (59%) of them.

No relationship was found between the operative time and alterations in trace element values; like between the intraoperative blood loss and these values. The type of the antibiotic didn't affect the results.

Symptoms associated with the decrease of the trace elements, were developed in only 4 patients, all healed at the postoperative second day.

The study confirmed a high incidence of hypomagnesemia and relatively lower incidence of copper decrease in patients who underwent spinal fusion; but the reason of this entity is still unclear.

Poster #13

MULTIFOCAL SPINAL TUBERCULOUS INFECTION A CASE REPORT.

M. Tezer, B. Aksoy, E. Ertürer, İ. Öztürk, A. Hamzaoğlu

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A 48 year old female was admitted to our clinic with neck, back and hip pain. There was mild quadriparasthesia. There were not any other neurological symptoms of spinal cord. Isolated C6-C7, T9-T10, L3-L4 and right sacroiliac joint involvement were shown in plain radiographs. Abscess formation at the paravertebral and epidural areas and also psoas abscess were revealed by magnetic resonance imaging. Solitary cavitary apical lesions were located bilaterally at the chest radiograph. For cervical lesions, anterior radical debridement and grafting harvested iliac crest were performed at the first session followed by posterior spinal instrumentation and fusion. Further more evacuation of psoas abscess and fusion of right sacroiliac joint was performed. This operative treatment followed by anti-tuberculous chemotherapy for 9 months period. The treatment was maintained by cervical collar and thoracic-lumbar-sacral orthoses postoperatively. The patient was followed-up by 34 months. The patient was completely pain free and the neurological status was improved. No clinical and radiological abnormality was seen at follow-up.

Poster #14

SOLITARY OSSEOUS MYELOMA OF SPINE TREATED WITH ANTERIOR AND POSTERIOR COMBINED SURGICAL METHODS. A CASE REPORT.

M. Tezer, R. Özbal, Y. Kabutçuoğlu, C. Eryiğit, Ü. Kuzgun

Şişli Etfal State Hospital Orthopaedics and Traumatology Clinics, İstanbul, Turkey

A 38 years old female patient was admitted to our clinic with back pain which had been lasting for 2 months. Physical examination was normal with the exception of back pain with palpation. There was no neurological symptoms of spinal cord. T5-T6 disc space narrowing was seen in plain radiographs. There was not any other radiological findings on bone survive. T5 and T6 vertebral body involvement with impression of epidural area were revealed by magnetic resonance imaging. Neither dysproteinemia nor Bence-Jones proteinuria was observed. In the first session, T5-T6 anterior decompression with T4-T5 and T6-T7 discectomy and spinal fusion by grafting fibula and rib was performed. Pathologic specimen examination revealed solitary osseous myeloma of the spine. In the second session, posterior spinal instrumentation and fusion was performed. Bone marrow biopsy taken from sternum was negative. Thoracic-lumbar-sacral orthoses was used 6 months duration. Early and late surgical complications were not seen. The patient was followed-up by 43 months. The patient was completely pain free and there was no neurological sign or symptoms. Grafts were incorporated and there was no radiological decriotaion in the sagittal and frontal plans.

Poster #15

HEMANGIOMA OF THE LUMBAR VERTEBRAE TREATED WITH TOTAL VERTEBRECTOMY, ANTERIOR GRAFTING AND POSTERIOR SPINAL INSTRUMENTATION AND FUSION. A CASE REPORT.

M. T. Tezer, M. Küçükkaya, E. Ertürer, İ. Öztürk, A. Hamzaoğlu

Şişli Etfal State Hospital Orthopaedics and Traumotology Clinics, İstanbul, Turkey

A 13 years old female patient was admitted to our clinic with low back pain and mild paraparesthesia. On physical examination L4 vertebral body was found to be tender on percussion. A mass that causes expansion and destruction on L4 vertebral body was revealed with plain radiographs. On MRI hipervascular, solid, expansive and destructive tumoral lesion was seen on L4 vertebral body that invaded the spinal canal, pre-and post-vertebral region. Blood cells were found on CAT guided needle biopsy. On angiography, it was seen that the mass perfused from L3-L4 vertebral arteries and selective embolization was performed. Total L4 vertebrectomy, anterior grafting, posterior spinal instrumentation and fusion was performed at the operation. Pathological specimen examination was correlated with hemangioma of the bone. Thoracic-lumbar-sacral orthoses was used 6 months. The patients was followed-up by 18 months. It was seen that complete fusion was developed with mild pain complaint at follow-up of the patient.

