

**III.INTERNATIONAL CONGRESS
ON SPINE SURGERY**

**ABSTRACT
BOOK**

**OCTOBER 2 - 6 1994
HOTEL DEDEMAN ANTALYA / TÜRKİYE**

III.

INTERNATIONAL
CONGRESS
ON
SPINE
SURGERY
IN
TÜRKİYE

OCTOBER 2 - 6 1994 ANTALYA

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EE Transfeldt

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MA Asher
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FJ Kramer
S Metz
EE Transfeldt
K Yonenobu

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JE Lonstein
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FREE PAPERS

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- 2. Biomechanics.**
- 3. Scoliosis**
- 4. Cervical Spine.**
- 5. Degenerative Problems of Spine & Spinal Stenosis.**
- 6. Spondylolisthesis.**
- 7. Kyphosis.**
- 8. Tumors and Infections of Spine.**

RADIOLOGIC ANALYSIS OF STABILITY IN THORACOLUMBAR FRACTURES

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To approach the stability problem in another point of view, three column distribution, sagittal index and compression ratio were examined with computerised tomography and conventional radiography.

Patients: In this study 71 cases with 100 thoracolumbar fractures were evaluated and approximately half of these (49%) were found in T12-L1 level.

The type of fractures were; compression (66%), Burst (26%), fracture-dislocation (3%), Seat-belt injury (1%). According to three column distribution, fracture were found in anterior (43%), anterior and middle (45%), anterior-middle-posterior (8%), posterior (3%). The fractures in the three column were 100% neurologic lesion, 50% in the anterior and middle column, none to be found in the anterior column only.

Results: The highest sagittal index value was 43 degrees, as well as the highest value of compression ratio was 83.4% and the lowest wedge index was 0.14. With the final stage sagittal index 18 degrees, compression ratio was over 40%, wedge index 0.66 with these results the fracture not only is seen in the anterior column but also appears in the middle column.

Discussion: The middle column has an important role while examining the stability in the fractures, sagittal index, wedging index and compression ratio has to be measured when instability is evaluated and treatment is scheduled.

THE ROLE OF NONOPERATIVE TREATMENT IN BURST FRACTURES OF THORACOLUMBAR SPINE

Haluk AĞUS MD

Indications of non operative treatment for burst fractures of thoracolumbar spine has not been cleared yet. Most of the spine surgeons have preferred surgical treatment if there is any canal compromise even if the patients are neurologically intact.

We have evaluated 9 patients without any neurological symptoms who are conservatively treated with thoracolumbar fractures. The average follow up was 12 months (8-20 months). Mean age was 49 (36-66 years). 7 patients were male and 2 patients were female. The average kyphotic deformity was 14° (7-20) at the beginning and it was 18° (5-25) during the follow up. The spinal canal compromise was between %25-%50 and it remodelled to %0-%34 during the treatment.

4 of the patients were symptom free, 4 of them had non specific complaints and 1 patient had intensive back pains. None of the neurological status of the patients have seen worsen.

Non operative treatment for the burst fractures of thoracolumbar spine should be considered as an effective treatment.

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THE RESULTS OF CONSERVATIVE TREATMENT IN THORACO-LUMBAR SPINE FRACTURES

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SUMMARY

80 of 120 patients who had fractures of vertebra had been treated by conservative methods between 1989 and 1994 in The Orthopaedics and Traumatologie Clinic 1 of The Kartal Education and Research Hospital. Fractures of vertebra had occurred due to fall from height in 56 patients, traffic accident in 21 patients and fall of a heavy object in 3 patients.

Treatment devices used in these patients were as follows: hyperextension body cast in 36 patients, Jewett brace in 24 patients, reclination orthoses in 8 patients and lumbostatt brace in 2 patients. 10 patients had been treated by bed rest.

Modified Moskovitch scoring system and Frankel scoring system had been used for the evaluation of these patients from the clinical point of view. Degree of loss in vertebral body height at the x-rays of vertebral column and localized angle of kyphosis according to sagital index were the parameters used in the evaluation of these patients radiographically.

When deciding surgical intervention, stability must be assessed carefully and as in all operations the cost of the operation must also be considered.

As a result, in the treatment of fractures of the thoraco-lumbar vertebra conservative management has an important role.

Key words: Thoraco-lumbar fractures, conservative treatment

THE LONG TERM FOLLOW UP RESULTS
OF CONSERVATIVE TREATMENT OF COMPRESSION
FRACTURES IN THORACOLUMBAR VERTEBRAE

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32 patients withouth neurologic deficit were treated conservatively for thoracolumbar vertebrae fractures. 28 of them were compression type and 4 were burst type fractures. After bed rest they were immobilised in a thoracolumbar orthosis or a plaster cast for an average of 22 weeks.

After mean 1.8 years follow up all but one patient returned to their activities that they had been doing before. 8 patients had more than 30 degrees kyphosis and 35 percent compression at the last examination. In none of the patients neurological degeneration occurred.

Conservative treatment can be method in the management of thoracolumbar injuries of compression type with an angle up to 25 degrees kyphosis and 30 percent compression. On the other hand 7 of 8 patients who had post-traumatic kyphosis at the last examination did not require surgical intervention.

THE RESULTS OF UNSTABLE THORACOLUMBAR VERTEBRAL FRACTURES TREATED BY POSTERIOR SURGICAL APPROACH

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Between April 1990 and June 1994, 67 patients with injury of the thoracolumbar spine were treated surgically. Of those 48 were male (%71.6), and 19 were female (%28.4). The average age at injury was 33 years (16-64 years). The aetiology of injury was fall from height in 36, traffic accident in 28 and crushing in 1. Work-related injuries were seen in 2 patients. The most frequently injured segment was L1 by 30 patients. This was followed by T12 (14 patients), L2 (6 patients), L3 (5 patients), L4 (4 Patients), T11 (4 patients), T10 (3 patients) and T9 (1 patient). The type of fracture were; burst (46 patients), compression (3 patients) and fracture-dislocation (18 patients). Surgical Instrumentations used were; Alico posterior spinal instrumentation (52 patients), Dick's "fixateur interne" (5 patients), Harrington Instrumentation (5 patients), and TSRH (5 patients) methods. The duration period between the trauma and the operation were in average 8.5 days (ranging 6 hours-20 days). The operation period ranged from 100 to 140 minutes, averaging 120 minutes and the blood transfusion was performed in average 2,8 units. All of the patients were braced after operation. Fifty-five of the 67 patients were followed up for 3 to 48 months, with an average of 18 months. The results of these patients were reviewed with respect to completion of healing, change in neurologic status, medical or hardware complications, and follow-up radiographic parameters. Among 33 patients with neurologic deficit 12 showed complete recovery while 5 patients had partial improvement according to Frankel classification. We performed 262 transpedicular screws in all patients. At the final control, bending in 16 screws, broken in 6 screws and migration in 10 screws were observed. Surgical interventions used for thoracolumbar fractures were all effective. However, Alico system has been found to be an excellent device for thoracolumbar fracture stabilisation.

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ADVANTAGES OF POSTERIOR FUSION AND STABILIZATION FOR UNSTABLE THORACOLUMBAR FRACTURES

(Erol Tasdemiroglu, M.D., Phillip A. Tibbs, M.D., UKMC, Div. Neurosurgery, Lexington, KY, USA): The surgical approach to acute unstable thoracolumbar fractures remains controversial. Anterior, posterior and combined approaches have been advocated in single and staged procedures. We found that a one stage posterior approach for decompression and stabilization yields excellent clinical results. Between 1982 and 1992, 70 patients (53 males, 17 females) with thoracolumbar fractures (T11-L2) were treated by posterior fusion and spinal instrumentation. Surgical technique included simple distraction reduction and modified posterolateral decompression by impaction or resection of disc or bone fragments, plus posterior stabilization with distraction or compression rods. At admission, according to modified Frankel Grading System, 13 cases were in A1, 3 cases were in A2, 3 cases were in B, 10 cases were in C, 11 cases were in D1, 6 cases were in D2 and 23 cases were in E grades. The patients with incomplete spinal cord injury showed significant functional improvement. During median 60 month follow-up period, 32 cases (66% of the neurologically impaired group) showed neurological improvement. Nineteen cases improved by 1 Frankel Grade (FG), 7 cases improved by 2 FGs, and 5 cases were improved by 3 FGs. Although postoperative complications occurred in 13 cases (18.5%) only one case with posterior fusion failed and required anterior approach, whose rods were removed before solid and stable bony fusion developed. Unstable thoracolumbar fractures are characterized by the failure of continuity of at least two of the three columns. The spinal canal is also compromised by bony fragments. Application of uniform distraction forces is an effective way to achieve posterior reduction of the intracanal fragment unless there is free fragment of bone or herniated disc. Bone and disc fragments not reduced by distraction can be impacted or excised. Since this posterior and posterolateral approach provides direct inspection of the dura and neural elements to assure excellent decompression by removal of free disc and bony fragments, we conclude that in most cases of unstable thoracolumbar fracture can be exposed, decompressed and stabilized by a one stage posterior approach.

THE EFFICACY OF TIMING OF THE SURGERY IN THE BURST FRACTURES

Muharrem YAZICI, MD Birol GULMAN, MD Koksal TILKI, MD

Study design: In this study, the efficacy of timing of the surgery in the burst fractures of the thoraco-lumbar junction which were surgically treated between May 1993-May 1994 with short segment fixation using transpedicular screws were evaluated.

Methods: The patients were divided into two groups according to time elapsed between injury and operation. Cases operated within the first 24 hours were taken as early surgery group (n=5) and cases operated later than 24 hours after the injury were considered as the late surgery group(n=6). The efficacy of treatment was assessed by evaluation of the sagittal index (SI) restoration and reduction of the canal compromise.

Results: The pre- and post-operative values for SI and canal narrowing for both groups are presented in the table:

	<u>EARLY</u>	<u>LATE</u>	
pre-operative			
SI *	27.0 ± 1.5	24.0 ± 1.1	p> 0.05
	* Farcy JPC et al: Spine 15(9), 958-65, 1990		
Canal			
Narrowing**	0.43 ± 0.04	0.65 ± 0.04	p> 0.05
	** Mumford J et al: Spine 18(8), 955-70, 1993		
post-operative			
SI	2.17 ± 0.83	11.4 ± 1.0	p< 0.01
Canal			
Narrowing	0.06 ± 0.04	0.38 ± 0.04	p< 0.01

Conclusion: There is still controversy concerning the relation between canal narrowing and neurologic deficit, and the effect, if any, of decompression on neural recovery. Nevertheless, if the main aim of the surgical procedure is to restore the sagittal index and decompress the neural canal, then anterior approach should be preferred to transpedicular fixation in cases to be operated later than 24 hours.

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THE ROLE OF CANAL COMPROMISE IN THE TREATMENT OF THORACOLUMBAR BURST FRACTURES.

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Background: Recent studies demonstrated the importance of the Posterior Longitudinal Ligament (PLL) and posterior annulus in the decompression of the medullary canal by reducing intracanal fragment.

Aim: Purpose of this study is to demonstrate the effects of canal compromise amount to the canal clearance by posterior distraction and ligamentotaxis.

Material and Method: There were 22 patients (14 women and 8 men) with average age of 34.3 years (range 15-71). The levels of fractures were: 2; T 6-8, 18; T9-L1 and 2; L2-L5. All patients had preoperative and postoperative CT scans which revealed narrowing of the medullary canal less than 30% in 5; 30-50% in 8 and more than 50% in 9 cases preoperatively. Narrowing of the medullary canal revealed 0-15% in 14, 15-30 % in 4 and more than 30% in 4 patients postoperatively. The patients were operated with in 4 hours to 18 days (av.1.8days) of the injury. Indications for surgery were: 1. Neurologic findings, 2. instability (According to Denis), 3. More than 35% canal compromise with or without neurological findings. 12 patients underwent posterior, 1 patient anterior and 9 patients combined anterior and posterior surgery. The average follow-up was 30.4 months (16 to 49 months). At follow-up examination 11 patients Frankel A remained unchanged and one improved to Frankel B; 3 Frankel C patients improved grade D, 2 remained unchanged; 2 of 3 grade D patients improved to grade E ; 1 remained unchanged; 2 patients did not have neurological deficits postoperatively.

Conclusion: Our results demonstrated that ligamentotaxis achieved by distraction was succesful in cases which medullary canal compromise was less than 30%, whereas in cases which medullary canal compromise was more than 30%, it was not succesful as previous one, and residual bone fragments still remained in the canal leading to various degrees of canal compromise. The possible cause for this may be that posterior longitudinal ligament (PLL) and posterior annulus could have been ruptured in cases with more than 30% canal compromise. We think that preoperative MRI might be helpful to evaluate PLL and posterior annulus. If this is not possible, anterior surgery should be chosen.

TREATMENT OF THORACOLUMBAR FRACTURES WITH ACCOMPAYING NEUROLOGICAL INJURY

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SUMMARY

The surgical treatment and approach is controversial for spinal reconstruction of thoracolumbar fractures.

By using preoperative and postoperative radiographs and computed tomographic scan, the degree of spinal canal compromise was quantified in the sagittal, coronal and axial planes. All fractures were stabilized by posterior instruments or done only laminectomy for spinal cord decompression. The relationship between initial spinal canal encroachment and neurological deficit demonstrates that the degrees of bony and neurological injury directly reflect the kinetic energy transferred at the time of impact. 56 cases of thoracolumbar fracture with accompanying neurological deficit were reviewed. Neurological status was graded at the time of admission, postoperatively or conservative treatment, and at a mean of 12 months postinjury.

The lack of correlation between the extent of spinal canal reconstruction and neurological recovery suggest that ongoing neural compression distortion contributes little to the overall neurological injury.

POSTEROLATERAL DECOMPRESSION ON THE TREATMENT OF VERTEBRAL BURST FRACTURES

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Primary aim for the treatment of vertebral burst fractures is decompression, stabilization and fusion of the involved segments. Direct decompression can be accomplished by anterior or posterior approaches. Posterolateral decompression, firstly described by Erickson in 1977, is a method which allows both decompression and stabilization on the same session.

Between the period October 1991-May 1994, in SSK İstanbul Hospital 2nd Orthopaedics and Traumatology Clinic, twentytwo patients with vertebral burst fractures were treated by the way of posterolateral decompression, stabilization and fusion operations. Mean age of the cases was 23.8 years (18-64 years) and there were six women and sixteen men. Except one, all the fractures were in thoracolumbar region, mostly in the first lumbar vertebrae (58.4 per cent).

Our indication for posterolateral decompression was narrowing of canal diameter 30 percent or more and presence of neurological deficit. In eight patients, Neurological deficit was seen (six in Frankel C level and two Frankel D level). Mean canal compromise of the patients detected by CAT was 43.4 percent. All the patients were evaluated in May 1994 and mean follow up time was 24.3 months. (5-30 months). In Assessment of the cases, radiologically and clinically five parameters were used: % canal compromise, local kyphosis angle, anterior body compression, neurological status, Denis work and pain scales.

Postoperatively on the latest follow up, in all patients with neurological deficit, there were improvement one or two Frankel level. and mean % canal compromise improvement was 28 percent.

Complications were seen in two patients, one postoperative exitus and one deep infection.

As a result, We concluded that, in vertebral fractures with neurological deficit, posterolateral decompression is an alternative and safe method according to anterior methods. In neurologically intact patients, because of the recent articles about the remodeling process, Difference between direct or indirect decompression should be kept in mind.

DIAGNOSIS AND THE TREATMENT PLAN:

"GREENSTICK VERTICAL LAMINAR FRACTURES ASSOCIATED WITH LUMBAR BURST FRACTURES"

Aydınlı, U., Bilgen, Ö., Durak, K., Sönmez, M., Gedikoğlu, Ö.

Nineteen patients with lumbar burst fracture treated between December 1991 and April 1994 were retrospectively reviewed. Ten (53 %) of them were male and nine (47 %) of them were female with an average age of 33 years old (15-70 yrs). Average follow-up period was 18 months. The etiology of injury was a fall from height in 17 (89 %) and traffic accident in two (11 %). L₁ was the most involved segment of the lumbar burst fractures (53 %). Using the Denis classification: 5 patients had type A, 8 patients type B, 5 patients type D and only one had type E fractures. Seven patients who had neurologic deficits were operated anterior-posteriorly. Harri-Luque, Alico and C-D instrumentations were used for posterior fixation. Greenstick vertical laminar fractures were diagnosed preoperatively in seven patients. These patients had undergone posterior exploration of the spinal canal with opening laminoplasty of the posterior neural arch. Dural lacerations were noted in two (30 %) neurologically normal patients and neural elements were entrapped within the greenstick laminar fracture in one of them.

Lumbar burst fractures with greenstick vertical laminar fractures should be treated initially with posterior exploration of spinal canal before any spinal reduction maneuver.

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ANTERIOR THORACOLUMBAR DECOMPRESSION, FUSION, INSTRUMENTATION FOR SPINAL TRAUMA

John P. Kostuik

Based on the biomechanical principles of anterior distractive forces combined with instrumentation to decrease sagittal bending moments, an anterior system using a modification of Harrington instrumentation has been developed for the correction of kyphotic deformities including the treatment of acute burst fractures in one hundred and twenty-five cases, post-traumatic kyphosis in sixty cases, Scheuermann's kyphosis in forty cases, rigid round backs in four cases, acute rigid kyphosis (congenital) in six cases, post-laminectomy in fifty cases, flat-back syndrome in eighty cases, kyphosis secondary to tumour in twelve cases, and kyphosis secondary to osteoporosis with fracture in seven cases. A total of three hundred and eight-four cases have been treated with anterior instrumentation. Complications include: breakage of forty screws and five rods. There have been no early or late vascular or neurological sequelae related to instrumentation. The biomechanical basis for the treatment of kyphotic deformities includes an anterior distractive force to resist compressive loads and where possible segmental fixation to decrease sagittal bending moments combined with bone grafts far from the neutral axis. This system provides these benefits with minimal risk and morbidity.

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THE EARLY RESULTS OF KANEDA SPINAL INSTRUMENTATION

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Between February 1993 and June 1994, Kaneda anterior spinal instrumentation was applied in 11 patients in our clinic. There were 6 males and 5 females. Mean age was 42,2 ranging between 20 and 60 years. Thoracolumbar fracture was the commonest cause. Bracing was done for the first 2 weeks postoperatively, and at the third p.o. day patients were allowed to (sit and walk) ambulate.

There was no major complication. In the early postoperative period, Kaneda instrumentation is found to be trustable support for anterior and middle columns.

PLATE-SCREW COMBINATION FIXATION OF UNSTABLE VERTEBRAL FRACTURES: (LONG TERM RESULTS)

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Thirteen patients (10 male and 3 female) with thoracal, lumbal or thoracolumbal fractures that were treated with St. George plate and pedicle screw combination were studied at long term follow-up. The average age at time of surgery was 29 years, and average follow-up was 63 ± 14 months. While 8 of the patients had complete neurological function loss (Frankel A), 2 patients had full neurologic function (Frankel E). The other 3 patients had incomplete cord lesions (Frankel B, C and D). The loss of vertebral height, degree of kyphotic deformity and translation were measured from the preoperative, postoperative and the last follow-up plain radiographs. The spinal canal and placement of the implants were evaluated with computed tomography. At last follow-up, neural functions of the 4 patients with complete neural function loss (Frankel A) and two patients with intact cord function (Frankel E) remained unchanged. Of the remaining 4 patients with complete neural function loss, 3 improved from A to B, and one improved dramatically from A to D. Of the three patients with incomplete cord or cauda equina lesions, one improved from B to C and the rest two improved to E. There were no pseudoarthroses or implant failure. With its strength the plate screw combination established the normal contours of the fractured spine. Plate-screw combination is a cheap, effective method for stabilization of the spinal column after fractures.

THE RESULTS OF TRANSPEDICULAR SCREW-ROD FIXATION IN THORACOLUMBAR VERTEBRA FRACTURES.

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Gürsel Leblebicioğlu, S. Aydın Yüçetürk.
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Ankara.**

Fifty-eight patients who had thoracolumbar vertebra fractures and that were fixed with transpedicular screw-rod combination between were evaluated after a minimum follow up of one year. Mean age of the patients was 38.08 (14-66) years. In their follow-up, patients were evaluated clinically and radiologically considering changes in neurological findings, functional status, number of vertebrae that was fused , development of spinal deformity and implant failure. The status of spinal canal was evaluated by CT at the end of first year in some of the patients. In conclusion, fixation with the transpedicular screw-rod combination was found to be a good stabilizing system that provided early rehabilitation.

LONG TERM RESULTS OF SURGICAL TREATMENT IN THORACOLUMBAR FRACTURES WITH TSRH SPINAL INSTRUMENTATION SYSTEM

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21 patients with unstable thoracolumbar vertebra fractures were treated surgically with TSRH Spinal Instrumentation System. The follow-up period was a minimum of two years (24-40 months).

Patients and method: 9 patients were female and 12 were male. The mean age was 32 (17-59). These 21 patients presented with 36 fractures and 66% of the fractures were at T12-L1 and L2 levels. At surgery, transpedicular screws or transpedicular screws with a combination of hook system were used, depending on the fracture level. All instrumentation were from posterior.

Results: Preoperatively, one patient had Frankel A, one had C and six had D type neurologic lesions. Postoperatively, one patient had A, two patients had D and five patients had E.

All patients were evaluated with conventional x-ray and computed tomography. In sagittal indices, wedging rates and canal compromise rates were noted. At the end of a minimum 2 years follow-up, taking the sagittal indices as reference, correction rate was 70% (42-100), the average loss of correction was 26% (0-50). It was observed the loss of correction was a problem markedly at thoracolumbar junction, especially when short segmented were fixed. Only one patient had a complication caused by the important which was due to a failure of an eyebolt.

Discussion: Clinical and radiologic evidence suggested that, short segmented fixation is not suitable at the thoracolumbar junction area. Still was loss of sagittal indices were not at levels to justify a re-operation.

We consider the TSRH Spinal Implant System as an effective method for the stabilization of unstable vertebra fractures.

TSRH INSTRUMENTATION IN THE TREATMENT OF UNSTABLE THORACOLUMBAR FRACTURES

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Mahmut KIŞ, SERDAR AKALIN, Mehmet ÇITAK,**

The results of 40 patients with unstable thoracolumbar vertebral fractures instrumented surgically by Texas Scottish Rite Hospital (TSRH) System in the 1st Department of Orthopaedics and Traumatology, Ankara Social Security Hospital were evaluated. Sixteen (40 %) of the patients were female and 24 (60 %) were male. Mean follow up was 13.2 (6 - 30) months. Mean preoperative sagittal index was 14.2° and was corrected 62.8 % postoperatively. In the 76.4 % of the patients TLJ angles came into physiologic limits. Spinal canal compromise regressed 66.7 % in the postoperative period. In the light of these findings, we concluded that TSRH Instrumentation was an effective way of treating thoracolumbar unstable vertebral fractures.

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THE COMPLICATIONS WE HAVE EXPERIENCED IN TREATING SPINE FRACTURES WITH AO SPINAL INTERNAL FIXATOR

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ABSTRACT

Between May 1989 and May 1994 AO Spinal Internal Fixator has been used for treating 76 patients with unstable thoracolumbar spine fractures in our department. Fiftyone of the patients were male and 25 were female. Their average age is 38.2 years; changing between 16 and 75 . The followup period is between 1 and 48 months (Mean: 31 months). We invited the patients for control examination on the postoperative 1.5, 3, 6 and 12th months respectively. In the late followup, we observed that most of the patients had loss of correction in varying degrees (Mean: 12.09 degrees; range 2 - 24). In five of the patients screw fracture and in four of them implant loosening were observed. Two patients came with superficial and another with deep infection. Also we have five paravertebral bursitis, one deep venous thrombosis and one urolithiasis among the patient group. In this study, we tried to find out the reasons of and remedies for these complications.

**OUR COMPLICATIONS IN VERTEBRAL
FRACTURES TREATED WITH
ALICI SPINAL INSTRUMENTATION**

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Between June 1990 and December 1993, seventy eight vertebral fractures were treated with Alıcı Spinal Instrumentation in 1st Orthopeadics and Traumatology Clinic of Ankara Numune Hospital. Mean follow-up duration was twenty four months.

In the follow-up, infection was found in nine cases (11,5 %), breakage of transpedicular screws in five cases (6,4 %), dislodgement of transpedicular screws in three cases.

One patient died of an anesthetic complication postoperatively.

Through this report, our complications will be presented and the causes will be discussed.

TREATMENT OF SPINAL FRACTURES DUE TO GUN-SHOT WOUNDS

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We evaluated retrospectively the results of 19 patients who had spinal fractures due to gun-shot wounds in the Orthopaedics and Traumatology Department of Gülhane Military Medical Academy between January 1988 and May 1994. Average age of the patients was 23 and average follow-up period was 2.5 years.

The neurologic level of the lesion might mismatch with the injury level in the spinal fractures due to gun-shot wounds,since the thermal and blast effect of the missile could cause clinical perspective of approximately 5 cm.proximal lesion level in these patients. While the early surgical stabilisation and decompression have found successful at the unstable spinal fractures,there is no indication of removal of foreign body inside the spinal canal in the patients with complete cord lesion.

Since this kind of patients show motor,sensorial and autonomic dysfunctions,the treatment must cover all of these with physical,psychological and rehabilitation components.

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REAL MINIMAL DIAMETER OF THE LOWER THORACIC AND LUMBAR VERTEBRAL PEDICLES.

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Transpedicular screw fixation is a widely used method in vertebral surgery, but the complications of this method have not yet been solved. The complications due to mismatches between the screw and pedicle are especially important. In order to prevent the complications, a detailed knowledge of morphometric characteristics of pedicles should be available before operations. Morphometric studies on vertebrae state that there are two main pedicle diameters (Vertical-VD, Transverse-TD). However, our studies have shown most vertebrae have a real "Minimal Diameter-MD" which is the smallest and cannot be definitely measured in vivo by the imaging methods currently in use. Information on MD is needed for the development of instrumentation techniques and new implantable devices. A total of 4212 measurements from 1404 pedicles of 702 human vertebrae were made from T11-L5. Based on these results, we suggest that neither VD nor TD gives accurate measurements of MD. However, MD size may be estimated using the ratio of VD or TD to MD reported in this study for each level.

A. STUDY ABOUT LUMBAR VERTEBRAL PEDICLE DIAMETER
MEASUREMENT FROM DIRECT RADIOGRAMS

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ABSTRACT

Transpedicular fixation of the spine, is a secure way of obtaining effective vertebral stabilization in the management of different spinal disorders. In this study we investigate whether the pedicle size measurement from conventional radiograms is possible for an healthy preoperative instrumentation planning. Transverse lumbar vertebral pedicle diameter is measured in 38 pedicles of 10 healthy individuals and 79 pedicles of 40 disarticulated cadaveric vertebrae for a total of 117 pedicles. In measurements, direct radiograms and for comparison, radiograms obtained with a computerized digital subtraction angiography system was used. In both of these investigations, magnification was corrected. In the cadaveric vertebrae, also the actual pedicle sizes were measured. We found that the diameters of pedicles measured on direct radiographs or DSA radiographs may differ significantly from the actual measurements of vertebrae even when there is no detectable magnification.

Biomechanical Testing of Posterior Spinal Implants Past, Present, and Future

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HISTORY: The modern history of posterior spinal implant components can be briefly summarized chronologically as "first there were hooks, then wires, then screws". At present, these three components represent basically the only methods of attaching implants to the posterior aspect of the spine. Each with relative merits and draw backs. Historically biomechanical testing of these spinal implant devices can be summarized as:

- Harrington, testing based on techniques

- Luque v. Harrington

- Post 1985 comparative testing

 - Multi-hook v. distraction

 - Screws v. hooks

 - Comparisons between similar systems

 - Development of standard tests

- Surgical technique related testing

- In vivo testing

 - Fusion v. stiffness

 - Comparison of clinical follow-up to biomechanical testing results

- Specific failure modeling

 - Analysis of implant failures

STRUCTURAL AND MECHANICAL REALITIES OF BIOMECHANICAL TESTING: The structural and mechanical reality of spinal implants, can be summarized as:

- 1) No single biomechanical test fully characterizes the

ultimate surgical performance of an implant. In fact, it can be argued that the biomechanical testing results reported to date on spinal implants suffer from many limitations.

2) No test, regardless of complexity, completely characterizes the in vivo situation. In most tests, loading tends to be simplified, the models used have been animals or ligamentous human cadaver material, and the numbers and types of implants tested have been small.

3) All biomechanical models, whether in vitro or in vivo are just that, models. Even if in vivo tests are performed, one must still ask the question, how well does the test model the clinical situation. Furthermore, the results may still be difficult to generalize to overall population.

4) Spinal implants are no different than other mechanical device. They obey the basic laws of physics and engineering principals. For example, larger implants tend to be stiffer and stronger, stress concentrations increase a device's risk of fatigue failure, implants utilizing more points of attachment to the spine tend to be stiffer and stronger, or the static strength of any method of fixation is no greater than the bone it is attached to.

5) Performance standards of spinal implants are difficult to define due to a lack of knowledge about the in vivo situation. However, the relative performance of various implant designs to different tests has been found to be an effective method of judging performance.

6) The regulatory concerns of the US FDA do not necessarily follow the concerns of surgeons, researchers, designers, or manufacturers. For example, the FDA often requires test results relative to pre 1976 devices. Such testing is of little interest to surgeons who have abandoned the older devices. Hence, testing performed for regulatory considerations is often considered separately.

7) Without appropriate statistical treatments, any conclusion is possible. Biomechanical testing must be subjected to the same

rigors of the scientific method as any other field.

8) From the surgeon's standpoint, the most relevant testing is that which directly assess the surgical goals.

- a) Can an implant impart corrective forces to a spine?
- b) What is the stability of the device, both in terms of immediate and long term performance?
- c) What effect will the implant have on fusion?

BIOMECHANICAL TEST RESULTS: Keeping in mind the realities of biomechanical testing of posterior spinal implant components, consider the following examples of what has been learned about the mechanical performance of spinal implants.

In vivo measurements of spinal loading have been made, offering some clue to the environment that implants are subjected.

The relative power of correction between distraction and transverse correction has been established. Most current implant systems are now capable of providing both types of correction.

Stress at the first ratchet joint of Harrington rods is now better understood. Both surgical techniques and manufacturing have been altered to limit the number of ratchets in Harrington rods.

The need for fatigue analysis of spinal implants has been firmly established.

Stress analysis has been used as an efficient alternative to cyclic testing.

The relative stability of graft placement has been investigated.

Relative differences in stiffness have been measured for various implant systems. Some devices have been shown to be clearly less stiff in axial or rotational loading compared to the more commonly used devices. This information has often lead to abandonment or redesign of the suspect devices.

The assessment of the relative performance of screws in fatigue loading has been established. The fatigue resistance of various screw designs has been greatly improved.

Specific failure mechanisms seen in vivo have been investigated.

Standardization of basic test protocols has begun.

The relationship between implant stiffness and fusion is better understood.

CONCLUSION: Considering the biomechanical testing performed to date and the state of the art of implant design and manufacturing, the following questions have been raised:

1. Are the corrective powers of current spinal implants great enough, or too great?

Implants have been described as being able to "overcorrect" the spine. Overcorrection can certainly occur, but is more a result of surgical planning and execution, not the design of the implant. It makes little sense to limit implants in terms of corrective power, since other performance factors like stiffness, strength, and fatigue life are often related.

2. Are spinal implants strong enough?

Clearly most are strong enough, most of the time. However, working to increase fatigue life, or increasing the static strength of interconnections between components will ultimately improve implant performance in the more complicated or problem cases.

3. Are spinal implants stiff enough, or too stiff?

Some screw devices are very stiff. Loss of bone density has been observed in the anterior spine with posterior fusion. However, it is clear that even the stiffest of devices must rely on bone fusion to reduce implant stress. Otherwise fatigue failures of the screws are certain. Hence, even these very stiff devices seem to allow the fusion process to proceed or the screws would fail. Once the spine fuses, the fusion mass itself stress shields the anterior spine. Whatever implant was used initially has less relative effect on the resulting construct.

Until better analysis is performed on the clinical outcomes, this question will remain difficult to answer.

A New Spinal Implant. The Concept for Menotic Implants.

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This presentation will report on the initial stages of a collaborative programme aimed at the development of an anterior spinal implant that can be used for replacement of spinal bodies or inter-vertebral discs. Avoidance of the use of iliac bone graft used to promote fusion is desirable, and the availability of hydroxyapatite granules has opened the possibility for a new range of "menlotic" (Greek - to be in close and settled union) implants which will provide rapid integration and a permanent biomechanically acceptable solution to the clinical situation. The present phase of the project is an intermediate one which utilises current concepts of spinal instrumentation together with a new implant. The aim is: (i) to achieve early stabilisation of the spine and mobilisation of the patient, (ii) to use HA as a bone graft substitute, (iii) to develop a degree of osseointegration that will cooperate with the healing, and provide restoration of biomechanical function at the level of spinal replacement, and (iiii) to develop associated spinal instrumentation to stabilise the implant position during the healing. The HA requires suitable containment to localise and limit its effect and mechanical support for the spine is also needed. A device has been developed made from a biocompatible metal which fulfils the aims and requirements. A new design for associated instrumentation has also been developed and is being tested biomechanically. The implant is being tested for mechanical properties of the bone-implant combination using pig spines and in vivo using a mini-pig. The early results of both sets of tests will be reported.

A HYDROXYAPATITE AND TRICALCIUMPHOSPHATE COMPOUND IN POSTERIOR SPINAL FUSION WITH COTREL-DUBOUSSET INSTRUMENTATION

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Between 1989 and 1991 a compound of Hydroxyapatite (HA) e TricalciumPhosphate (TCP) was used to prepare posterior spinal fusion with Cotrel-Dubousset instrumentation in 21 patients, affected by an adolescent idiopathic scoliosis (4 cases, with a mean angle of 51° ranging between 45° e 72°), a fracture from T10 and L2 (9 cases, with severe paraparesis in 6 of them and without neurological disturbances in 3) or a spondylolisthesis of L5 (8 cases, 6 grade II and 2 grade I).

A posterior fusion was performed in all patients, using autologous bone chips obtained from resected spinous processes or removed lamina and applying a compound of HA and TCP, without resorting to autologous grafts from the iliac crest. In all cases was used the Cotrel-Dubousset instrumentation. The patients were ambulated early after 5 days and a plaster cast worn for 6 weeks.

All patients were checked again at least 2 years and 6 months after operation. Arthrodesis was consolidated in all cases. The correction obtained in cases with scoliosis at the end of the treatment was equal to 67% of the initial value and remained stable at last follow-up. In cases with post-traumatic paraparesis a complete neurological recovery has been obtained. No complications were reported.

In conclusion, although the number of cases is still limited, the authors believe that HA and TCP may also be very useful in preparing spinal fusion, due to the excellent biocompatibility and the absence of rejection reactions or infections.

The Hartshill pedicle screw system

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Our system for spinal fixation based on the Hartshill rectangle has been in use in our centre since 1983 and we now have experience of more than 1000 cases with a minimum two year follow-up. Like many others we have found that in the lumbar spine there are clear advantages in gaining fixation by the pedicle as the result of which we developed a pedicle screw bridge device to complement our system. The development, biomechanical testing and clinical results of the first 200 cases with an adequate surgical follow-up will be presented.

Screw Pull-Out Tests for the İbn-i Sina Transpedicular Spinal Instrument

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Transpedicular spinal implants are known to be the most effective systems in the treatment of burst fractures. However, migration, pull out and pedicle screw breakage are the most troublesome issues of these systems. The İbn-i Sina universal transpedicular system is developed to overcome such difficulties. The anterior portion of the pedicle screw of the İbn-i Sina instrument is specially designed to improve contact between the spongy bone of the vertebral body and the posterior portion that will remain inside the pedicle is similar to a cortical screw. This modification is suspected to improve the stability of the system. Two types of the İbn-i Sina screws, mainly the original design and the AO type screws of three sizes (5.5 mm, 6.5 mm, 7.5 mm), were compared with the same size and length of Alici, Isola and TSRH pedicle screws. Sizing of the screws was performed using the results of a previous anatomical study in which the standard of the pedicle sizes of the Turkish population was estimated. A quadrangular frame was developed to perform the experiments. The vertebral bodies were placed obliquely into the frame to allow the pedicle screw to be pulled in the vertical direction. All tests were performed on the M 30 K (Lloyd, UK) mechanical testing device. Pedicle screws of the above mentioned spinal systems were furthermore evaluated by photoelasticity after placing them into epoxy resin (Araldit D + HY 951, Ciba-Geigy, Istanbul). Early results of the experiment suggest that the İbn-i Sina type pedicular screws are as stable and powerful as any other universal screw design. Loads up to 2500 N and 3000 N caused the pull out of the 6.5 mm AO type screw and the original design İbn-i Sina screw respectively. The results suggest a slight improvement in the stability with the new design.

COMPLICATIONS OF PEDICLE SCREWS. Dr. J.E. Lonstein, Dr. R.B. Winter, Dr. M.R. Pinto, Dr. J.H. Perra, Dr. F. Denis, and Dr. M.D. Smith. With the increased use of pedicle screws in spinal fusions for low back problems, spinal deformity, spondylolisthesis, and spine fractures, questions have been raised regarding the safety of screw insertion and the complication rate associated with this method of fixation. This study was undertaken to address this problem. Nine hundred and fifteen performed by six operating surgeons met the inclusion criteria. The diagnosis in the majority of cases (55%) was lumbosacral surgery for degenerative disc disease or failed low back surgery. Other diagnoses were spondylolisthesis (21%), spinal deformity with pedicle screws used as an adjunct to other instrumentation (16%), and acute trauma (9%). The majority of patients had Cotrel-Dubousset instrumentation (69%) with 26% having VSP instrumentation, and the remaining 5% having other systems. A total of 4,610 screws were inserted, averaging five per case (range 1-12). The majority (80%) were inserted from L4 to S1, with the levels of insertion ranging from T9 to S2. The screws were found to be positioned completely within the pedicle in 96% of cases, with 0.56% being medial, 1.3% lateral, 0.41% superior, 0.82% inferior and 3.0% anterior, 3/4 of the latter being in the sacrum. No screw problems or complications were found in 92% of the screws inserted. During the screw insertion, 689 screws (1.45%) cut out of the pedicle or were malpositioned, half of these being successfully reinserted, and the other half being removed and not reinserted. Nerve root irritation or injury related to the pedicle screw occurred with six screws (.13%), all of these being removed at a subsequent operation in the immediate postoperative period. An additional 259 (5.7%) screws were removed at a subsequent surgery, for reasons unrelated to specific screw problems, for example pseudarthrosis,

painful instrumentation, exploration of fusion, extension of fusion. Screw fracture occurred in 26 screws (.56%), with 2/3 of these occurring with the VSP system. The screw breakage rate thus was 1.7% for the VSP system, and 0.5% for the Cotrel-Dubousset system. Bent screws occurred with seven screws (0.18%), and dural tears due to screw insertion occurred in six cases (.13%). The accuracy of screw placement within the pedicle was very high (96%) with only a small number being associated with nerve root injury or irritation (1.4%). The penetration of the vertebral body with the screw tip being anterior was the most common malpositioning found, the majority being in the sacrum with deliberate penetration to improve screw purchase. The rate of problems associated with screw insertion and complications of screws is low. The rate of nerve root injury or irritation is very low (.13%). The most common problem (5.7%) was screw removal due to fusion or pain problems unrelated to the screw itself. This occurred in 39 patients and was necessitated by a pseudarthrosis, painful instrumentation, or extension of the fusion. The placement of the screw within the pedicle can be accurately performed by skilled experienced spinal surgeons and in their hands the technique is safe with a minimal rate of complications and problems.

BIOMECHANICAL EVALUATION OF ALICI SPINAL SYSTEM

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Spinal instrumentation in the past few decades has developed extensively. Recently this has occurred rapidly and has been closely related to an improved understanding of biomechanical properties of the spinal column.

Alici Spinal System has been being developed in recent years and provides three dimensional correction and stabilization to the applied spinal column.

This system consists of rods, hooks, transpedicular screws, sacral screws and transverse connectors.

In this study, axial loading, distraction and three point bending forces has been being applied to the system in different configurations by Instron 1114 Universal Testing machine.

Loads causing elastin deformation, plastic deformation and amount of displacements have been analysed from the graphical output of the machine. Elastin deformation occurred at 400 da N, plastic deformation occurred at 515 daN and amount of displacement was 2.5 milimeters.