Poster #16

THE RESULTS OF CHEMOTHERAPY, ANTERIOR AND POSTERIOR SURGICAL INTERVENTIONS ON TREATMENT OF ADULT SPINE TUBERCULOSIS

M. Tezer, Ç. Koçkesen, E. Ertürer, İ. Öztürk, Ü. Kuzgun

Şişli Etfal State Hospital Orthopaedics and Traumatology Clinics, İstanbul, Turkey

The tuberculous infection is still important and is rapidly increasing in the world and in our country. The vertebral colon is the most involved area of the skeleton. In this study, we aimed to present the results of the Pott's disease cases, which were treated by the surgical methods of anterior drainage, anterior decompression, anterior fusion, posterior instrumentation and posterior fusion.

Between 1995-1998, 8 cases were treated with these methods. The average age at the time of surgery was 31.8 years (17-48). Infection involved the cervical area in 1, thoracal area with extensive dissemination in 1, thoracolumbar area in 4 and lumbar area in 2 cases. All cases have been verified through culture and pathologic specimen examination. For the anterior approach tricortical iliac crest and for the posterior approach cancellous chiped autografts were used. Chemotherapy has been used for a period of 9 months. The average duration of follow up was 21.3 months (12-45). Preoperatively patients were classified as 1 Frankel A, 1 Frankel C, 3 Frankel D, 3 Frankel E. Postoperatively both Frankel A and C cases improved to Frankel D, whereas Frankel D cases improved Frankel E and Frankel E cases remained as they were. In all cases solid fusion was obtained. In one case a non-specific infection was observed postoperatively. As a result of no response to conservative treatment, following achievement of solid.

In treatment of Pott's disease, anterior or posterior drainage, decompression and fusion operations, with or without instrumentations, can be done. We believe that anterior radical debridement-fusion and posterior instrumentation-fusion are the best methods of treatment, not only in the treatment of the disease, but also in the prevention of neurological deficits and vertebral deformities.

Poster #17

THE CLINICAL SIGNIFICANCE OF ERYTROCYTE SEDIMENTATION RATE AND C-REACTIVE PROTEIN IN SPINAL SURGICAL OPERATIONS

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The aim of this study is to delineate the postoperative normal changes of ESR (erythrocyte sedimentation rate), and CRP (c-reactive protein) values in uncamplicated spinal surgical cases, and to detect if there is a clinical significance of changes in the values that can be suggestive of a complication by comparing the values with those in cases with obvious or clinically proven infections.

Forth-three cases were taken into the study. In all cases, anterior or posterior spinal operations were performed either with or without instrumentation for various clinical diagnosis. The results of cases with no clinical signs of infection and negative microbiological cultures preoperatively and postoperatively were evaluated separately, and the results of cases with positive microbiological cultures or with mal de Pott were evaluated separately. In all cases, the blood samples were taken at preoperative, postoperative, 1st, 3rd, 7th, 15th, 28th, and 42nd days. First group (with no infection) consisted of 40 patients, and ESR values were 12.2, 27.8, 68.9, 70.5, 56.3, 37,8 and 28.4 mm/hr respectively, and CRP values were 6.3, 113.1, 111.7, 40, 16.8, 6.4 and 5 respectivel, There were 3 cases in the other (complicated with an infection) group, and the ESR values were 7, 25, 82.6, 97.5, 67, 79, and 76 mm/hr, and CRP values were 18.5, 33, 82, 59.5, 58, 88 and 86 respectively. These results were the averages, and variations were seen among the patients.

We concluded that, although individual variations in the values can be seen, it is important to know the average values of ESR and CRP for certain postoperative periods, and resistant high values of ESR after the 15th postoperative day, and CRP after the 7th postopertive day can be suggestive of an infection.