As a result, Alici System seems to provide a reliable stabilization against axial loading and bending forces.

Assessment of Spinal Implants Under Cyclic Loading

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An experimental technique is developed to study the transfer of load through spinal instruments when subjected to cyclic loading. In this study two series of tests are conducted on in vitro calf spines comprising of three vertebrae. First series consists of testing intact vertebrae without instrument cyclically (cross head speed 50 mm/minute). The change of stiffness is studied both in short and long period of loading. Second series of testing are performed on fractured and instrumented vertebrae. In order to asses the power of correction of the spinal instrument the change in the participation factor of the vertebra is studied. For this purpose a model is developed to simulate the burst fracture where the transected vertebral body is replaced by a plastic spacer with a certain elasticity. Furthermore, strain gages were placed to the central parts of the posterior rods. The load carried by this setup is designated as P_s . This model, in the presence of spinal instruments are then tested under the aforementioned loading and the load carried is called as P_{appl} . At the end of tests axial stiffens versus load curves drawn at the end of quasi-static tests supply the necessary preliminary information for the adequate prediction of the behavior of vertebrae (intact and/or instrumented) under cyclic loading. Alıcı and TSRH spinal instruments are compared with respect to the additional stiffness supplied by the instruments and with respect to the participation factor (Participation factor of the instrument = $1 - P_s/P_{appl}$) of the instrument. Results of the experiments indicate that Alıcı spinal instrument, under axial cyclic loading can compete favorably well with the other two instruments.

BIOMECHANICAL ANALYSIS OF SPINAL INSTRUMENTATION FOR LUMBAR BURST FRACTURES

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The goal of this study was to assess of axial stiffness of several Alıcı Instrumentation procedures. Compressive axial stiffness were measured in eight calf lumbar spines at the Middle East Technical University. A corpectomy was performed to simulate a burst fracture injury. One calf spine was tested intact . The tested construct patterns were : Corpectomy model without instrumentation (ICM); upper and lower hook pattern (HPI); upper claw and lower hook pattern (CPI); upper claw with lower pedicle screws (CTPI); short segment pedicle instrumentation (SPI). In addition to the tests performed for CTPI and anterior instrumentation with anterior strut grafts (CTPIG,AIG) were employed. These analysis showed that the stiffest construct was the posterior instrumentation with anterior strut (CTPIG). In addition to these findings claw pattern and pedicle screws were found to be the best bone-metal connections.

Biomechanical Evaluation of Transpedicular Spinal Implants in Burst Fractures

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An experimental technique is developed in order to study the transfer of load through spinal implants. For this purpose three vertebrae (in vitro calf spines) specimens are tested under axial compressive loading. Vertebrae are tested both as intact and as instrumented (i.e. injured spine plus spinal implant). The burst fracture was simulated by transecting the anterior longitudinal ligament, the vertebral body and the posterior longitudinal ligament. For the first set of experiments the removed vertebral body and the adjacent disc spaces were replaced by three plastic spacers of different hardness. The second set of experiments was conducted in the presence of various transpedicular spinal implants (Alici, TSRH) and compared to the intact and injured spinal specimen without the transpedicular spinal in place. At the end of tests axial load versus deformation curves are drawn. In addition, a comparative study with regard to the stiffness imparted by the instruments to the spine is also performed. The results reveal that Alici instrument while decreasing the energy absorbed by the spinal construct, increases its stiffness.

SCHOOL SCREENING FOR SCOLIOSIS IN ANKARA

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School screening is a technique of importance for early diagnosis of the spinal deformities. Through this method, only observation and early bracing prevent costly and hazardous surgical interventions. 11,116 students attending to the 6th-9th grades of secondary schools in Ankara were included in this study. 2.4 percent of these students were referred for further evaluation. The voluntary school screening which is started in Ankara is an efficient method and worth continuing in following years.

Treatment of Scoliosis with Boston Brace
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Between 1989 and 1994, 55 patients with idiopathic scoliosis and 5 patients with congenital scoliosis were treated by Boston-Brace. We evaluated curve progression during treatment and after completion of treatment.

32 of patient were female and 28 of them were male. The average age was 11.75 years. The scoliosis angles were measured by Cobb technique. Pretreatment curves ranged from 16 degrees to 57 degrees. (33.2 degrees average) The curve patterns were thoracic for 28, thoracolumbar for 30 and lumbar for 2 of the patients.

The average Cobb angle with brace was 24.6 degrees (from 8 to 41). After application of brace, curves were within the 30 % of the pretreatment Cobb angle.

We found that, Boston Brace treatment for idiopathic scoliosis during adolescence prevents curve progression. One of the most important advantages of Boston Brace is patient tolerance and its cosmetical appearance. Initial curve and flexibility are the most important factors for curve prognosis.

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SELECTION OF FUSION AREA IN THE SURGICAL TREATMENT OF KING TYPE II CURVES

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One of the most important problems with instrumentations doing 3 D correction in the surgical treatment of idiopathic scoliosis is decompensation which especially develops following selective thoracic fusion performed for King type II curves.

Between 1990 and 1993, in our clinic fusion and instrumentation in selected thoracic area was performed in 19 (15.4%) of 26 (21.1%) cases with King Type II curves out of 123 surgically treated idiopathic scoliosis patients.

In the selection of fusion area, standing standart AP and lateral radiographs, supine bending radiographs and sometimes tractions radiographs at Risser table were taken. In the selection of distal fusion level, stable and neutral vertebra was used and intraoperative X-rays were taken to avoid overcorrection of the curve.

Mean follow-up was 16 months (min 6 months, max. 3 years). There was no postoperative decompensation in any of King Type II cases, who had selective thoracic fusion. In cases with Risser 0-1 (immature) , a brace was used postoperatively for the lower curve.

We think that, in King type II curves, it is sufficient to end the fusion on at stable and neutral vertebra when the flexibility of the lumbar curve is over 50% and absence of kyphotic deformity at the thoracolumbar junction. In these cases, no decompensation is seen when the amount of correction of the thoracic curve does not exceed the flexibility of the lumbar curve seen on preoperative bending radiographs.

Our results confirm the validity of selective thoracic fusion for King Tpe II curves.

TREATMENT OF ADULT IDIOPATHIC SCOLIOSIS WITH COTREL-DUBOUSSET INSTRUMENTATION

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Between 1986-1990, one hundred twenty-three adults (one hundred five females and eighteen males) underwent correction of their spinal deformity secondary to idiopathic scoliosis with Cotrel-Dubousset Instrumentation (CDI). Average age was 41 years (twenty to seventy-five years) with 53 patients older than 50 years. The curve types included 39 primary thoracic; 37 primary lumbar; 35 double major, and 12 thoraco-lumbar. Twenty-eight had previous spinal fusion. The surgical indications were disabling back pain or disabling back pain and neurological symptoms in one hundred fourteen patients and in nine patients the indication of surgery was progression of their curves. Pre-operative thoracic curves measured 55°, lumbar 56°, thoracolumbar 64°, double curves 65° and 78°, range 13° - 130°. Lumbar and thoracolumbar curves were divided into 4 groups. A) Flexible, good lordosis, treatment: posterior C.D. B) Rigid kyphoscoliosis, painless L5-S1 disc, treatment: 1) Anterior release, bone graft, 2) Posterior C.D. C) Lumbar Scoliosis, flexible painful L5-S1, disc, treatment: 1) Anterior fusion and instrumentation L4-S1, 2) Posterior C.D. D) Rigid lumbar kyphoscoliosis, painful L5-S1 disc; 1 stage anterior release, bone graft, anterior instrumentation L4-S1; 2nd stage: posterior C.D. Patient over 50- pseudoarthrosis 6%; curve correction thoracic 40%; lumbar 33%; overall complications 51% (US entire group 40%). Thirty-six patients required anterior and posterior staged surgery. Eighteen patients had fusion extending to the sacrum. The others were rigid thoracolumbar and lumbar curves, kyphotic and rigid requiring anterior release with bone grafting and posterior C.D. to restore lordosis. Follow-up averaged 44 months range (twenty-four to sixty-six months). Average pre-operative scoliosis was 64 degrees (range 13 to 115 degrees) and post-operatively averaged 38 degrees (forty-two percent correction). Post-operative thoracic 35°, lumbar 29°, thoracolumbar 42°-48°. Sagittal curve correction was most dramatic in the hypokyphotic thoracic or hypolordotic lumbar spine averaging 173 and 133 percent improvement respectively. For lumbar curves especially, surgical technique depended on the flexibility of the curve, sagittal alignment and on the need to fuse to the sacrum as determined by pre-operative lumbar sacral discography and pain reproduction. Forty-eight complications occurred in forty patients. Loss of fixation due to lumbar

laminar fracture and hook pull-out occurred in eight patients (six over the age of fifty years). Supplementing distal fixation with pedicle screws in this category of patients appears to be a viable solution. Two nerve root neuropraxia attributable to instrumentation were resolved. Pain relief occurred in eighty-six percent of the patients. Pseudoarthrosis 5%.

THE SURGICAL TREATMENT OF SEVERE IDIOPATHIC SCOLIOSIS BY CDI

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Some neglected cases of idiopathic scoliosis can present with a curve over 80 degrees. The surgical therapy in these cases has some difficulties, such as requirement for anterior release, limited correction rate, postoperative pulmonary complications due to compromised pulmonary functions.

33 cases of severe idiopathic scoliosis (over 80 degrees) have been treated by CD Instrumentation in our clinic during the period between April 1990 and June 1993. 13 patients were male, 20 were female. Age varied from 9 to 17 years with an average of 13.8 years. Follow up varied from 7 months to 39 months with a mean of 23 months.

Combined anterior and posterior surgery performed in all cases. In 26 cases anterior and posterior procedures were performed in different sessions, in 7 cases were in one session. Among patients operated in two sessions, 14 received halo-femoral traction in between the two operations.

The average frontal Cobb angle of the curve was 98.4° (80° to 120°). Mean postoperative Cobb measurement was 51.7° (22° to 88°). The mean postoperative correction rate was % 47.4 (%25 to %76). Mean preoperative frontal balance deviation of 2.2 cm improved to 0.6 cm postoperatively.

In the treatment of rigid and severe scoliotic curves, 50 % correction rate and a well-balanced spine can be obtained by posterior fusion with CDI following anterior discectomy and fusion. Regarding the correction rates, there is no significant difference between cases operated in one session and those operated in two sessions. In two-session operated cases, application of a halo-traction between the two operations improved correction rates. In one-session operated cases, immediate mobilization can be achieved, hospitalization time and pulmonary complications can be decreased.

Surgical Treatment of High Grade Scoliosis

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The main aim of treatment in high grade scoliosis is not to correct the deformity and improve the cosmesis but to obtain a balanced, painless back. . In Marmara University School of Medicine, Department of Orthopaedics and Traumatology 64 cases with different causes of scoliosis were operated between 1989 and 1983. In 17 of these subjects the scoliotic curve (Cobb's angle) was greater than 70 degrees. (mean: 98,6; maximum 158; minimum 70) Nine of the patients were male, eight were females. The average age was 18 (32 - 12). Eight patients had idiopathic, another eight patients had paralytic, one patient had congenital scoliosis. There were also various degrees of combined sagittal deformities. Eight of these patients were operated with the double stage anterior release and posterior instrumentation. Single stage posterior instrumentation was performed on 9 patients. Cotrel-Dubousset instrumentation was employed in all cases. The postoperative Cobb's angles were between 90 and 20 (mean: 55). In the majority of the patients a balanced spine was obtained although the cosmesis did not improve.

SPINAL IMBALANCE AND DECOMPENSATION PROBLEMS IN PATIENTS TREATED BY COTREL DUBOUSSET INSTRUMENTATION FOR IDIOPATHIC SCOLIOSIS

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Current principles of idiopathic scoliosis are three dimensional correction and rigid fixation. Although it is accepted that the Cotrel-Dubousset Instrumentation (CDI) meets these goals, there is concern about the potential risk of trunk imbalance and spinal decompensation during the derotation manouvre. The results of 45 patients with Idiopathic Scoliosis treated by CDI between December 1988 and December 1992 were prospectively analyzed. Mean age was 14.3 years and mean follow-up was 48.6 months. A mean correction of 49.6 % was achieved in the Cobb angles of major curves. The best results were obtained in King Type III curves with a 69.4 % correction. Spinal imbalance was evaluated by measuring Lateral trunk Shift (LT), Shift of head (SH) and Shift of stable vertebrae (SS). Decompensation was measured by the increases in secondary curves. When all curve types were included, the average preoperative LT value of 1.96 Vertebral Units (VU) was brought down to 0.91 VU postoperatively, achieving a 55.9 % correction. Fourteen patients had a SH of zero preoperatively and remained balanced after instrumentation. Of the 31 remaining cases, 21 became zero postoperatively. When all cases were included the average preoperative SH was 1.0 VU and was corrected to 0.42 VU with CDI (69 % correction). An average of 75.5 % correction was obtained in SS, and the mean preoperative value of 0.73 VU was corrected to 0.19 VU. At the last follow-up visit a secondary curve had formed above the major curve in one case and three patients had a junctional kyphosis. Loss of correction in the frontal plane was correlated with loss in the correction of LT. The rigid and semi-flexible lumbar curves had a tendency to progress when they were not instrumented, especially in Type II curves Junctional Kyphosis could be prevented when concave laminar claws were used in the thoraco-lumbar region. It was concluded that spinal decompensation and imbalance could be minimized with careful preoperative planning, avoidance of over-correction and a long instrumentation in double major curves.

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THE RESULTS OF LATE ONSET IDIOPATHIC SCOLIOSIS TREATED WITH TSRH INSTRUMENTATION

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Texas Scottish Rite Hospital (TSRH) Instrumentation, one of the recently developed systems, is a system which builds a rigid frame with multiple hook and crosslink plates and is effective in correcting the deformity in three planes in the treatment of scoliotic deformities. From September 1991 to December 1993, 53 TSRH instrumentations were performed for the treatment of idiopathic scoliosis at the 1st Orthopaedics and Traumatology Clinic of Ankara Social Security Hospital. When all curve types were included, the mean preoperative Cobb angle of the major curve that was 59.8 ± 15.6 were corrected by 58.8 ± 19.9 %. The highest correction rate was obtained in King Type III curves with a single thoracal flexible curve (mean 64.4 %). In 67.9 % of the patients physiologic thoracal kyphosis and in 43.4 % physiologic lumbar lordosis were reconstituted. In all of the patients, an improvement in pulmonary functions was observed at 6 months follow-up. In light of these findings it is suggested that TSRH system is one of the first choices, in the surgical treatment of idiopathic scoliosis surgery, as it has advantages such as providing correction in three planes and the possibility of building a rigid frame with crosslink plates.

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THE SURGICAL SCOLIOSIS THERAPY WITH THE ISOLA INSTRUMENTATION

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Over 50 cases of instrumented scoliosis corrected surgeries at thoracic and/or lumbar level are performed. Due to the stable instrumentation of a double rod system, the use of a postoperative brace treatment is not necessary

Especially, we would like to present our experience with the instrumentation for the treatment of children in their development before the age of 12 years. For these children and individual treatment is required. Besides short fusion to balance the lumbar spine, spinal correction by means of a vertebrectomie with short V.D.S. stabilization can be indicated for congenital scoliosis at young age. A so-called growing Isola Rod consisting of two rods with a special tandem connector can be used for idiopathic scoliosis with a Cobb angle over 50°. The preliminary results with this new technique are encouraging.

TREATMENT OF ADOLESCENT IDIOPATHIC SCOLIOSIS USING ISOLA INSTRUMENTATION. Lynn M. Nelson, M.D. and Marc A. Asher, M.D., University of Kansas Medical Center, 3901 Rainbow Blvd., Kansas City, KS 66160.

Purpose: This study was undertaken to determine the effectiveness and current status of the application concepts utilized.

Materials and Method: From February 1989 through December 1993, 81 patients (65 females, 16 males) with adolescent idiopathic scoliosis underwent posterior instrumentation and fusion. Mean age at surgery was 14.6 years. Thirty-five of 44 patients (80%) with at least 2 years follow-up (average 3.0 years) were available for review.

Results: Of patients with at least 2 years follow-up, mean correction was 63% (preop 60°; postop 22°) with a correction loss of 3% (follow-up 24°). Since correction loss was not significant, all 81 patients were analyzed. No King-Moe II, III, IV, or V curves were instrumented below L3. Immediate postop curve correction was significantly better in 1993 patients (mean 73%, preop 62°; postop 17°) than in 1989 patients (mean 56%, preop 59°; postop 26°). Better correction did not result in worsening of trunk balance (coronal T1 offset) as 10 of 17 (59%) 1989 patients and 12 of 16 (75%) 1993 patients were improved immediately postop. Complications occurred in three patients, each having a satisfactory final outcome. There were no neurologic complications.

Conclusion: Based on quality of curve correction obtained and maintained, as well as lack of serious complications, these preliminary results support the continued evolution of the application concepts being utilized by the Isola Spinal Instrumentation System.

COMPUTED TOMOGRAPHIC (CT) AIDED EVALUATION OF THE SURGICAL REALIGNMENT OF ADOLESCENT IDIOPATHIC SCOLIOSIS UTILIZING ISOLA INSTRUMENTATION. Hiroshi Gondo, M.D. and Marc Asher, M.D., University of Kansas Medical Center 3901 Rainbow Blvd., Kansas City, Kansas 66160-7387

Purpose: To determine the extent of spinal realignment currently being achieved by the three dimensional instrumentation techniques utilized with the Isola Instrumentation System (SRS Technique Manual, 1994).

Materials and Methods: From June 1993 through October 1993, pre and postoperative CT evaluations were done on 12 patients (11 females and 1 male), average age 14 years, 6 months with King-Moe II (3) or King-Moe III (9) curve patterns. Six curves were instrumented as single curves, the lower instrumented vertebra being T12.5, an average of 1.5 vertebra above the stable vertebra. Six curves were instrumented with partial inclusion of the lumbar curve, the lower instrumented vertebra averaging L2, being an average of 2 vertebra above the stable vertebra.

Results: Cobb angle improved from 61° preoperatively to 18° postoperatively (70%). Preoperatively, 4 patients had T1 offset (balance) more than the normal 20 mm (Ashton-Miller et al, J. Orthop. Res. 10:217, 1992), whereas postoperative none did. There was significant improvement in major apex rotational (RAsag) correction (22-15°, or 30%), $p < 0.005$ and in the compensatory apex vertebra (8° to 5°, 47%) $p < 0.05$. Facet hooks were more effective in achieving rotation correction, but subpars wires were more effective in achieving Cobb correction in stiff curves.

Conclusion: Utilizing these instrumentation techniques, coronal and transverse plane realignment of 30% to 87%, depending on the parameter measurement, is achieved without creating coronal or transverse plane decompensation.

THE TRANSVERSE PLANE EVOLUTION OF THE MAJOR ADOLESCENT IDIOPATHIC SCOLIOSIS DEFORMITIES. Marc Asher, M.D., and Larry Cook, Ph.D., University of Kansas Medical Center, 3901 Rainbow Blvd., Kansas City, KS 66160-7387

In this study the proposition that thoracolumbar and lumbar, just like thoracic deformities, evolve as a torsion is tested.

Materials and Methods: This is a cross sectional study of the 156 patients in our 212 patient 3-D data base with single major curves.

The dependent variable studied is coronal plane angular deformity (Cobb angle) and its relation to the independent variables of lateral and anteroposterior translations and transverse plane translations and angulations of the apex vertebra relative to the upper end vertebra

Results: For all three curves there are highly significant positive correlations of lateral apex translation to coronal curve magnitude and negative correlations with transverse plane angulation.

Discussion: This study, coupled with our earlier studies showing a positive correlation of apex vertebra angulation to L5 when viewed in the transverse plane (DeSmet, 1984) suggests that the global evolution of the scoliotic deformity occurs in an opposite direction to the regional deformity as viewed in the transverse plane. For right apex deformities, a global counter clockwise torsion is occurring at the same time as a regional clockwise torsion. For left apex deformities, the curves evolve as a clockwise torsion globally, whereas regionally as a counter clockwise torsion.

Conclusions: This study supports the theory that the transverse plane evolution of thoracolumbar and lumbar deformities is similar to thoracic deformities.

LATE EFFECTS AND COMPLICATIONS OF SUBLAMINAL WIRE APPLICATIONS

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499 sublaminal wire applications were done in the operations of 58 patients with different vertebral disorders between 1985 and 1993. 0,9 mm wires were used in all of these operations and all operations were performed by the same surgeon. Number of sublaminal wires used for each patient varied from 1 to 26. Cerebrospinal fluid leakage from the incision site and infection due to this fistula was observed in one patient on 3rd postoperative day. Harrington rod and sublaminal wires of this scoliosis patient were extracted 9 months after the surgery. Late infection occurred in another patient. No major neurologic complication was observed in any of the patients. During a mean follow-up period of 55 (12 - 91) months, 17 of these 499 (3,4 %) wires were found to be broken. The level of the broken wires were found to be either the most proximal or the most distal segments. We did not observe any neurologic deficits or any pathological changes in the adjacent tissues at final clinical and radiological evaluation of the patients. In conclusion, the use of sublaminal wires can be performed with a low incidence of complications if proper technique is used.

ANTERIOR-POSTERIOR CONVEX HEMIEPIPHYSIODESIS IN THE SURGICAL TREATMENT OF CONGENITAL SCOLIOSIS

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This article reviews the results of anterior-posterior convex hemiepiphyodesis applied to 7 cases of congenital scoliosis between 1990 and 1993.

The procedure was applied to congenital scoliosis cases whose bone age was below 5 years, Cobb angle in the frontal plane less than 60° and in whom the number of vertebrae involved under 8. For each patient, the growth potential on the site of the concavity was evaluated with conventional tomography. Anomalies with the potential to prevent growth on the concave side were not detected, except for one case with an unsegmented bar. The procedure was performed in one session in all cases but one. External immobilisation with Risser type cast applications were used postoperatively. Cast immobilisation for 6 months was followed by Milwaukee braces for 6 months.

The mean age of the patient group was 2.9 (1-5 years) years and their mean follow-up period 21.6 months (12-34 months).

Patients with a mean Cobb angle of 46° (28°-60°) in the frontal plane were observed to have a mean Cobb angle of 28° (13°-55°) postoperatively. The Cobb angle was not changed in the one patient who presented with an unsegmented bar on the side of concavity.

Our results show that spontaneous correction can be achieved with anterior-posterior convex hemiepiphyodesis in patients with congenital scoliosis.

SUBCUTANEOUS ROD INSTRUMENTATION WITHOUT FUSION FOR TREATMENT OF SCOLIOSIS

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One of the major problems in treatment of scoliosis is the difficult curves of children which require early fusion of many vertebrae. Subcutaneous rod instrumentation (SCR) has been suggested for such curves which could not be controlled with conservative methods. To our knowledge, long term follow-up studies of this method is not published yet.

Sixteen patients (7 girls and 9 boys) treated with SCR instrumentation were evaluated prospectively. The average age at time of surgery was 7 years. The curvatures of 11 patients were idiopathic, one was neuromuscular and the rest had complex syndromes associated with scoliosis. The curves had an average of 55 ± 10 degrees. The average rib-vertebra angle difference (RVAD) was measured as 33 ± 11 degrees. The patients were instrumented with subcutaneously placed rods without fusion as described by Moe. The surgical procedure was performed in 7 patients after a trial of conservative treatment and for 9 patients after the first evaluation because of their significant deformity. The instruments that were used included 12 Harrington rods, 7 Isola rods and 1 TSRH rod. Posterior fusion as a definitive surgery was performed 4 patients after an average of 24 ± 11 months follow-up. The total number of operations per patient was 4 ± 2 . The average measure of the curves was 42 ± 16 degrees after an average of 48 ± 23 months follow-up. Fourteen complications occurred in 8 patients (3 rod breakage, 2 rod dislocation, 3 infections, 4 hook dislocations, 3 pressure sores due to the rods). These complications did not affect the progress of the treatment.

Conclusion: When conservative methods can not control the curvatures of the scoliotic children who still have a significant growth potential, SCR instrumentation without fusion is an effective alternative.

THE EFFECT OF HOOK PATTERN ON THE SAGITAL PROFILE IN IDIOPATHIC SCOLIOSIS

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Background: The importance of sagittal profile in idiopathic scoliosis is well known. We know that kyphosis may be present in junctional areas, usually between T12-L1. Distraction forces create or increase junctional kyphosis when instrumentation is ended at T12-L1. That is, one should either by-pass the junctional zone or modify the hook pattern by means of reversing the very caudal hooks.

Aim: This study evaluated the effect of reverse hook pattern on sagittal profile on T12-L2 region.

Material and Method: We have identified 32 patients when hooks ended between T11 and L2. (Table I). There were 16 females and 16 males, their average age was 15.5 years. Sagittal profiles of 25 patients where we used classic hook pattern (distraction on concave side) revealed an average of 7° worsening of kyphosis. On the contrary, in 7 patients, where we used a reversed hook pattern (hooks placed in the direction of compression on concave side rod), sagittal profile on T12-L2 segment preserved or increased the lordotic nature of that segment.

Table 1

Hook Pattern	n	T 12	L 1	L 2	Preop T12-L2	Postop T12- L2
Classic	25	6	9	10	-1°	6°
Reversed	7	1	5	1	-1°	-5°

Conclusion : Though our reversed hook pattern group is not big enough as the classic hook pattern group, we could say that reversed hook pattern should be used if the instrumentation is going to be ended at T12-L2 segment.

POLIOMYELITIS SCOLIOSIS: THE RESULTS OF SURGICAL TREATMENT

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14 patients with the diagnosis of poliomyelitis scoliosis (9 female 5 male) were operated in the Department of Orthopaedics and Traumatology, Faculty of Medicine, University of Çukurova Adana, Turkey, between March 1989 and November 1993. The mean age of the patients was 16.77 (range between 7-60 years). Eight of the 14 patients had combined fusions and the remaining 6 patients had posterior fusions. The surgical methods were as follows: Luque-Galvestone (with Isola instrumentation) combined with anterior fusion in 5 patients and one Luque-Galvestone without anterior fusion. Luque posterior instrumentation in 3 patients. Hartshill posterior instrumentation (2 combined with anterior fusion) in 3 patients and Harrington posterior instrumentation in 2 patients. Cobb angles of the scoliotic curves were measured preoperatively in traction and postoperatively. The mean preoperative magnitude of the curves was 90.57 degrees which improved to 58 degrees (36% correction) in traction and improved to 44.6 degrees (51% correction) postoperatively. The mean preoperative decompensation of the torso was 18.6 cm which improved to 0.6 cm (44% correction) and pelvic tilt improved from a mean value of 24.3 degrees to 12.5 degrees (51% correction). The mean follow-up period was 18.9 months. The main complications were as follows: Rod breakage and curve progression in one case, urinary incontinence in one case and curve progression in two cases.

(Key words: Paralytic scoliosis, surgical treatment)

EARLY SURGICAL STABILIZATION OF THE SPINE IN DUCHENNE MUSCULAR DYSTROPHY

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The natural evolution of Duchenne Muscular Dystrophy (DMD) leads to an almost constant appearance of scoliosis which tends to deteriorate rapidly after the arrest of deambulation. Frequently, the disease tends to develop a characteristic deformity of the cervical spine in extension, with fibrosis and retraction of the erector muscles of the spine ("stiff back").

In accordance with the most recent trends, the authors believe that an early stabilization of the spine is advisable, when there are signs of misalignment and even a minimum deterioration in the curves, also dealing with the cervical deformity during the same operation.

A total of 6 patients suffering from DMD, aged between 12 and 13 years and 9 months, were operated upon between november 1987 and January 1990 in the Orthopedic Clinic of the University of Bologna. The scoliosis angle was between 10° and 30°. In all the cases the spine was stabilized posteriorly with Hatzhill instrumentation from T1 to the sacrum, without arthrodesis; apposition of autologous bone grafts (taken from the spinous processes) was done at the lumbo-sacral passage alone. In 4 of these patients during same operation the stabilization of the kyphoscoliosis curve was associated with reduction of cervical lordosis, by posterior arthrodesis from C2 to C7 with the insertion of homoplasty cortico-spongiose bone grafts between the cervical spinous processes, leaving the movement between C1 and C2 free.

All the patients underwent the operation without any anesthesiological problem and without the need for preoperative tracheotomy. There was no complications in the postoperative period. All the 6 patients were checked again at a follow-up after at least 35 months and no loss of correction was recorded. In 4 cases the spine had returned to correct alignment; in the other 2 the residual curves were 5° and 10°. The absence of pelvic obliquity, together with the absence of spinal misalignment, made it possible for all the patients to sit comfortably without pain and with no limitations.

FACTORS PREDICTING POST-OPERATIVE COMPLICATIONS FOR
NEUROMUSCULAR SÇOLIOSIS AND SPINAL FUSIONS IN CEREBRAL
PALSY

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At the Alfred I. duPont Institute a retrospective review of 62 patients with cerebral palsy and who had undergone a posterior spinal fusion with unit rod instrumentation was done in order to determine what factors cause complications that lead to delayed recovery time and a longer than average hospital stay. These factors that compromise recovery were determined by assessing the patients medical history, pre-op status, intra-op status and post-op status.

The study group included 30 males and 32 females. The mean age at surgery was 13.8 years. At surgery the mean weight was 29.5 kg. Fifty of sixty-two patients were in the bottom 5th percentile for weight compared to age. These fifty patients were in the hospital for an average of 23.2 days, were in the intensive care unit for a mean of 5.8 days and were intubated for 3 days. The twelve patients who were above the bottom fifth percentile spent an average of 13.5 days in the hospital. They were discharged from the intensive care unit on the 3rd post-op day and were intubated for an average of 1 day. Nineteen of the 62 patients had some level of speech. Their average length of stay was 16.5 days. They spent an average of 2.9 days in the intensive care unit and remained intubated for a mean of 1.8 days. From these and other factors a model for estimating recovery time has been established that takes into account the ever changing status of a patient. A comprehensive approach for the assessment of a patient's risk factors and estimation of recovery time is described.

SSI AND GALVESTON PROCEDURES FOR CORRECTION AND STABILIZATION OF NEUROMUSCULAR SCOLIOSIS

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Between 1986 and 1993, posterior spine fusions were performed by SSI-Galveston method in 5 patients with severe pelvic obliquity and by SSI method in the remaining 6 of 11 patients all of whom had neuromuscular scoliosis. 8 (73 %) of the patients were female and 3 (27%) were male. The average age at operation was 15,2 years (11-21). Mean follow-up period was 49 months (5-98). Diagnoses included poliomyelitis in 9 cases and Kugelberg-Welander's disease in 2 patients. 7 patients had only posterior fusion while 4 of the patients had also anterior fusion, one with Webb Morley, one with Zielke and two with Alici types of instrumentation. Average preoperative scoliosis was 71° (57°-115°). This was corrected to 45° (30°-76°) postoperatively and found to be 51° (31°-82°) at final follow-up. 7 of 8 patients who were not able to walk preoperatively began walking with the help of crutches after the operation. Sublaminar wires in the most proximal level in one patient and in the second distal level of another patient were broken bilaterally. The proximal parts of the rods of the patient whose proximal wires were broken migrated into the subcutaneous tissue. A revision operation was performed and the rods were shortened but a loss of correction in the thoracic curve happened in that patient.

FUSION TO THE SACRUM IN ADULT IDIOPATHIC SCOLIOSIS USING CD INSTRUMENTATION (1986 - 1990) . John P. Kostuik

Initial studies (1983) reported by the senior author, a 40% pseudoarthrosis rate and 50% incidence of flat back in primary fusion to S1 in 45 adult scoliosis (non degenerative) patients using Harrington instrumentation (published Spine).

In 1988, using Luque rods and segmental wiring the pseudoarthrosis rate decreased to 15% and flat back to 20%.

Deolen et al (Minnesota) on 27 adult fused to the sacrum using CD reported 70% instrumentation difficulties, pseudoarthroses 26%, increased flat back 19%.

This report done prospectively describes our experience in 21 adult patients fused to S1, using a combination of anterior and posterior CD surgery between 1986-1990.

Average age was 21-63 (46) all were ♀, 19 were idiopathic, thoracolumbar 12, lumbar 9, pain and deformity progression 20, pain only 1, sciatica 8. In all cases, pain was defined also in the L5-S1 disc by discography. Nine patients had proven spinal stenosis on myelography, six of who has associated decompressive surgery. Surgery was performed the same day, anterior and posterior in 19 and 1 week apart in 2. The number of anterior levels fused was 5 (2-8) and posterior 8 (3-14). Autogenous graft was used in 14 and a mixture of autogenous and allograft in 7. Blood loss single stage 2, 1750 cc; 2 stage 3.600 cc.

Treatment Consisted of:

a) Rigid curves with loss of lordosis 19, anterior release morsalized grafts at all levels to L4; block iliac crest grafts L4-S1, L5-S1 with anterior instrumentation usually with 1 plates and 6.5 mm cancellous screws-posterior CD with preferably 4 sacral screws to derotate and increase lordosis.

b) Flexible curves 2

-Posterior CD to S1 to derotate and increase lordosis.

-Anterior L4-S1, L5-S1, interbody fusion with fixation.

COMPLICATIONS

Bleeding > than 5000 cc 1; root injury 1 minor, atelectasis attentions 5; hook pullouts 1; infection 1; increased imbalance 1; Parotitis 1; pseudoarthrosis 1; flat back 1, same patient had hook pullout; cardiac 1.

Radiographic Analysis

Scoliosis pre-op 55 degrees (37-92) post-op 31.5 (23-55) 33 per cent correction. Lordosis Pre-op 37 degrees; post-op 48 degrees, (30% improvement). Imbalance AP C7-S1 pre-op; post-op (1 worse; 12 fully balanced, 8 same).

Pain Relief

	pre-op	post-op
None	0	9
Mild	2	9
Moderate	5	2
Severe	7	1

Excellent to good relief in 85%, fair to poor 15%.

Fixation Loosening 4 Patients:

AO anterior L5-S1 screws 1, sacral screws 4.

CONCLUSIONS

The combination of anterior and posterior fusion with instrumentation has markedly decreased the pseudoarthrosis rate to \approx 5% and the flat back rate to 5%. CD instrumentation serves to derotate the spine and increase lumbar lordosis. The spine must first be rendered loose by anterior release if rigid. Interbody L4-S1, L5-S1 block grafts with instrumentation increases lordosis and helps to obtain a fusion.

Since 1990, a further 36 patients have similarly been treated. Four sacral screws are necessary because of the long lever arms. Anterior fusion and instrumentation significantly helps to decrease the pseudoarthrosis rate.

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EXTENSION OF PREVIOUS ADOLESCENT SCOLIOSIS FUSIONS TO THE SACRUM IN ADULTHOOD.

The advent of Harrington instrumentation saw an explosion of adolescent scoliosis patients fused. Many of these fusions extended to L3,L4 or L5. Cochran Nachemson et al noted a proportionally increased late incidence of pain, below the fusion, the more distal the termination of the fusion.

This paper describes the surgical evolution for the treatment of those patients who in adult life became incapacitated and unresponsive to non operative treatment, because of pain emanating distal to their adolescent fusion, requiring fusion to the sacrum based on plain xrays showing instability on discograms and facet blocks.

Material

Fifty six patients, average age 48 (20-70) years, 51 females, 46 idiopathic, 6 paralytic, 3 congenital curves underwent fusion extension to the sacrum between 1975-1990. Presenting complaints included pain 91%, sciatica 62%. Average number of previous operations 2. Time interval since previous adolescent surgery 137 months (7-540). Termination of previous fusion L3-16%, L4-41%,L5-31%. Sacrum (with pseudoarthrosis) 12%. Pre-operative radiological assessment in all cases included discography at all levels, diagnostic facet blocks and C.T. myelography

Treatment: Decompression with fusion 32%, Same day ant/post procedures 28 patients, two stage 22 patients, single stage posterior Harrington 6 patients (1975-78). Avg levels fused anterior 2.4, posterior 4.2.

Instrumentation Phase 1) 1975-78, 6 cases posterior Harrington. Phase 2) 1978-86, 18 cases, 9 without and 9 with posterior osteotomy to increase lumbar lordosis. Posterior instrumentation, L.Rods 4, Pedicle screws 13 (Zelke, Dwyer, Kostuik) Compression Rods 1. Anterior Instrumentation Kostuik 6, Zelke 10, Hall 2. Phase 3) 1986-90. 32 cases. Posterior Instrumentation AO plates 6, Kostuik 4, AO plates + CD 7, CD 15. Anterior Instrumentation AO screws L5-S1 + plates, 4-5, 30, Kostuik 2.

Results: Blood loss single stage same day, 2.2 litres, two stage 3.3 litres.

X-rays: Lordosis pre-op 32(L1-S1) post-op 51 greatest improvement seen in phase 3. Pseudoarthrosis: Phase 1) 1975-78 50% (3/6) Phase 2) 1978-86,(2/18) 11%. Phase 3) 1986-90 (2/32) ~6%.

Pain Relief Overall: Good 82% fair, 18% Poor(subjective-objective analysis)

Complications. Intraoperative Vascular 6, Neurological 7 (minor 6-major 1) Bleeding >5000 cc, Infection 1, Thrombophlebitis 1, Respiratory 6, Pancreatitis 1, Ureter Obstruction 2, S.I joint pain (temporary)2, Rod (Zelke)3.

Conclusion: Fusions done in adolescent scoliosis into the lower lumbar spine have a high incidence of pain distally which may require fusion extension. If to the sacrum, a combined single same day stage anterior and posterior fusion with modern rigid fixation (plates + CD) increasing lordosis yields good results.

Additional 30 cases have been done since 1990, similar to Phase 3 techniques. There have been no pseudoarthroses. Extension of a previous scoliosis fusion to the sacrum is best dealt with, if surgery is required by a combined single stage (same day) anterior and posterior fusion with rigid fixation. A simultaneous posterior osteotomy through the pars area may be necessary to increase lordosis. Morbidity since 1986 has been minimal

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**SACRAL FIXATION WITH THE VARIABLE ANGLE SCREW-
PRELIMINARY RESULTS.** Chester E. Sutterlin, III, MD†§; N. Anand,
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Sacral fixation with most instrumentation systems has always been a challenge, especially so at the end of long constructs. The senior author introduced the Variable Angle Screw (VAS) in 1992, as a modification of the original TSRH bone screw. The screw has since been used routinely in all TSRH constructs. The first 25 consecutive cases with sacral fixation have been reviewed with an average follow-up of 9 months. To date there have been no implant failures, screw loosening or demonstrable pseudarthroses. We feel that few screws allow such extreme variability in all degrees of freedom as the Variable Angle Screw. It consequently allows for easy contouring and attachment of the rods, while at the same time achieves safe and secure fixation to the sacrum in most instances.

REALIGNEMENT OF LUMBAR VERTEBRAE WITH VSP INSTRUMENTATION

Frank J.Kramer

Since may 1986 the VSP (Steffee) instrumentation is used for fusion of the lower lumbar spine in segmental instability (isthmic, degenerative and post laminectomy spondylolisthesis).

The procedure is combined with PLIF, at first with allograft bone, but because of the unpredictable results later with autograft bone and since 1991 with carbon fibre cages, packed with autologous spongiosa.

VSP fixation allows correction of deformity and the balance of the spine can be restored.

Careful radiography with flexion-extension and distraction-compression X rays is taken care for proving instability (shift-dysalignment) to justify the procedure.

Complication rate is low, the clinical improvement and fusion rate are high.

Postoperative regimen is easy. Today it is a standardised procedure with a predictable outcome.

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EXPERIENCES WITH THE VSP FUSIONS WITH DIFFERENT INDICATIONS

Siegling CW, Regel W

Over 100 VSP instrumentation cases for the treatment of different lumbar instabilities are performed. Posterior Lumbar Interbody Fusion Cages (PLIF) or Anterior Lumbar Interbody Fusion Cages (ALIF) were used depending on the indication. In case of infections or tumours so far the Moos system has been used for interbody fusion.

Of 444 screws used 2 broke due to incorrect fusion procedure in case of spondylolisthesis. 2 temporary and 2 permanent neurological complications were found postoperatively.

The experiences with the combination of the anterior interbody fusion with different approaches and additional posterior instrumentation are very positive. Early mobilisation without bracing is possible.