Poster #18

INCIDENCE OF NEURAL AXIS ABNORMALITIES IN ADOLESCENT IDIOPATHIC SCOLIOSIS

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One hundred twenty patients with adolescent idiopathic scoliosis, for whom operative treatment modality was chosen, underwent routine total spine magnetic resonance imaging (MRI) to evaluate neural axis abnormalities. Incidence of neural axis abnormalities on MRI was 9.2% (11 patients); namely, syringomyelia (4 patients), syringomyelia plus Arnold Chiari malformation (1 patient), tethered cord (2 patients) tethered cord plus intradural lipoma (1 patients), tethered cord plus diastometamyelia with widened canal (2 patients), diastometamyelia plus spina bifida (1 patients). Of these, 7 patients underwent neurosurgical operation before surgical correction and fusion operation of scoliotic deformity. This study suggests that adolescent idiopathic scoliosis may posses an underlying neural axis abnormality. Especially, left sided curves and atypical curves may have much higher incidence for presence neural axis abnormality, i.e, possibility of neurologic hazard during correction of scoliotic deformity. Thus, MRI screening is recommended at presentation of scoliosis. However, the incidence of neural axis abnormalities is not well established in scoliotic patients and a multicenter study with prospective control group is needed.

Poster #19

OSTEOID OSTEOMA OF T12 VERTEBRA

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Osteoid osteoma is a benign osteoblastic tumor with distinctive histologic abnormalities consisting of a central core of vascular osteoid tissue and a periferal zone of sclerotic bone. Osteoid osteoma is a reactive bone lesion that is usually diaphysial in location and observed in young adults. The femur is the most frequently involved bone and ther is predilection for the proximal part of the bone, especially the neck and the intertrochanteric region.

Vertebral osteoid osteoma that arises from the left pedicle of T 12 has been reported because of his rarirty.

Poster #20

LONG TERM RESULTS OF POSTERIOR SPINAL INSTRUMENTATION IN THE TREATMENT OF IDIOPATHIC SCOLIOSIS

Ö. Akçalı, Ö. Gül, E. Kıter, E. Alıcı

Dokuz Eylül University Medical Faculty Department of Orthopaedics and Traumatology, İzmir, Turkey

The Alıcı Spinal System is an instrumentation used in the correction and fixation of various structural disorders of the spine. Idiopathic scoliosis is one of the most important indications. Scoliosis is a complex deformity in the frontal, sagittal and axial planes, and this system can provide correction in all three planes. In this study, we present the long term results of fusion and posterior spinal instrumentation with Alıcı Spinal System in idiopathic scoliosis.

123 cases with adequate follow-up treated by posterior spinal instrumentation and fusion for idiopathic scoliosis between July 1988 - July 1995 were taken into the study. The mean follow up was 74 months (41-18 months). Preoperatively, the mean curve was 58.4 degrees. The mean correction was 81.3%. Except two, fusion was achieved in all cases. Revision was performed for pseudoarthrosis and implant failure in these two cases. Fusion was achieved in these cases after the revision. No neurological complication was encountered in any cases.

We concluded that, the Posterior Alıcı Spinal Instrumentation is a reliable and safe method and has a high success rate in the treatment of idiopathic scoliosis.

Poster #21

PROPOFOL vs. THIOPENTONE-SEVOFLURANE ANAESTHESIA FOR SCOLYOSIS SURGERY WITH WAKE-UP TEST

A. Yılmazler, N. Uçkunkaya, O. Kutlay, G. Korfalı, U. Aydınlı

Uludağ University Medical School Dept. of Anaesthesiology and Dept. of Orthopadics, Bursa, Turkey

BACKGROUND: Wake-up tests are spesific and necessary for the scoliosis surgery.

METHODS: Propofol anaesthesia (P group) and thiopentone-sevoflurane anaesthesia (S group) were compared for the wake-up test. The study was performed in 30 spinal surgery patients undergoing CD instrumentation.

RESULTS: The two groups gave no statistically meaningful differences of mean arterial pressure, heart rate, SaO2, ETCO2 and arterial blood gasses were monitored before, during and after the wake-up test. On the other hand, the wake-up test was done in average 3.54 h 1.31 minutes in the P group, while 12.12 h 1.30 minutes in the S group ($p<0.001$).

CONCLUSION: Wake-up test can be conducted faster with a propofol anaesthesia to thiopentone-sevoflurane anaesthesia for scolyosus surgery.