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REGRESSION ANALYSIS OF PAIN FACTORS TEN YEARS FOLLOWING SCOLIOSIS SURGERY

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Idiopathic scoliosis is the most common form of spinal deformity. The indications for operative treatment are well established. The extent of instrumentation and fusion is dependant upon careful analysis of the curve pattern. Although an attempt to preserve lumbar motion segments should always be made, the long term functional outcome of patients fused to the lower lumbar is not well defined.

The purpose of this study is to analyze the long term effect of Harrington instrumentation and fusion to the Lumbar spine in the treatment of Adolescent Idiopathic Scoliosis.

METHODS: A review of the medical records at the Toronto Sick Children's Hospital from 1975 to 1981 was performed. A total of 1,620 scoliosis patients were initially identified from this group. One hundred, forty-two patients were identified as having undergone Harrington instrumentation and fusion to L2 or below for Idiopathic Scoliosis. Ninety one patients or families were contacted. One patient had died in MVA. Other patients whereabouts were unknown to family members. Eighty-three of the eighty-nine patients completed a lengthy questionnaire; 55 patients returned to Toronto General Hospital for follow up exam and x-ray. Information from questionnaire was used to give each patient a grade on a 100 point functional assessment. The patients three foot standing x-rays of the spine were measured for deformity angle via the Cobb Method. Spine balance was assessed via a plumb line from the tip of the C7 spinous process and measuring the displacement of this line from the sacral midline. Lumbar lordosis was evaluated by measuring the L1-S1 angle on the standing lateral x-ray. Both the AP and lateral xrays were examined for degenerative changes. Specifically, disc space narrowing, facet sclerosis, AP or lateral listhesis or spondylolysis. Statistic analysis was performed via linear regression and ANOVA analysis.

RESULTS: There were 83 patients, 76 females & 7 males. Average age 13.8 years (range 11-18 yrs). Average follow-up 12 years (range 10-16 yrs). Thirteen patients were fused to L2, eighteen were fused to L3, forty-one were fused to L4, ten fused to L5. One patient's fusion level was not well defined (L3 vs L4). There were twelve King I curves, twenty-six King II, sixteen King III, and one King IV, zero King V. Twenty-eight patients did not have xrays at follow-up and were not graded. Post op Cobb angle primary curve avg. 35 degrees (range 15-65), secondary curve 28 degrees (range 3-50). L1-S1 angle avg. 43 degrees (range 8-78), T2-T12 angle 28 degrees (range 5-54).

Overall sixty-three of the eighty-three patients (75.9%) had a complaint of low back pain (control group 35% incidence of low back pain). Eighteen of the patients (21.6%) required additional spinal surgery. Fourteen patients (16.8%) did not feel the goals of the initial surgery had been accomplished. The results of linear regression analysis; increased daily pain was related to a lower spine score ($p=0.0001$). Increased Cobb angle was related to a lower spine score ($p=0.02$). Increased kyphosis was related to a lower spine score ($p=0.001$). There was a trend relating decreased L1-S1 angle (flat back) with a lower spine score but this was not statistically significant. A higher incidence of listhesis, disc space narrowing, and facet sclerosis was noted with descending level of fusion. The presence of facet sclerosis and hypertrophy was related to a lower spine score ($p=0.04$). Descending level of fusion was not related to lower spine score.

CONCLUSION: In this study of adolescent patients fused to the lumbar spine for Idiopathic Scoliosis we report a higher incidence of low back pain than similar control group at ten years following surgery. A higher incidence of degenerative xray changes were noted with descending level of fusion; but fusion to the lower lumbar spine alone was not indicative of a poor result. Our report of sagittal plane imbalance (flat back junctional kyphosis) and its association with a poor result is consistent with similar reports. The 21.6% rate of additional surgery is higher than previously reported in the literature.

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Intramedullary Changes of the Spinal Cord in Cervical Myelopathy -MRI and delayed CT after myelography- by E. Wada, H. Sakanaka, M. Oomura and K. Yonenobu, Kansai Rosai Hospital, Hyogo JAPAN

In 27 patients with cervical myelopathy, intramedullary changes of the spinal cord were evaluated preoperatively by magnetic resonance imaging(MRI) and postoperatively by delayed computed tomogram after myelography(delayed CT). These findings were compared with the severity of myelopathy and surgical results. A high intensity area on the T2-weighted image in MRI was observed in 18 patients(66%) before surgery. In these 18 patients, 14 cases revealed Intramedullary enhancement in delayed CT after surgery. These intramedullary changes were located predominantly around the mostly compressed portion of the spinal cord. The presence or absence of a high intensity area did not correlate with the age of patients, the duration of symptoms, the severity of myelopathy or with surgical results. However, multisegmental high intensity area was related with the presence of muscle atrophy in upper extremities. From the findings of MRI and delayed CT, high intensity area on the T2-weighted image in MRI might be cavities or cystic necrosis in the spinal cord.

LAMINOPLASTY FOR THE CERVICAL SPINAL CORD INJURY WITHOUT DAMAGE TO THE SPINAL COLUMN

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We investigated the significance of the surgical therapy of the cervical spinal cord injury without damage to the vertebral column. Forty cases were treated in our hospital for the past ten years. Thirty-one of them were treated by operative therapy: twenty-four by laminoplasty, six by anterior spinal fusion, one by laminectomy. Nine cases were treated by conservative therapy. The difference of conservative therapy and operative therapy could not be cleared by Frankel's classification. However, some neurological recovery; for example, the smoothness of finger motion and ankle motion, was seen in sixty percent of cases which were treated by laminoplasty. Although the mechanism of recovery is not clear, it is recognized that the cross-sectional area of spinal cord of CT myelography was enlarged in both the MRI signal intensity changed area and the narrowest spinal canal area after laminoplasty. This suggests that the spinal cord plasticity is remained in the incomplete spinal cord injury.

POSTERIOR CERVICAL ARTHRODESIS AND STABILIZATION: A CLINICAL STUDY CORRELATING LATERAL MASS SCREW PLACEMENT AND ASSOCIATED COMPLICATIONS. Chester E. Sutterlin, III, MD, Angus W. Graham, III, MD, Richard E. Kinard, MD, Gary L. Lowery, MD, PhD. Florida Foundation For Research IN Spinal Disorders, Gainesville, Florida.

The purpose of this study was to examine the placement of lateral mass screws and associated complication rates in a clinical series. Thirty-seven consecutive patients underwent posterior cervical arthrodesis via lateral mass plating and received post-operative CAT scans. Post-operative complications involving the nerve roots, vertebral arteries, or spinal cord were recorded. The CAT scans were independently reviewed by an orthopaedic spinal surgeon and radiologist. Lateral mass screw position was matched with the occurrence of each complication. The lateral mass zone system Heller devised for the sagittal plane was combined with zones we developed in the axial plane to evaluate lateral mass screw position and potential injury to neurovascular structure. Our functional axial plane zoning system is based upon screw entry point and angle of screw insertion into the lateral mass correlating with the location of the neurovascular structures at risk. There was a 0.7% incidence (2/291) of nerve root compromise per screw placed. There was a 3.4% (10/291) incidence of nerve roots at risk per screw placed based on CT scan post-operatively. There was a 5.4% per patient risk (2/37) of persistent radicular symptoms significant enough to prompt screw removal. Our clinical series reports a rate of radicular risk and compromise similar to previous cadaveric studies. Those injuries that corresponded to an over-penetrated screw resolved with screw removal. With these results we are able to recommend variations in technique to decrease risk of neurovascular injury using this method of posterior cervical fusion.

REVISIONIST SURGERY IN THE CERVICAL SPINE UTILIZING LATERAL MASS PLATES. Chester E. Sutterlin, III, MD, Bill E. Dials, MLA Florida Foundation For Research In Spinal Disorders, Gainesville, Florida.

Patients with failed previous spinal surgery present a very difficult situation for the spinal surgeon. Not only does the spinal surgeon have to approach the problem of the original diagnosis but this is also compounded by the condition of the failed procedural results. Quite often failed previous spinal surgery results in pseudoarthrosis, increased movement due to removal of particular anatomic structures, and/ or increased motion at adjacent segment levels. Once the normal biomechanics of the cervical spine have been disrupted by a failed invasive technique, extreme caution must be taken to ensure the maximum amount of stability available. Posterior stabilization utilizing lateral mass plates results in a stronger construct than could be achieved through a second anterior procedure. In addition, posterior stabilization successfully tackles the problem of multilevel fusions. After previous failed anterior cervical surgery, 14 consecutive patients (8 male, 6 female) subsequently received posterior instrumentation in the cervical spine with lateral mass plates. Average patient age was 50 (range: 28 to 73). Average follow-up was 11 months (range 3 to 22 months). Post-operatively there were two major complications (14%). One year after surgery, one patient began to develop a possible reflex sympathetic dystrophy and therefore the lateral mass plates were removed. Another patient had a case of recurrent anterior strut graft dislodgment and eventually was placed in a halo brace because of noncompliance with post-operative instructions regarding activities. Post-operatively, 11 patients (79%) subjective pain scores improved, one patient (7%) stayed the same, and two patients scored their pain as being worse than before surgery. Neurologically, 10 patients (71%) improved after surgery, one patient (7%) stayed the same, and three were worse than before surgery. There have been no broken plates; all instrumentation systems are intact. Thirteen patients (93%) have solid fusions with only one patient (7%) having a pseudoarthrosis (same patient with halo). Revisionist surgery for the reconstructive spinal surgeon is a difficult task further complicated by the fact that procedural options have been limited by previous failed surgery. Lateral mass plating has become a successful technique available for utilization in the spinal surgeon's armament.

REVIEW OF RHEUMATOID CERVICAL INSTABILITIES REQUIRING SURGERY INCLUDING NEWER FIXATION METHODS. Chester E. Sutterlin, III, MD†; O. Richard Singer, DO; Merrill W. Reuter, MD; Gary L. Lowery, MD, PhD; Glenn Rehtine, MD. †Florida Foundation For Research In Spinal Disorders.

Fifty rheumatoid patients requiring cervical spine surgery for instabilities were reviewed to determine if our patient population and surgical outcome utilizing standard wiring procedures were comparable to previously published reports. Thirty-one patients had sufficient documentation for inclusion. Some had newer methods of fixation including plates and screws. Mean follow-up time was 28 months. Our series demonstrated similar outcome when compared to previously reported series on cervical wiring techniques with 85% bony fusion rate, no neurologic deterioration, and 6% requiring reoperation for later subaxial instability following upper cervical procedures. Newer methods of fixation were helpful in treating more complicated cases including multilevel involvement, deformity and higher grade instability. There were no pseudoarthroses noted in the 8 patients who received plates for fixation.

TRANSORAL APPROACH TO CRANIOVERTEBRAL JUNCTION PATHOLOGIES CAUSED BY RHEUMATOID ARTHRITIS

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Thirteen transoral surgical approaches were performed in the Department of Neurosurgery of Marmara University Medical School between the years of 1990 and 1994.

Among these 13 cases, 5 had surgical pathologies caused rheumatoid arthritis.

In this study, we report the craniovertebral junction lesions caused by rheumatoid arthritis and discuss their surgical management by transoral approach.

A NOVEL RETRACTOR FOR THE ANTERIOR APPROACH TO THE CERVICAL SPINE

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Anterior approach to the cervical spine, first described four decades ago by Robinson and Smith, was popularized following the design of a particular retractor and drill system by Cloward in 1962. This retractor system has been widely used since its description. In this report we describe a new retractor for the anterior approach to the cervical spine.

The new retractor consists of two symmetrical parts which are connected at the proximal area by a screw that adjusts the angle between them. The distal end of each part has a blade, and the two blades, when considered together form a conical shape perpendicular to the main axis. The distal part of the blades has two nails on each, which enables insertion to the anterior aspect of the cervical vertebrae. Their proximal part has a base where the hammering force is applied in order to secure insertion. The operation is performed through the inner conical space formed by two blades.

At the operation, the involved intervertebral disk space is exposed by using conventional retractors. Following adequate exposure, our retractor is placed in its closed position and fixed to the adjacent vertebral bodies in such a way that centralizes the intervertebral disk space. The inner conical volume between the blades is sufficient for performing the operation. This technique eliminates the use of a vertebral spreader because adequate separation of the adjacent vertebrae is achieved by increasing the angle between the two parts, which in turn separates the blades. Therefore, without having the necessity of placing a vertebral spreader, an excellent surgical exposure including the whole aspect of the disk space can be obtained. An additional advantage is easy placement of the retractor which shortens the time spent during the operation. This new retractor has been used in over 30 operations without any surgical morbidity including major vessel injury and organ perforation.

TRANSMANDIBULAR APPROACH TO CERVICAL SPINE - CASE REPORT

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Anterior cervical deformity extending to the lower retropharyngeal level needs to be explored in a wider fashion than conventional transoral approach. This could be obtained with transmandibular incision. This report describes transmandibular approach to mid-cervical region in a patient with basilar invagination.

Case Report: A 56 years old male patient has admitted to our neurosurgical department with a complaint of progressive tetraparesis for 1 year. On physical examination he had a short neck and khyphosis with severe spastic tetraparesis predominant on his left side. Direct X-rays, CT and MRI imaging showed basilar invagination, severe cervical lordosis with maximum on C5-6 levels and severe cord compression on mid-cervical levels. He was operated on two consequent sessions; first a C1-C7 posterior laminectomy, and after 2 weeks a second operation: anterior decompression, deformity correction, anterior fusion and plating. First, a Gardner Wells traction with 2 kg weight was applicated. After tracheotomy, a midmandibular incision was done. Mandible was transected on midline with Gigli saw. Tongue and epiglottis were retracted medially, pharynx and mandible were retracted laterally. After a C5-6 anterior osteotomy and cord decompression, a wedge bone graft from iliac crest was inserted on the resection space and cervical plate with 4 screws from C3-C6 was applicated in the resected anterior spine.

Postoperative period was usneventful except a transient difficulty on swallowing. During postoperative follow-up period for 7 months his tetraparesis improved quite well and he could walk without external supports. He weared an external support with Halo vest for 6 months.

Conclusions: Transmandibular approach to anterior cervical spinal pathologies with extended deformities not possible to be dealt with conventional anterior cervical or transoral approaches seems to be a reliable method without significant morbidity.

HISTOPATHOLOGY OF HERNIATED LUMBAR INTERVERTEBRAL DISCS COMPARED WITH NON-HERNIATED LUMBAR INTERVERTEBRAL DISCS

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Introduction: Pathoanatomic conditions of the lumbar intervertebral disc can be associated with low back pain. Disc prolapse or herniation of nuclear material mostly occur in discs that already show degenerative changes, but also non-degenerated discs can prolapse. The purpose of our study was to compare the histopathology of herniated with non-herniated discs.

Methods: 21 cadaver spines (>60a n=16; 30-60a: n=5) without history of surgical treatment were investigated. Magnetic resonance imaging and lumbar roentgenograms were conducted to differentiate between herniated and non-herniated intervertebral discs. Sections from the levels Th12/L1 to L5/S1 were obtained. Using different stains (Hematoxylin-Eosin, Elastica van Gieson, Alcian-PAS at pH 2.5. Mowry, Prussian Blau, von Kossa, polarisationsmicroscopy) the histomorphology of the annulus fibrosus and the nucleus pulposus was studied separately. Degenerative (annular tears, neovascularisation, loss of acid mucopolysaccharides, calcification, scarring, collagen fiber density, tissue dissociation) and regenerative (cluster formation, synthesis of acid mucopolysaccharides, width of lacuna surrounding cells, cell density) alterations were investigated.

Results: Nucleus prolapse or herniation of nuclear material was found in eight discs of six different spines (levels L2/3 n=1, L3/4 n=2, L4/5 n=5; age: >60a n=6). In the control group 49% were considered degenerated with MRI and 58% with roentgenograms.

HISTOPATHOLOGY :	Annulus		Nucleus	
	Non-Herniated	Herniated	Non-Herniated	Herniated
DEGENERATION				
Annular tears	30%	45% (↑)		
Vascularisation	8%	0% (↓↓)	9%	14% (↑)
Normal MPS	31%	0% (↓↓↓)	28%	0% (↑↑↑)
Ca-dihydrogen-phosphate	10%	18% (↑)	9%	29% (↑↑)
Other calcifications	16%	18% (↑)	15%	29% (↑)
Scarring	10%	0% (↓↓)	9%	14% (↑)
Tissue dissociation	73%	82% (↑)	90%	71% (↓)
High collagen fiber density	15%	9% (↓)	3%	14% (↑↑)
REGENERATION				
Cluster formation	12%	18% (↑)	33%	57% (↑)
Synthesis of MPS	85%	100% (↑)	82%	100% (↑)
Lacuna-round cells	90%	100% (↑)	91%	100% (↑)
Normal cell density	76%	100% (↑)	65%	72% (↑)

Conclusions: Within degenerative features both the annulus fibrosus and the nucleus pulposus of herniated discs showed considerable loss of acid mucopolysaccharides and an increase in calcification. Collagen fibers, scarring and tissue dissociation however exhibited opposite changes in annulus and nucleus. Compared with non-herniated discs, regenerative processes in herniated discs are increased in annulus as well as in nucleus. It must be concluded that these are compensatory futile reactions toward degeneration. The structural constellation of a fibrotic, calcificated nucleus and a torn, dissociated annulus with reduced collagen fibers on the one hand and extensive regenerative processes on the other hand must be considered important differences between herniated and non-herniated discs.

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The prognostic relevance of lumbar discography in PLDD of lumbar disc protrusion and herniation.

Since about 1988 the percutaneous laser therapy of lumbar disc protrusion and herniation started to take over the role of chemonucleolysis as a so-called "minimally invasive method."

In summer 1993 we started to apply PLDD (Nd:YAG-Laser, 1064 nm, 20 W/pulse with a duration of 1 second) to patients with the clinical symptoms of lumbago or radicular pain syndroms. In the beginning patients with a rupture of the "anulus fibrosus" were treated, too (5 out of 25 patients).

The follow up examination showed that those patients didn't achieve a long-term-improvement and therefore had to undergo a conventional lumbar disc operation. This phenomenon is common in patients, who were treated by "PLDD" in other departments and afterwards examined in our outpatients, too.

Regarding those results of follow-up-examination/-evaluation we decided not to apply "PLDD" when seeing a ruptured "anulus fibrosus" in the lumbar discography ("Solustrast").

It seems to be important to use continuous suction after the application of the contrast medium to provide a "contact mode" to make the "PLDD" more successful.

***FORAMINAL DISC HERNIATIONS and PARALATERAL
DECOMPRESSION***

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Recent advances in imaging techniques have made it possible to diagnose foraminal disc herniations more frequently. Herniated disc material causes to compression to root in the foramen. Majority of these herniations are seen at the L4-5 level and characterized by sudden onset of severe leg pain. Back pain is usually minor. Straight leg raising is mildly positive, but femoral stretch test is highly positive. Conservative treatment usually fails in these patients. Surgical decompression is difficult by using classical hemilaminectomy. Because of the herniated material is in the "hidden zone of Macnab". it is necessary to perform complete facetectomy which is undesirable. The paralateral muscle splitting approach enables surgeons to remove disc herniation without entering the spinal canal. It saves pars interarticularis and the inferior facet. In this paper we would like to present two typical cases of foraminal disc herniations treated by paralateral approach .

THE INTERTRANSVERSE, MICROSURGICAL APPROACH TO EXTRAFORAMINAL LUMBAR DISC HERNIATIONS.

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The surgical incidence of the far lateral ('extraforaminal') lumbar disc herniation varies between 2.6 and 11.7 %. It is localized predominantly at L 4/5 or at the levels above and its diagnosis has been improved in the last years by modern imaging techniques like MRI or post-discographic CT - scan. The surgical approach through the midline implies a large exposure and retraction of the paraspinal muscles as well as a partial or total facetectomy which bears the risk of postoperative instability. We present our results with an extraforaminal, microsurgical approach. **Surgical Technique:** The procedure is performed with an operating microscope. The dorsal fascia is exposed through a 4 - 5 cm paramedian (3 - 5 cm) skin incision. The intertransverse region is reached through gentle dissection of the septum between the multifidus and longissimus muscle groups. The medial parts of the intertransverse muscle and ligament are incised and 2 - 3 mm of the lateral part of the facet is removed with a diamond drill. The dorsal root ganglion is exposed and the herniated nucleus pulposus removed. **Results:** A total of 20 patients (10 m, 10 f, mean age: 57 yrs) have been treated this way. The disc herniation was localized at L 3/4 (9), L 4/5 (8) and L 5/S 1 (3). All patients presented with preoperative sciatica, sensory- (11/20) or motor-deficits (14/20). Diagnosis was established by spinal CT - scan combined with discography (Disco-CT) in 15/20 cases. In 16/20 patients there was a sequestered disc herniation. Postoperative follow-up ranged between 6 months and 3 years. The result was good or acceptable in 17/20 patients. One patient had to be reoperated due to recurrent symptoms. Two patients showed a bad postoperative result. There were no complications or postoperative instabilities in the presented series. The intertransverse, microsurgical approach to extraforaminal lumbar disc herniations allows optimal exposure of the region of interest as well as removal of the disc herniation with minimal surgical trauma and no risk of producing iatrogenic segmental instability. The clinical results are good.

POST - SURGICAL MAGNETIC RESONANCE IMAGING OF THE LUMBAR MOTION SEGMENT FOLLOWING MICRODISCECTOMY FOR DISC HERNIATION

- Results of a prospective, controlled study -

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Aim of the Study: Epidural fibrosis and recurrent disc herniations are the most common causes of 'failed' lumbar disc surgery. There is only scarce information about early postoperative changes of the lumbar motion segment following surgical discectomy. We investigated the morphological changes in the disc and epidural space in a prospective, controlled study using Magnetic Resonance Imaging (MRI). The purpose of the study was to evaluate the healing process of the structures surrounding the affected spinal nerve. **Patients and Methods:** A group of 20 patients (f:12,m:8, age range: 20 - 65 y) with a lumbar disc herniation was operated in a microsurgical technique due to failure of conservative treatment. All patients had routine clinical and plain radiological investigations. In addition, all patients had an MRI investigation of the lumbar spine with/without Gadolinium preoperatively as well as 1 and 6 months following the operation. T1 and T2 - weighed pictures were evaluated in axial as well as sagittal planes. The following parameters were analyzed: *Clinical result* according to Economical / Functional rating system (EFR - System , Prolo 1986); *Changes of vertebral bone structure* adjacent to the treated disc space; *development of scar tissue, water content and height* of the disc space; *disc configuration; development of scar tissue in the epidural space as well as in the region of the surgical approach; demarcation of the affected spinal nerve.* Morphological findings were correlated with the clinical result. **Results:** At follow -up, the clinical results (EF-rating) was 'excellent' in 10/20 patients, 'Good' in 5/20, 'fair' in 1 and 'bad' in 4 patients. In 10/20 patients the cancellous structure of the adjacent vertebral bodies was unchanged. Five patients presented an intraosseous edema, 3 patients showed a localized transformation of cancellous bone into fatty bone marrow and 2 other patients had sclerotic endplates. The disc space was filled with postoperative scar tissue in 8/20 patients, water content was diminished in 9/20 patients as compared to preoperatively. Decrease in disc height was between 1 - 4 mm in 16/20 patients. Three patients presented a slight annular protrusion. In 13/20 cases there was scar tissue in the anterior part of the spinal canal. However at 6 months follow-up, the spinal nerve could be delimited on MRI in 17/20 cases and was deformed in only 4/20 patients. In 9/20 patients there was scar tissue in the extraspinal part of the interlaminar space, 7/20 patients showed scar tissue in the paravertebral muscles of the approach region. There was no statistically significant correlation between any of the morphological findings and the clinical result. **Conclusion:** Our results show, that postoperative changes of the lumbar motion segment as shown by MRI - investigations are slight following microdiscectomy. There were no signs of epidural fibrosis affecting the spinal nerve in 85 % of the patients.

SURGICAL TREATMENT OF FORAMINAL STENOSIS IN DEGENERATIVE LUMBAR DISEASE

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In degenerative lumbar disease, entrapment of nerve roots occurring within the intervertebral foramen is less common than within the central spinal canal or the lateral recess.

The authors reviewed 36 consecutive patients with foraminal stenosis who underwent surgery from 1983 through 1993. The average age of the patients was 57.6 years (range, 43–77 years). The L3/4 level was involved in 1, L4/5 in 6, and L5/S1 in 29. All of the patients had radicular leg pain, and 16 of them had neurogenic intermittent claudication. Ten patients had low back pain. Neurologic examinations showed a sensory deficit in 26, motor weakness in 23.

All 6 patients, who were treated before 1986, underwent posterolateral fusion with spinal instrumentation following decompression by unilateral facetectomy. Since 1987, only 4 patients, who had radiologic evidence of instability, were treated in this way. The other 26 patients underwent only decompression, because they didn't have the instability. Our procedure for foraminal stenosis without instability is to decompress the nerve root by removal of both a lateral portion of the lamina and a small upper portion of the facet. Removal of a lower portion of the pedicle is also necessary for adequate decompression. A medial half of the pars interarticularis is spared to preserve spinal stability.

The average time to follow-up is 46 months. The clinical results were evaluated according to the Kaneda's criteria. Fifteen of the 36 patients (42%) were excellent, 15 (42%) good, 5 (13%) fair, and 1 (3%) was poor. All of the ten patients who underwent spinal fusion obtained successful fusion.

In foraminal stenosis due to degenerative lumbar disease, decompression by facetectomy should be limited to only cases with instability, as this procedure destabilizes the spine and spinal fusion must be performed. The clinical results, which showed satisfactory relief of symptoms and neurologic recovery, proved our decompressive procedure without performing spinal fusion can provide adequate decompression. Thereby we recommend our procedure for patients with foraminal stenosis who don't show any evidence of instability.

MR IMAGING OF DIASTEMATOMYELIA: Report of 41 Cases

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Diastematomyelia is a form of occult spinal dysraphism that could go undetected until adulthood with nonspecific complaints and neurologic-orthopedic symptoms. We present the radiological features and MR Imaging findings of 41 cases with diastematomyelia .

Methods: 41 patients (31 females, 10 males) with ages between 1-month and 36 years had X-rays, spinal MRI and either spinal CT or myelo-CT scan. Myelography and myelo-CT were performed with nonionic contrast medium. MR Imaging was performed with a 0.5 Tesla unit (GyroscanT5, Philips). 61% (25 patients) had scoliosis, 58% (24) had cutaneous stigmata, 49% (16) had neurologic symptoms such as paraplegia or incontinence and 17% (7) had talipes equinovarus deformity.

Results: We detected 43 diastematomyelic segments in 41 patients (two patients had two different locations with reunited spinal cord in between). Bony spur was present in 27. The most common location for spur formation was L3 (5 cases); Th11 and L4 were the second most common sites (4 cases each). Hidromyelia (22 cases), tethered cord (19), sacral lipoma (9), meningocele-myelomeningocele-lipomyelomeningocele (8) and caudal regression (7) were the associated spinal anomalies.

Conclusion: 60% of our cases had scoliosis and 20% had complaints related to lower extremity deformities. Two of our cases had preoperative myelography performed with Myodil and diastematomyelia was missed. These patients were operated for correction of the scoliosis deformity and ended with paraplegia. Likewise, we detected tethered cord in 46% of our cases that might be responsible for severe vascular insult to the cord if not detected before scoliosis treatment. We conclude that the contents of the spinal canal must be carefully evaluated with cross-sectional imaging techniques such as CT, myelo-CT or MR Imaging in patients with scoliosis, before surgical correction. By these studies, major complications due to diastematomyelia can be avoided.

THORACOSCOPIC ANTERIOR APPLICATIONS TO THE SPINE

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Endoscopic applications to the body spaces and joints are used very frequently in recent years. This applications were first done to the knee joint and then used to the other joints in orthopaedic surgery.

Thoracoscopic applications to the spine has been performed in recent years (1,2,3)

Thoracoscopic applications are especially used in;

- a) biopsy of the spine tumors
- b) anterior release of the spinal deformities.
- c) Anterior decompression of the spine fractures
- d) Anterior discectomy
- e) Drainage of the abscess formation.
- f) Anterior fusion.

In this study we want to explain the technical principles and clinical applications of the thoracoscopic anterior surgery.

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A B S T R A C T

The Hartshill horseshoe for anterior lumbar fixation

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An anterior lumbar disc excision and fusion is a proven surgical method for certain well selected cases of discogenic low back pain. Clinical results however are often marred by graft displacement or collapse. We have thus developed the Hartshill horseshoe which is a simple anterior fixation device to protect the graft in such cases. The development, biomechanical testing and clinical results will be presented.

TOPOGRAPHY AND FUNCTION OF PELVIC VESSELS IN SPONDYLOLISTHESIS

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There is a close topographic relationship between the anterior part of the lower lumbar spine and the pelvic arteries and veins. Whereas neurological and anatomical changes are well described due to anterior slippage of a spondylolytic lumbar vertebra, there is little information on corresponding changes anterior to the slippage.

We report on a total of 314 patients who have been treated because of spondylolysis / - olisthesis of L 4/5 or L 5/S 1. They were divided into 3 groups: 1 = patients with a 2nd degree (acc. to Meyerding) spondylolisthesis at L 5/S 1; 2 = 3rd - 4th degree spondylolisthesis L 5 / S 1, and 3 = patients with a 2nd degree spondylolisthesis L 4 / 5. Group # 4 served as control - group and consisted of 20 patients with low back pain of other causes. The patients had a clinical examination and a doppler - ultrasound investigation of the pelvic and femoral vessels. Seven out of 9 patients from group 2 had phlebography.

Results: Spondylolisthesis did not influence the hemodynamic parameters of the iliac arteries or the aorta. However on the venous side there were obviously pathological changes in the groups 2 and 3 of the investigated patients. There were changes in the venous flow pattern in group 2. In group 3 we found constantly an elevated venous pressure in the femoral and pelvic venous system. These changes correlated with the localization of the venous bifurcation, the severity of spondylolisthesis and the direction of anterior slippage. The anterior movement together with the downward rotation of the spondylolytic vertebral body may lead to a lateral movement of the iliac veins on both sides of the vertebra. This obviously increases the disturbances of venous reflow. We do not think that our results justify a routine phlebographic investigation in patients with indication for surgery. However, the position of the pelvic vascular system, especially the veins, should be determined preoperatively by contrast - CT - scan or MRI. Our results in addition suggest, that surgical reduction of spondylolisthesis will exert a positive effect on the topography and function of the pelvic venous system.

Experimental spondylosis in the mouse.

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"Spondylosis" is thought to be related to the aging process or mechanical overload applied to the spine. However many questions about the pathogenesis of the condition remain unsolved. We produced an experimental model of spondylosis in animals with the working hypothesis that mechanical instability would induce disc degeneration and spondylosis.

Method: A mouse was anesthetized intraperitoneally with ketamin. A longitudinal incision was made through the skin dorsal to the vertebral column from the base of the skull to the base of the tail. The posterior paravertebral muscles were detached from the spinous processes, laminae and facets of the cervical thoracic and lumbar vertebrae were resected. Thirty mice were the subjects of this experiment and 27 mice for the control group. The animals were killed at 2, 6 and 12 months after surgery to observe pathological changes of the disc.

Results: In the experimental group, proliferation of cartilaginous tissue, fissures in the annulus fibrosus, shrinkage of the nucleus pulposus, herniation of disc material, and osteophyte formation were found. Incidence of these pathological changes was higher in the experimental group than in the control and the changes appeared earlier in the experimental group than in the control.

Conclusions: An animal model of spondylosis was produced without direct intervention to the anterior elements. Results of this study indicates that mechanical overload play an important role in the pathogenesis of spondylosis.

THE SURGICAL TREATMENT OF SPONDYLITIS

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The non - invasive treatment of spondylitis implicates a high risk of secondary complications such as segmental destruction or deformity with subsequent instability and / or neurological deficits. The surgical treatment with resection of the inflammatory focus combined with segmental stabilization under antibiotic protection is therefor the therapeutic option which is favorized at our department. In most cases with spondylitis, be it tuberculous or unspecific, the inflammatory focus is located in the anterior column i.e. the vertebral body. This is the reason why the focus has to be resected by a ventral approach. Between October 27, 1986 and December 29, 1992 a total of 65 patients (26 f; 39 m ; age range 12 - 84 yrs; av. age: 54 yrs) were treated at our department because of spondylitis. There were 16 cases with tuberculous spondylitis (24.6 %). There were 35 patients (53.8 %) with a history of previous non - spinal infection. Three patients had recurrent spondylitis. In 4 cases, the focus was localized in the cervical spine, and in 61 cases in the thoracic spine. The average time between the first symptom and the hospitalization was 6.4 months for patients with unspecific and 11.9 months for those with tuberculous spondylitis. Thirty percent of the patients suffered from diabetes, 11 patients from other accompanying diseases like tumors or endocrine disorders. Before the operation, 64 % of the patients complained local pain in the affected area. In 78 % there was pain with axial compression. There were 36 % with sensory and 37 % with motor disturbances preoperatively. The diagnosis was confirmed radiologically with plain x - rays and CT and / MRI. Surgical removal of the inflammatory focus and anterior fusion with autologeous bone grafts was performed in 94 % of the patients. In 31 % of the patients, the anterior procedure was followed by a posterior stabilization with internal fixation devices. The mean duration of the operation was 211 min, the blood loss averaged 653 ml. An organism was identified in 58 % of the cases. Most common was Staph. aureus (15 %), Mycobacterium tuberculosis (14 %) and coagulase - negative Staphylococci (8 %). More than 80 % of the patients were treated with a spinal orthosis following the operation. Out of 65 patients a total of 58 (89.2 %) could be followed - up by an independent observer (C.W.). Results were classified according to the economic and functional rating score (Prolo 1986). Thirty percent of the patients had excellent, 49 % good and 16 % moderate clinical results. Only 5 % of the patients were classified as bad. We conclude, that the surgical treatment of spondylitis leads to good and excellent results in the majority of the patients.

THE NECESSITY OF REDUCTION IN SPONDYLOLISTHESIS
CASES TREATED WITH DIAPOSON SYSTEM
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We treated 17 patients who had chronic low back pain and/or neurologic deficit due to spondylolisthesis with Diapason System at the Orthopaedics and Traumatology Department Gülhane Military Medical Academy between January 1989 and May 1994. We applied decompression, reduction and fusion to the patients with an average age of 38. We externally supported the patients with body cast in first 3 months postoperatively. Average follow-up was 18 months and all of the complaints of the patients were ceased at the postoperative period. We do believe in the necessity of reduction in order to obtain the mechanical axis of spinal column in spondylolisthesis cases.

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EARLY RESULTS USING MULTISTRAND TWISTED TITANIUM CABLES AS AN ADJUNCT TO LATERAL MASS PLATING. Chester E. Sutterlin, III, MD, Bill E. Dials, MLA. Florida Foundation For Research In Spinal Disorders, Gainesville, Florida.

The purpose of this study is to determine the safety and efficacy of using a cable system in conjunction with lateral mass plating. Recently, lateral mass plating has become a new viable option in promoting stabilization and arthrodesis in the cervical spine. However, lateral mass plating need not take the place of wiring techniques. In fact, in many cases it is beneficial to use lateral mass plating augmented by the use of wiring techniques. There are numerous wiring techniques available to the orthopaedic spinal surgeon. Twisted cable is superior in biomechanical strength to wire. In addition, cable is more flexible thereby reducing the level of difficulty associated with insertion and tension adjustment. The cable system reduces risk to neurovascular structures while providing stability to the spine. Twenty-six consecutive patients (male: 14, female: 12) who received lateral mass plating and cables were retrospectively reviewed to determine the safety and efficacy of the technique. Average patient age was 56 (range: 29 to 82). The average number of levels fused was four (range: 1 to 9). Average length of follow-up was 6 months (range: 2 to 13 months). There was only one minor complication intraoperatively, a small dural tear repaired immediately, and this was not related to the cables. One patient died while in the hospital. The patient's cause of death was unrelated to the operative procedure. Of the 25 remaining patients there was only one postoperative complication - a wound infection which was treated successfully with no recurrence. Pain improved in 23 patients (92%), one patient had no improvement (4%), and one patient's pain worsened (4%). Neurologic symptoms improved in 24 patients (96%) while one patient had no improvement (2%). To date, there is no evidence of pseudoarthrosis in any patient. There has been one broken plate which is asymptomatic. The remaining 24 patient's implants are intact. The use of cables in conjunction with lateral mass plating appears to be a safe and effective method of treating cervical spine instabilities.

OUR GALVESTONE TECHNIQUE EXPERIENCE IN THE
TREATMENT OF SPONDYLOLYTIC & SPONDYLOLISTHETIC PATIENTS

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ABSTRACT

Between June 1989 and May 1994, 56 patients with spondylolysis and spondylolisthesis were treated by posterior instrumentation and posterolateral fusion in our clinic. Since May 1992, we have been performing Galvestone technique in L5-S1 lytic and olsthetic lesions and treated 9 patients with this technique using ISOLA Spinal System. All of these patients were female and have low back pain which was unresponsive to conservative treatment. The average age was 45.6 years, ranging between 14 - 61 years. The mean follow-up was 12 months, ranging between 3 and 23 years. We prefer this technique since it is much more reliable than sacral fixation in our series.

COMPARISON OF INSITU FUSION AND INSTRUMENTATION WITH FUSION IN TREATMENT OF SPONDYLOLISTHESIS

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We are presenting a retrospective study to comparing the results of insitu posterolateral fusion and instrumentation with posterolateral fusion (with or without reduction) performed in 18 (13 female and 5 male) patients with spondylolisthesis. The mean age was 46 (range 20-63), average follow-up was 3.5 (range 1.5-8) years. There was grade 1 spondylolisthesis in 2 patients, grade 2 in 9, grade 3 in 5, grade 4 in one and grade 5 spondylolisthesis (spondyloptosis) with para-aortic neurofibroma in one patient. We performed insitu posterolateral fusion in 10 patients and posterolateral fusion with instrumentation in the remaining 8. Decompression was added in 3 of the cases with instrumentation and reduction in 4 of them. Reduction and decompression were combined in the remaining one patient. In addition to reduction, instrumentation and posterolateral fusion, anterior fusion was also performed in the patient with spondyloptosis. While there were no nonunions in the instrumented group, 2 cases with insitu posterolateral fusion failed to unite. Infection which responded to intravenous antibiotics and debridement occurred in two instrumented cases. Radicular type pain was diminished in all the patients which we achieved union. When reduction was added, in addition to obtaining good decompression, fusion and radicular pain relief, improvement in low back pain due to mechanical imbalance was observed. The two cases who developed pseudoarthrosis were revised with reduction, decompression, instrumentation and posterolateral fusion; union was obtained in both cases. In conclusion, insitu posterolateral fusion appears to have a higher rate of pseudoarthrosis, but in those cases in which union is achieved, there is not any significant difference in radicular pain relief from those which are instrumented. Addition of reduction distinctly improves mechanical pain as well as the radicular pain. In the instrumented cases however, the infection rate is higher.

THE SURGICAL TREATMENT OF SPONDYLOLYSIS by MORSCHER SCREW

(Primary Spondylolysis Hook Screw)

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Between June 1989 and May 1991, we have applied Morscher Screws (Primary Spondylolysis Hook Screw) for 16 pars interarticularis defects of 9 patients. All the patients had low back pain, and 90 % of them were suffering from a disabling pain for an average of three years. To investigate the etiology of pain, C.T., E.M.G. or myelography was done. Also under fluoroscopy, we infiltrated the facet joints with local anaesthetic agents to check whether the pain was originated from facet joints or spondylolysis. To the patients whose pain were established of spondylolytic origin, we implanted Morscher Screw (Primary Spondylolytic Hook Screw) fixation and bone grafting. The mean follow up is 26 months (range:18-36 months). In all of the patients, except one, pain was relieved.

In preoperative period, in all cases, we applied special lumbosacral stabilization braces as a predictive test. When we obtained pain relief we considered surgical internal stabilization intervention. Careful patient selection is the basic factor of such a success.

We believe that Morscher Screws can be used for patients in all age groups who were determinated as having no degenerative changes.

THE SURGICAL TREATMENT FOR DEFORMITIES OF THE SPINE IN THE SAGITTAL PLANE

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In this study, we evaluated the results of 25 kyphosis cases, surgically treated at our clinic between 1989 and 1993 and we reviewed the principles of surgical treatment of the deformity.

9 cases had Scheuermann's kyphosis, 8 had posttraumatic kyphosis and 8 had postinfectious kyphosis. The average age was 22.3 (13-42) and the average follow-up was 2.1 years (1-3.2 years).