Poster #22

THE RESULTS OF ANTERIOR RADICAL DEBRIDEMENT AND ANTERIOR INSTRUMENTATION IN POTT'S DISEASE AND COMPARISON WITH OTHER SURGICAL TECHNIQUES

İ. T. Benli, M. Kış, S. Kanevitçi, E. Aydın, S. Akalın, M. Çıtak

1st Department of Orthopaedics and Traumatology, Ankara Social Security Hospital, Ankara, Turkey.

Classic procedure in the treatment of vertebral tuberculosis is drenage of the abcess, curetage of the devitalized vertebra and application of antituberculous chemotherapy regimen. Posterior instrumentation results are encouraging in the prevention or treatment of late kyphosis, however, a second stage operation is needed. Recently, posterolateral or transpedicular drainage without anterior drainage or posterior instrumentation following anterior drainage in the same session is preferred to avoid kyphotic deformity. Seventy-six patients with spinal tuberculosis were operated in the 1st Department of Orthopaedics and Traumatology, Ankara Social Security Hospital, between January 1987 and January 1997. There were four children in our series. Average follow-up was 36.1 ± 14.5 months and the average age age at the time of operation was 40.8 ± 15.2 years. This study reports the surgical results of 45 patients with Pott's disease who had anterior radical debridement and anterior fusion and anterior instrumentation (14 patients with Z-plate and 31 patients with CDH system). The results are compared with those of 8 patients who had posterolateral drainage and posterior fusion, 12 patients who had only anterior drainage and anterior strut grafting, 11 patients who had posterior instrumentation following anterior radical debridement in the same session in terms of fusion rates, effect on the kyphotic deformity, recurrence and clinical results. All patients had one year continued triple drug therapy. Preoperative 23.2° ± 12.5° local kyphosis angle was lowered to 6.1° ± 6.9° with a correction rate of 77.4 ± 22,3%. When the other three groups which had been instrumented were compared, the correction rates in the local kyphosis angle values were not statistically different and the variation in loss of correction at the last follow-up was also statistically insigntificant. The sagittal contour of the involved vertebra's region did not change in the uninstrumented group, while it did so in instrumented groups which had normal range vlues postoperatively. Overall, 27 patients had neurologic deficits preoperatively. Twenty of three (74.1%) had complete, and 5 (18.5%) had partial recovery with a combined 92,6% neurologic improvement. All the patients had a solid fusion mass at the last controls. Reactivation was not seen. Additionally, contrary to the common belief, anterior instrumentation following anterior radical debridement and anterior autologous strut grafting can be a good treatment option with low complication rate, high correction rate in acute local kyphosis, and high fusion rate.

Poster #23

HYDATID CYST INFECTION OF THE SPINE

E. Yalnız

Trakya Üniversitesi. Tıp Fak. Ortopedi, Edirne, Turkey

Hidatid disease of the spine is a rare condition. İts incidonee is fess that 1% of all cases of echinococcosis in the literature. Diagnosis may be difficult because of the rarity of the disease. Radical debridement with removal of all the cysts and decompression of neural structures in case of neurological deterioration are the keystone of treatment. Antihelminthic drugs appears to be effective for decreasing the recurrence rate. The author presented two cases who have been treated surgically and adjunctive chemotherapy with mebendazole.

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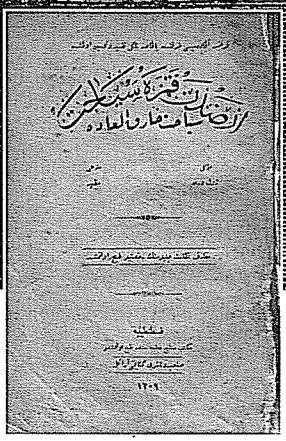
One of the most widely read authors of his time, Jules Verne harboured a grand dream, that of travelling to the moon. USD 1,446,675 was collected in Europe alone and 5 % of that amount was channelled through Ottoman Bank to help that dream come true. Ottoman Bank is always happy to be a part of projects and developments towards shaping the future.



The inner cover of the first Turkish translation of Jules Verne's "Voyage to the Moon". Jules Verne mentions the support of Ottoman Bank in the novel, which was first published in 1865.

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