Preoperatively, 20 patients complained of pain and 8 cases had neurologic deficit. In all cases, except 3 with Scheuermann's kyphosis, we performed anterior and posterior combined procedures and we used CD instrumentation for posterior correction and stabilization.

Average kyphosis angle was 83 ° (76°-95°) preoperatively, and 38 ° (30°-62°) postoperatively. All cases with neurologic deficit were able to walk without any external support at the last follow-up. Postoperatively there was no pain in 18 patients, mild pain 4 cases, severe pain in 2 cases and radicular pain in 1 case.

Our cases illustrate that, in posttraumatic and postinfectious kyphosis progressive neurologic deficit predominates the clinical picture and combined procedures are required, however, in Scheuermann's kyphosis pain predominates the picture and, posterior surgery is required in cases with less than 80 degrees of deformity and, anterior and posterior surgery are required in cases with a more severe deformity.

COTREL - DUBOUSSET INSTRUMENTATION IN THE TREATMENT OF KYPHOSIS

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There are various diseases causing kyphotic deformity, which range from simple postural kyphosis to severe congenital or tuberculous kyphosis. Muscle imbalance, loss of bone mineral content, infection, osteoporosis, ligamentous laxity may cause kyphosis. The aim of this study is to determine whether a single instrumentation (CDI) system can provide correction in a group of kyphotic patients which have heterogenous etiologies. The extent of performed surgery varied according to the etiology and radius of the curvature but the instrumentation system (CDI) remained unchanged. Twenty-six patients (13 F, 13M) who were followed for a mean period of 15 months (1 - 34) operated at Marmara University Hospital between February 1989 and December 1992 were evaluated. The etiology of kyphosis among our patients were as follows: Tuberculosis(n=8), Fractures (n=6), Paralytic Diseases (n=5), Neoplasms (n=4), Scheuermann's Kyphosis (n=2), Congenital Kyphosis (n=1).

In conclusion, kyphosis with different etiologies should each be considered as separate entities. Also long and short radius kyphosis are biomechanically different problems. However, all different types of kyphosis can be treated effectively with a single universal system.

SEQUENTIAL - SIMULTANEOUS CORRECTION OF SHORT SEGMENT HYPERKYPHOSIS. Lynn M. Nelson, M.D. and Marc A. Asher, M.D., University of Kansas Medical Center, Kansas City, Ks. 66160

Short segment hyperkyphosis correction/stabilization frequently requires anterior strut grafting to replace the compromised anterior column and posterior instrumentation to provide greater stability. Eleven consecutive patients (7 males, 4 females) (7 posttraumatic, 2 short stature, 1 metastatic tumor, 1 scoliosis revision) were reviewed. Parameter means and ranges were age was 31 years (14-45), operative time was 620 min. (420-885), estimated blood loss was 1,950 cc (750-4,000), hospital stay was 7.8 days (5-12 days), and follow-up 10 mo. (3-18).

Results Function score mean at follow-up improved to 4.2 (on a 5 point analogue scale with 5 being best possible) versus 3.0 preop. Pain score improved to 4.2, compared to a mean of 2.4 preoperatively. Appearance mean score preop was 2.0 versus 3.9 at follow-up. Pre-operative kyphotic deformity (over "normal") per patient averaged 40°. Mean correction immediately post-op was 84% (70-113%). Overall mean correction at longest follow-up was 74% (19-106%). Eight of 11 (73%) had $\geq 75\%$ correction at follow-up. There were no serious complications.

Conclusion The concept of sequential-simultaneous anterior and posterior correction of short segment hyperkyphosis, in which posterior instrumentation placement and osteotomy performance are done in the preferred prone position, while still allowing for direct control and visualization of both the anterior and posterior columns appears to be viable.

SURGICAL TREATMENT OF SPINAL DEFORMITIES IN ANKYLOSING SPONDYLITIS

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Fifteen patients with the diagnosis of ankylosing spondylitis (14 male and 1 female) were operated in the Department of Orthopaedics and Traumatology, Faculty of Medicine, University of Çukurova between December 1992 and January 1994. The mean age of the patients was 37 (range, 23-35). The surgical methods were as follows: Twelve patients had posterior lumbar egg-shell procedure (posterior transpedicular vertebral body decancellation) with internal fixation, 2 patients had thoracal anterior release and posterior multi-segment osteotomy with instrumentation, and one patient had cervical egg-shell procedure with halo-body external fixation. Isola system was used in the instrumented cases. Overall mean correction was 27.2 degrees in lumbar osteotomy cases. The mean follow-up period was 7.9 months (range, 4 -15). All patients had the ability to look forward postoperatively, and were satisfied with the result subjectively. We had two partial loss of correction, one minor root lesion, one hematoma, and one deep infection that resulted in removal of internal fixation material. In conclusion, surgical treatment of ankylosing spondylitis especially with egg-shell procedure is satisfactory for realigning the vertebral column.

(Key words: ankylosing spondylitis, kyphosis, osteotomy)

POSTERIOR WEDGE OSTEOTOMY FOR TREATMENT OF SEGMENTARY KYPHOSIS

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Segmentary Kyphotic deformities,not uncommonly caused by Pott's Disease,trauma and congenital kyphoscoliosis clasically treated by conventional surgical methods,combined anterior and posterior approaches.For these hyperkyphotic deformities one session posterior wedge osteotomy is an alternative method to clasical ones.

Twentyfour patients(13 men,11 woman ;mean age 18.3 years) diagnosed as having segmentary kyphotic deformities were operated using posterior wedge osteotomy techniques from May 1991 to May 1994 ,in SSK İstanbul Hospital' 2.nd Orthopaedics and Traumatology Clinics.Largest Follow-up Period was 32 months,shortest was 6 months (mean 18 months).

Preoperative mean kyphosis angle was 68 degrees,and postoperative was 21 degrees.Fusion was detected radiologically,in all cases, within 6 months.Evaluation at 3 patients showed 15 degree correction loss in whom anterior fusion was delayed.Problems related to instrumentation material was not seen.

Clinical assesment of the patients according to Denis Pain and Work Scale showed excellent and good results except of one patient.Improvement of postoperative complete neurologic deficit of one patients was up to Frankel D level in latest follow-up of that patient.

With proper and experienced surgical technique posterior wedge osteotomy provides necessary correction and is effective on combined clasical methods is .Furthermore being one session operation makes it more advantageous both for the patient and for the surgeon.

Double Stage Surgical Treatment of Posttraumatic Late Kyphosis

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The secondary deformity and incapacitating back pain seen after conservatively treated thoracolumbar spine fractures may be treated by reconstructive surgery. The single stage posterior wedge excision + instrumentation, two stage anterior release + posterior instrumentation and the single stage anterior release + posterior instrumentation are the surgical alternatives.

In Marmara University, School of Medicine, Department of Orthopaedics and Traumatology 8 cases were operated to correct posttraumatic kyphotic deformity between 1990 and 1993. The average age of the patients was 34,2 (24-52). The average period after the fracture was 28,5 months (8 months - 10 years). Postoperative follow-up period was 19 months average (14 - 58 months) . The first 5 patients were operated with the two stage procedure. The other three cases were operated in the lateral decubitus position with no intraoperative repositioning and redraping. In these cases, posterior instrumentation followed anterior release. The mean acquired surgical correction was 28 degrees (17 - 38). Anterior and posterior fusions were performed as the last step. Performing both operations in the lateral decubitus position shortens the duration of the operation. Correction is easier because of the combination of anterior and posterior manipulation, but there are technical problems causing difficulties during the posterior approach due to inadequate exposure.

MANAGEMENT OF SPINE TUMORS

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From March 1988 to April 1994 9 patients with spinal tumoral lesions have been operated in our clinic. 6 malignant (3 metastatic) and 3 benign tumor were localized on thoracal (5), lumbar (3) and sacral (1) regions. Primary malign group consist of 22.2% plasmacytomas (2 cases), 11.1% osteosarcoma (1 case) , 33.3% of metastases (3 cases) were arisen from Lungs (1 case) 11.1%, from thyroid gland (1 case) 11.1%, from prostate (1 case) 11.1%. 3 Benign tumoral lesions of our cases consist of 22.2% osteoit osteoma (2 cases) and 11.1% aneurysmal bone cyst (1 case). Two patients were paraplegic and the other two patients were parasthetic. The surgical procedure was resection in 33.3%, resection and stabilization with Alici Spinal System in 11.1%, resection and stabilization with bone cement and Anterior Alici Spinal System in 44.4%, laminectomy and posterior decompression in 11.1% of the cases. The mean follow up was 18 months and 4 deaths have been observed in this period. All the patients who had a metastatic tumoral lesions and osteosarcoma were died within 6-12 months after surgical operations.

PRIMARY AND METASTATIC

LESIONS OF THE SPINE

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ABSTRACT

From September-1986 to March-1994 , 57 of 71 patients with spinal tumoral lesions have been operated on our clinic and 14 of them were conservatively treated. From March-1989 to March-1994 302 patients with various tumoral lesions have been consulted in our clinic. 52 Of 302 patients localized on the spine. In the patients which were operated on, 14 primary benign, 19 primary malign and 25 metastatic lesions were localised on the spine . In the patients which were not operated on , 6 primary benign, 1 primary malign and 7 metastatic lesion were localised on the spine. The surgical procedure was only incisional biopsy 21 % , resection 5 % , laminectomy 1.7 % , anterior fusion 13.7 % , instrumentation 58.6 % . Mean follow-up was 15 months and 13 deaths have been observed in this period.

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SURGICAL TREATMENT IN THE METASTATIC

TUMORS OF SPINE

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Most of the spinal tumors are metastatic tumors. These require close follow-up and exact timing for surgery since they could cause destruction of vertebral body, thus creating instability.

We operated 15 cases with metastatic tumors of spine in Orthopedics and Traumatology Department of Gülhane Military Medical Academy between 1988 and 1994.

Average age of the patients was 45 (Range: 20-63). 4 of the cases were female and 11 were male. Average follow-up period was 3 years.

The surgical intervention to this kind of patients should not be much aggressive. Stabilization and decompression without fusion is satisfactory especially in the patients with multiple metastasis. We found it noticeable that the early loosening of transpedicular screws applied close to target vertebral body could be seen at the patients under radiation therapy. It is more safe to keep the fixation long enough in this particular situation.

The histopathological diagnosis of primary origin of the metastatic foci were as follows in our cases: Breast cancer, Hypernephroma, plasmocytoma, Renal cell ca, Hemangioma, Lung cancer and Adeno ca. We determined the primary foci of 3 cases with surgery. Oncological treatment must be applied together with the surgical treatment in the metastatic cases.

The aim of the surgical treatment is;

1) To prevent medullary compromise, 2) To cease pain with stabilization, 3) To augment the effect of chemotherapy and radiotherapy by way of elimination of tumor and, 4) To enable an increased life standart to the patient.

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SURGICAL TREATMENT OF METASTATIC DISEASE OF THE SPINE

John P. Kostuik

Patients with metastatic tumours to the spine have increased longevity because of the improved chemotherapy and radiotherapy. As a result, problems of pathological fracture and neuro-compression together with incapacitating pain have increased. Surgery has played an increasing role in alleviating these problems. Past studies have shown that the efficacy for improving the neurological problems related to either tumour extension or pathological fracture are only valid in about 40% of the patients treated by either radiotherapy or laminectomy and indeed in the later, many are made worse. A review of 100 patients of metastatic disease published in 1988 by the senior author, infection rate overall was 3%. Average longevity was eleven months.

In a sub-section, thirty-one renal tumours subsequently published in 1992 showed a longevity of fourteen months. Fifty percent of patients undergoing decompression of metastatic renal cell carcinoma of the spine underwent repeat decompression with similar improved neurological results in 70%. Preoperative embolization for renal cell carcinoma is important. The techniques for cervical, thoracic, lumbar and sacral metastatic disease are given.

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RECONSTRUCTION OF SPINE BETWEEN T10 AND L4 IN METASTASIS WITH KANEDA DEVICE

Frank JK Kramer

*Willam Alexander and Carolus Hosp.

In excruciating pain and/or neurological involvment and when radiation therapy is not possible (anymore) an anterior decompression and fusion with a tumour jack an Kaneda instrumentation can be achieved. A nice alignment and a solid construction can be made, with predictable outcome. The scoring system for the pre operative evaluation of metastatic spine tumour prognosis from Tokuhashi e.a. is very helpful to decide if this procedure can upgrade the quality of life of terminally ill patients without jeopardizing the prognosis.

ANTERIOR VERTEBRECTOMY FOR TREATMENT OF VERTEBRAL PROBLEMS:

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Twenty patients who were treated with anterior vertebrectomy were evaluated retrospectively. Six patients had congenital anomalies, 8 had traumatic destruction and 6 had metastatic carcinoma. Total vertebrectomy was performed in 14, partial vertebrectomy in 6 patients. The space from vertebrectomy was filled with a strut bone graft in 4 patients, while in 4 patients the defect was filled with polymethylmetacrylate bone cement and was additionally fixed internally with instrumentation. Posterior instrumentation and fusion was performed in three cases with congenital anomalies. The mean blood loss was 3600 ml. Correction of the vertebral column alignment, union of the grafts and stability of the instrumentation were evaluated. Average follow-up was 2 (range 1-5) years. One patient expired at surgery. Implant related problems were encountered in 2 patients. Increase in kyphosis was not observed.

Vertebrectomy is an effective procedure in treatment of various pathological conditions, which are located on the anterior side of the vertebral column. But the procedure is extremely demanding especially when anterior instrumentation is combined and therefore should be performed by an experienced surgeon.

OSTEOID OSTEOMA AND OSTEOLASTOMA OF THE SPINE

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True back pain and painful scoliosis are uncommon in children and adolescents. One of the causes of these complaints is osteoid osteoma or osteoblastoma of the spine.

Seven patients with osteoid osteoma and four patients with osteoblastoma of the spine were evaluated after operative excision of the tumor. 6 patients were girls and 5 boys with an average age of 14.4 years (range 4 to 20 y.). The average follow-up was 25.4 months with a range from 6 months to 4.5 years.

Eight cases involved the lumbar spine, two the thoracic spine and one the cervical spine. In all 11 patients the lesion was situated in the posterior vertebral elements. All patients complained of back pain on presentation. Aspirin or naprosyn afforded good symptomatic relief in four patients. Two patients presented with painful scoliosis.

Radiography, computerized axial tomography and scintigraphy showed to be efficient for the diagnosis, which was confirmed histopathologically in the case operated on.

Complete excision has led to a complete cure in all cases. One case required posterolateral fusion and instrumentation due to instability created by excision of the lesion. Following surgery, preoperative pain was completely relieved and the spinal curvature had partially regressed.

An underlying osteoid osteoma or osteoblastoma of the spine must be strongly suspected in all young patients presenting with back pain and painful scoliosis. Preoperative evaluation should include a bone scan and computed tomography to localize the tumor accurately. If the diagnosis is made early, the scoliosis is reversible after excision of the tumor. When the spine becomes unstable due to the extent of the excision, stabilization may be required.

TUMORS ENCROACHING UPON THE SPINO-CRANIAL JUNCTION: PERSONAL EXPERIENCE.

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Intra and extramedullary tumors involving the spino-cranial junction present challenging difficulties because of the complex relationship with blood supply of the upper cervical region and brain stem structures lower cranial nerves and cervical roots are also a relevant problem in managing lesions of this area. Careful neuroradiological assessment requires CT, MRI and angiographic evaluation; BSER and SSEP add neurophysiological informations before, during and after the surgical procedure. Posterior median, lateral, far lateral, extreme lateral transcondylar transjugular, and transoral approaches have been devised to remove growths of the spino-cranial junction, depending on the available room provided by the tumor size and site of development. Twelve patients affected by spino-cranial tumors have been operated upon over the last ten years; although the posterior median approach had been elected as the most suitable for the majority of the cases, far lateral and extreme lateral transcondylar transjugular ways have been employed. Indications for different approaches, difficulties encountered with the complex anatomy, and surgical outcomes are proposed for discussion.

EN-BLOC RESECTION OF A COSTO-VERTEBRAL CORNER CHONDROSARCOMA WITH A NEW SURGICAL TECHNIQUE (CASE REPORT)

**Bora GÖKSAN, Azmi HAMZAOĞLU, Cüneyt ŞAR,
Levent ERALP, Sarper ÇETİNKAYA**

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We operated a male patient, 47 years old, who had a costovertebral corner chondrosarcoma between the sixth, seventh, and eighth thoracic vertebrae, which attacks the left lateral bodies, pedicles and laminae of the above mentioned vertebrae, with a new technique.

We totally resected the 1/3 left lateral bodies, laminae, pedicles and costae between the levels of T5 to T9 with safe surgical and pathological margins. After two weeks, we performed a posterior fusion with CD Instrumentation. After a follow-up of two years, the patient has no evidence of disease (NED).

ANTERIOR RADICAL DEBRIDEMENT AND ANTERIOR SPINAL FUSION IN SPINAL TUBERCULOSIS

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In the years between 1971 and 1994, of 125 cases diagnosed with spinal tuberculosis and surgically treated at the Department of Orthopaedics and Traumatology, The Faculty of Medicine, Atatürk University, 67 cases were performed anterior radical debridement and anterior spinal fusion and the cases were followed 8 months to 134 months, average following period 3,2 years.

The rate of male and female are equal, the youngest age 2 years, the oldest 65 years. 3 children cases were performed anterior fusion as well as posterior fusion. It was observed that the disease affected lower thoracal region the most frequently, in 30 cases neurologic findings were determined.

The results were evaluated as to Malawski and Mirovski criters. According to this perfect result in 64 patients (95,5 %), adequate result in 2(3 %) and inadequate result in 1 patient (1,5 %) were obtained. Except 1 in all patients, neurological findings improved. Postoperatively, in 10 cases (14,9 %) angle of kyphosis increased over 10°. Regardful of the results, it was concluded that this operation method should be effective on the treatment of spinal tuberculosis.

RETROSPECTIVE EVALUATION OF TREATMENT ALTERNATIVES OF TUBERCULOUS SPONDYLITIS:

Adil Surat, R. Emre Acaroğlu, M. Cemalettin Aksoy, A. Mazhar Tokgözoğlu, Nasır Özdemir.

Hacettepe University Faculty of Medicine, Hacettepe, Ankara.

We studied 125 patients that were treated for Tuberculous Spondylitis. All patients had at least had a one year follow-up (mean 53 months, range 12-277 months). The mean age of the patients was 24.3 (range 2-72) years.

The patients had received three different treatments. The first group consisted of 11 patients who were treated with antituberculosis antibiotics only. The second group consisted of 56 patients treated both medically and with in-situ posterior fusion. The third group consisted of 58 patients who were treated medically and surgically with anterior drainage and with or without fusion. Thirty-six of the patients had neurologic impairment of different grades. (Five of the patients from the first group, 14 from the second group, 17 from third group). Among these neurologically compromised patients 26 improved completely, 8 partially. Five patients from the first group, 13 from second group, 14 from third group improved positively from their previous neurologic status. Anterior drainage and fusion procedure proved to be better than other treatment modalities.

POTT'S DISEASE

RETROSPECTIVE EVALUATION OF PRELIMINARY RESULTS

Erbil AYDIN, Mahmut KIŞ, İ.Teoman BENLİ,
Şükrü SOLAK, Mahmut GİDER, Cüneyt YÜCESOY

The results of 28 operations on 24 patients in whom the diagnosis was confirmed histologically at Pott's disease is evaluated retrospectively. 11 patients were female and 13 patients were male and the average age was 30.3 years ranging between 3 and 70 years. The mean follow up was 19 months (3-60 months). The surgical procedures were performed in the Orthopaedic Clinics of Ankara Social Security Hospital between May 1989 and February 1994. Ten patients had anterior drainage only, while 4 had anterior drainage + anterior bone grafting, 3 had posterior instrumentation and fusion after having an anterior drainage in the first operation, 4 had posterior instrumentation and fusion only, 1 had anterior decompression and bone grafting + anterior instrumentation, 1 had anterior decompression and bone grafting after posterior instrumentation and fusion in the same session and one patient had only biopsy from the posterolateral structures of the spine. One patient had anterior drainage from both sides of the lumbar region with an interval of two months because of two separate masses of cold abscess. Eight patients had had neurological deficits preoperatively in different severities, five of which completely resolved while two of them improved postoperatively. One patient died in the early postoperative period. At the last follow up the patients were evaluated neurologically, functionally (returning to work and daily activities) and radiologically. The conclusion is that better and the sooner the debridement, the better and more satisfactory the outcome.

SURGICAL TREATMENT OF SPINE TUBERCULOSIS WITH ALICI SPINAL SYSTEM

Alici Emin, MD., Berk Haluk, MD., Özkan Mustafa, MD., Yıldız Kadir, MD.

Tuberculosis of spine has been recorded in ancient times and first written description was given by Hippocrates. Pott described it as a kyphotic deformity of the spine associated with paraplegia so that since 1779 it has been known as Pott's disease.

Although it has been recognized for such a long time, its treatment has not been clearly specified.

Since Ménard 1894, anterolateral approach allows direct approach to the lesion and adequate decompression.

According to Hodgson anterior approach allows direct approach and proved its efficiency in the management of spine tuberculosis.

This approach gives possibility for adequate decompression and fusion of the affected part.

The aim of this study is to show the effectivity of the anterior approach and fusion with anterior instrumentation.

Material and Method : From 1987 to 1994 30 patients (19 male, 11 female) of spine tuberculosis were operated through anterior approach and anterior decompression and fusion were done. Stabilization was provided by anterior Alici Spinal instrumentation.

Average age of these patients was 53 years. Average follow - up period of 22 patients was 24.6 months. Before operation, CT and MRI evaluation of the spine were done. Operation consisted of wide anterior approach and wide exposure of the diseased area, debridement of bone and dissection of cold abscess sac, decompression of medullary canal if necessary, spine fusion with autografts (Rib grafts were used in all patients) and stabilization with Alici Spinal system were applied. In prevention of graft collapse, grafting was extend from end plate to end plate.

In 45% of cases gibus kyphosis was between 15°-45° 55% of cases gibus kyphosis was greater than 45°.

All patients were preoperatively treated by tuberculostatics. Also In post operative period four tuberculostatics are given to all patients at least 6 months after surgery. Fusion was seen at all patients.

In order to obtain exact diagnosis, early eradication of the disease, decrease of cord compression, to obtain early and adequate fusion of the spine, to shorten the immobilization period, anterior approach to the spine and anterior instrumentation is the best way to treat spine tuberculosis.

HYDATID CYST OF SPINE

AYDOĞAN,N,MD., TUNAY,S.MD., SOLAKOĞLU,C,MD., YAZICI,V,MD.

Hydatid cyst is a parasitary disease encountered in poor hygenic conditions. Besides the usual placement of soft tissue,it can also be observed in bone such as vertebra,femur,tibia and pelvis.

We applied medical and surgical treatment to two cases who had hydatid cyst disease in their vertebral column at Orthopaedics and Traumatology Department of Gülhane Military Medical Academy between January 1990 and May 1994. One patient was suffering from paraparesia and loss of motor function in her lower extremity.We applied anterior excision together with graphting after irrigation of cavity with hypertonic saline.Neurologic deficit was healed after the treatment.

While one of the case was undertaken the therapy of mebendasole for 2 months and albendasole treatment later on,the other case was given albendasole only for one year.The patients are under follow-up for 3 and 2 years consequently and we did not observe any relapse in these cases.

We observed that MRI is especially valuable in both,diagnosis and follow-up of this disease.

The Comparison of the Fusion Rate in Anterior Interbody Fusion between Infected and Non-infected Diseases of the Spine

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The anterior interbody fusion become the popular measure in the treatment of the several spinal diseases. We analyzed the 326 cases of the several spinal diseases - tuberculosis of the spine, infectious spondylitis, discitis, spondylolisthesis, spondylolisthesis, spinal stenosis, and herniated nucleus pulposus, who were treated from January, 1979 to December, 1991. And we compared the fusion rate between infectious spinal diseases (Tbc spine, pyogenic spondylitis, discitis) and non-infectious spinal diseases (spondylolisthesis, HNP; spinal stenosis, spondylolysis).

The purpose of this study is to compare the fusion rate and the fusing pattern of the grafted bone between the infectious and non-infectious spinal diseases.

Following results were obtained from analysis of the cases studied

1. Over all fusion rate of the infectious spinal diseases was 88.0% and that of the non-infectious spinal diseases was 91.8%.
2. Radiologically, complete fusion was in 73.3%, Incomplete fusion in 17.4%, and absorption of grafted bone in 9.3%.
3. The fusing pattern of grafted bone could be categorized into five different types and the common type was type 1 (61.1%).
4. High fusion rates were obtained in spinal stenosis and spondylolysis.
5. In clinical result, 82.2% of non-infectious group was satisfied, and in infectious group it was 77.5%.
6. In non-infectious spinal diseases group, the clinical result was most favorable in herniated nucleus pulposus.

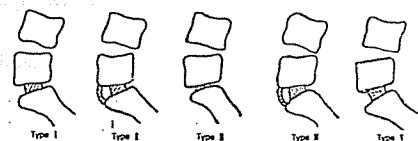


Fig. 1. Diagram of fusing pattern.
I : Fusion without space narrowing or anterior bridging
II : Fusion with anterior bridging
III : Fusion with disc space narrowing
IV : Fusion with anterior bridging and partial absorption of the grafted bone
V : Fusion failure
■ Fusion □ Failure of fusion

ASSESSMENT OF THE RESULTS OF X-RAY AND CT IN THE DIAGNOSIS OF THORACO-LUMBAR SPINE FRACTURES

Tuğrul Berkel (1), Cuma Kılıçkap (2), Ercüment Zayim (3), Hasan Dermesi (3), Hakan Eren (4).

SUMMARY

Of the 120 patients who were treated in The Orthopaedics and Traumatology Clinic 1 of The Kartal Education and Research Hospital during 1989/1994 because of thoraco-lumbar spine fractures in the 68 cases CT scanings were done. The CT scanings and x-rays of the patients were evaluated by the three orthopaedic surgeons, first one by one and then together. CT assessments were compared with x-ray reports. In 10 cases postoperative CT scanings were done.

During the assessment of those cases in 1 case 3, in 1 case 2 and in 3 cases additional fracture which could not seen at the x-rays was established. X-ray diagnosis of these cases were; in 2 cases L₁, in 1 case T₁₂, in 1 case L₂ and in case T₁₀₋₁₁. Although 9 cases were evaluated as stabil fractures by the assessment of the x-rays, after the CT scanings they were considered as unstabil fractures. 12 cases were accepted as neurologically unstabil since there was narrowing in the neural canal more than 50%.

For the assessment of the neural canal of the patients who were treated surgically postoperative CT scanings were done. But because of the reflections the comparison of the x-rays and CT scanning could not be done.

As a result:

(1) CT scanning in the diagnosis of the thoraco-lumbar spine fractures were found to be effective in 30% of the cases and therefore whenever it is possible CT scanning should be done before the treatment of the thoraco-lumbar spine fractures

(2) And it should not be forgotten that both x-ray and CT scanning has a meaning if they are accompanied with the physical examination.

Key words: X-ray, CT, thoraco-lumbar spine fractures.

The Results Of The Non-Operative Treatment Of Thoracolumbar Vertebra Fractures

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KAFADAR, Adnan MD, ABBASOĞLU, Adnan MD.

Of 159 Patients with vertebra compression fracture who have been treated non-operatively at orthopaedics and traumatology department in Haydarpasa Numune Hospital between June 1988-December 1992, 32 patients (21 Female, 11 Male) have accepted our invitation. The average age were 36 years. The mean follow-up time was 48 months.

After staying in bed for 6 weeks, they have been allowed to walk with chairback or TLSO brace for 2 months.

Patients returned to their former jobs. 18 of them (56.25%) couldn't lift up heavy things, 7 of them (21.87%) couldn't walk long way and stay long time. The pain was evaluated according to Denis and 10 of them (31.25%) were in group P1, 7 of them (21.87%) were in group P2, 10 of them (31.25%) were in group P3, 4 of them (12.50%) were in group P4. No patient has restriction of motion.

All patients but three have compression less than 40% and anterior compression angle less than 30° at the beginning and at the follow-up. 3 patients who have compression more than 40% had kyphosis later.

We have satisfying results with non-operative treatment in patients with vertebra compression fracture who have compression less than 40% and anterior compression angle less than 30° .

THE RESULTS OF THE SURGICAL TREATMENT IN THORACO-LUMBAR SPINE FRACTURES

Tuğrul Berkel (1), Bülent Kavaklı (2), Haldun Orhun (3), İsmail Yedek (4),
Erkal Bilgiç (4)

SUMMARY

40 patients who had unstable thoraco-lumbar spine fractures were treated by posterior spinal instrumentation and fusion combination in The Orthopaedics and Traumatology Clinic 1 of The Kartal Education and Research Hospital during 1989/1993.

The mean age of the patients was 31 years (15-64), 32 of them were male and 8 were female.

Most of the fractures were located at the thoracolumbar region (19 cases), the others at the lumbar (15 cases) and thoracic region (6 cases). 15 patients had neurologic deficits at admission.

We used 6 different devices for posterior spinal instrumentation; to 7 patients Harrington rods, 12 patients AICI, 12 patients CD, 4 patients Diapazon, 4 patients TSRH and 1 patient FVM (Malaga).

After an average 24 months (53-4) follow up time the results were evaluated. For clinical evaluation modified Moskovich scoring and neurological evaluation Frankel/MIS grading systems were used. The assessment of x-ray analysis were done by preoperative-postoperative height loss of the anterior and posterior corpus and local kyphosis angle according to the sagittal index.

We saw deep infection in 1 case and paraplegia in another one as early complications. As late complications 4 implant failure and 2 foreign body reactions were detected. We obtained in 15 cases excellent, 10 cases good, 7 cases fair and 8 cases poor results.

CD device has both less correction loss and complication rate than the others.

Posterior spinal fusion should be done together with spinal instrumentation. Reverse hook patterns should be used for the short segment instrumentation.

The quality and the cost of the device should be considered when implant choosing.

Key words: Thoraco-lumbar fractures, surgical treatment

COTREL-DUBOUSSET INSTRUMENTATION IN SURGICAL MANAGEMENT OF THORACOLUMBAR AND LUMBAR BURST FRACTURES

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Twelve patients who had burst fractures in thoracolumbar junction and lumbar region, had been managed with Cotrel-Dubousset instrumentation between August 92-December 93, at the department of Orthopaedics and Traumatology, in Haydarpaşa State Hospital, İstanbul.

Six of our patients were female and the average age was 29.2. According to the level of the lesion, one of the patients had burst fracture at T 12, eight of the patients at L 1, one of the patients at L 2, one of the patients at L 3, and one of the patients both at L 3 and L 4.

Our average follow up time was 10.5 months. Though, preoperative average local fracture angle was 20° , it became 8.7° postoperatively. Average local kyphosis angle was 15.6° preoperatively and 4° postoperatively. Average preoperative compression of anterior vertebral body percentage was 41.6% and in the last follow up it was 16.9%. On CAT scan, preoperative average vertebral canal obstruction was 51.9% and postoperatively it was 31.3%.

Four patients who had incomplete neurologic deficits had improvement, and fell in to one grade higher category according to Frankel and et al.'s classification system.

As complication, one patient had peroperatuar laminar fracture and the other one whom short segment was performed had upper pedicular screws broken postoperatively 8 and 12 th months.

Surgical Treatment of Thoracal and Lumbar Fractures with Alici Spinal System

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It is generally accepted that surgical management of unstable spinal fractures offers advantages over conservative management. Different considerations and the rapid development of new fixation procedures are widely used for this reason. In a cases of a surgical indication in thoracolumbar spine our choice mainly the less cheap spinal instrumentation system of Alici. Between December 1991 and April 1994 33 patients were treated for thoracolumbar fractures, 26 of them who were adequately followed up were evaluated. 53.8% of them were involved to a traffic accident. 8 patients (30.8%) had neurologic involvement. The mean initial deformity kyphosis and scoliosis were 22.8°, 1.6° respectively. We had used 3 anterior, 20 posterior Alici Spinal System and 3 combined procedures of them. Post operatively significant neurologic improvement was seen in 6 patients (23.1%). The mean kyphosis and scoliosis angles were found to be 14.6°, 0.8° postoperatively. These values were determined as 15.3°, 1.1° at the most recent follow up. On complication we had 1 deep infection, 1 kyphoscoliosis, 2 junctional kyphosis, 4 failure of the implants. The spine is stabilized primarily to prevent further spinal cord injury. In addition, restoration of spinal alignment and reduction of posterior wall fragments are of equal significance. In using Alici Spinal System we see the right way to achieve these goals.

THE EARLY RESULTS OF THORACOLUMBER FRACTURES

WHICH TREATED WITH TSRH SYSTEM

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In Ankara University Ibn-i Sina Hospital, Department of Orthopedics and Traumatology, between October 1992 and June 1994 15 patients with thoracolumber fractures were operated with TSRH system. 11 of these cases were primary and the other 4 cases were pathologic fractures. The mean follow up was 13 months (3-22). 9 of these cases were men and the others 4 were women. The mean age was 43,8 years old (16-64).

In this study, we want to discuss the early results of the patients with thoracolumber fractures which were operated with TSRH system.

SURGICAL TREATMENT FOR BURST FRACTURES OF THE LUMBAR SPINE

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Surgical treatment has been performed for 21 cases of burst fractures of the lumbar spine between the years 1990 and 1993. Cases had different fracture levels varying between L2 and L4 and Farcy's criteria were used for evaluating the stability.

Posterior reduction, fusion with Cotrel-Dubousset instrumentation and anterior decompression, fusion with Kaneda instrumentation were used in 15 and 3 cases respectively. Anterior decompression with strut graft and posterior fusion and CD instrumentation were performed in two cases. One case had anterior strut graft without decompression and posterior fusion with instrumentation. Dura rupture was repaired in four cases with fractured lamina.

Posterior fusion and stabilization were to be adequate for sagittal plane alignment, restoration and preservation in cases having a sagittal index between 15 and 25 degree and demonstrating grade III mechanical instability. Cases with a sagittal index above 25 degree and grade III mechanical instability necessitated anterior strut graft with posterior fusion and instrumentation to restore and preserve the sagittal plane alignment. It was also concluded that posterior procedure should be preferred first in cases with vertical fractures of the lamina

**THE HARRINGTON DISTRACTION RODS AND INTERSPINOUS WIRING IN THE
SURGICAL TREATMENT OF UNSTABLE THORACOLUMBAR FRACTURES
OF THE SPINE**

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H.ÖZYALÇIN **

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*** Resident " " " " " " " "

ABSTRACT

Between 1986-1993, we have treated 51 patients with fractures of the thoracolumbar spine at the Departement of Orthopaedics and Traumatology in Ege University with a combination of Harrington distraction rods and interspinous wiring.

We have combined the Harrington distraction rods and interspinous wiring in unstable fractures according to Dennis's "Three column theory" in order to prevent the over-distraction forces of the rods and to direct the distractive forces through the hooks to the middle and anterior columns. By doing this, we achieved a better reduction of the fragments, and a more stable internal fixation with balanced distraction.

Key Words :Fractures of Vertebrae, Harrington, Thoracolumbar Spine

COMPARISON OF THE RESULTS OF SHORT SEGMENTED AND LONG SEGMENTED APPLICATION OF DORSAL INSTRUMENTATION IN THORACOLUMBAR VERTEBRAE FRACTURE

**Yalçın Tabak , Ahmet Uçaner , Alihan Sarsu
Ali Bıçımoglu , Uğur Günel**

The aim of the treatment in spine injury is to restore stability, to reduce malposition, to improve neurological damage and to achieve normal function. In this situation there are two paradoxical items. While short segmented application of instrumentation and fusion provides better function, long segmented instrumentation and fusion gives better stability but worse function.

Between 1991-1994 posterior instrumentation was applied to 56 patients who had suffered from thoracolumbar vertebrae fractures. The patients were between 18-57 years old. Three different instrumentation systems were used, named as DICK, ISOLA, and ALICI. Short segmented instrumentation and fusion applied to 26 patients. Long segmented instrumentation and fusion applied to 30 patients. In sagittal plane loss of correction is found higher in the short segmented group during the follow up (2.1 years).

Therefore during the preoperative evaluation surgeon has to decide the most important aim. Is that stability or function?

THORACOLUMBAR SPINE FRACTURE-DISLOCATIONS IN CHILDREN BECAUSE OF A CASE

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In this study a 12-year child patient with L3 - L4 vertebra fracture-dislocation, who was operated upon in our clinic and thoracolumbar spine fracture-dislocations in children related to this were examined.

In this patient, who was brought to our emergency room after being exposed to a collapse, in addition this L3-4 vertebra fracture-dislocation, incomplete progressive neurological injury that is compatible with these levels were found out. Upon an immediate operation posterior reduction and stabilization was applied by TSRH spinal instrumentation. In the patient that is still in follow up, a very fast neurological recovery was observed and walk without support was maintained in the postoperative second month. EMG data also supported this recovery.

As an operative technique, laminar hook guide was used to reduce fracture-dislocation. As it was a flexion-distraction typed fracture-dislocation screw-rod system was by setting up transpedicular and making compression, functional lumbar lordosis and a perfect anatomical reduction were obtained.

This case has been aimed to be presented, since spine fracture-dislocations are rarely seen at children and, due to an interesting reduction technique used in this case and the perfect neurological recovery.

Root Injuries Due to Transpedicular Screw Application and the Role of DSEP

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The popularization of transpedicular screw fixation of the spine has given rise to an increasing number of iatrogenic nerve root lesions. The aim of this study is to determine the frequency, the severity and the natural history of iatrogenic spinal nerve root lesions caused by incorrect transpedicular instrumentation. Ninety patients with various spinal disorders underwent surgery at Marmara University, School of Medicine, Department of Orthopaedics and Traumatology. There were 51 females, 39 males with a mean age of 37,4. The follow up period was 25 months average. The diagnoses were as follows: spondylolisthesis (32), spondylolysis (5), scoliosis (27), fractures (26). 400 transpedicular screws were inserted between the thoracal 8th and sacral second vertebrae. Postoperatively six patients were found to have incomplete root lesions of L2 to S1. These were generally from the earlier cases of the series. The follow up period of these patients were 31,4 months (54 - 18 months). These cases were investigated with DSEP, standart radiographies and computerized tomography (CT). EMG was employed to verify the DSEP findings. In one case the screw was found in the intervertebral foramen close to the nerve root on CT and lateral radiography. In this patient DSEP demonstrated acute denervation and reduced interference patterns. This screw was removed two months later and the patient's radiculopathy symptoms healed almost completely within the following three months. In the remaining five patients the symptoms healed gradually within three to six months. On electrophysiologic evaluation of these five patients there were different pathological findings. In conclusion, patients with postoperative root lesions may be evaluated with DSEP, EMG and radiological monitorization of the screw position and close observation of the clinical findings. With this methods unnecessary further surgery for implant revision can be avoided. DSEP as a noninvasive and relatively simple tool can be used as a screening method in these patient group but its reliability needs further investigation because of the false negative and positive results.

FRACTURE-DISLOCATIONS OF THORACOLOMBAR SPINE

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There is tension,rotation or shear enforcement in every three column of spine at the fracture-dislocation injuries.High grade neurologic deficit usually accompanies to this condition and often the neurologic deficit is complete.

Early surgical intervention maintaining reduction and fixation could lessen the neurologic deficit in these fractures with such high grade unstability. But the result may not be satisfactory in severely injured patients.

We operated 7 patients with fracture-dislocations in their thoracolumbar spine at the Orthopaedics and Traumatology Department of Gülhane Military Medical Academy between 1988 and 1994.

The injury was in type of flexion-rotation (Type Aa) in 2 of the cases, shear type (Type Ba,c) in 3 cases, and flexion-distraction type (Type C) in 2 of the cases.

The cases without neurologic deficit were stabilized with early surgical intervention. One case who admitted to the hospital with complete lesion was operated in first 8 hours and he stayed in incomplete level. The lesion was at L1-L2 level in 3 of the cases,at L2-L3 level in 2 of the cases and at T12-L1 level in 2 of the cases.

The success of surgical treatment in spinal fracture-dislocations is apt to the early reduction with special method,anatomic restoration and rigid fixation +posterior fusion.

SURGICAL TREATMENT OF THORACOLUMBAR VERTEBRAL FRACTURES (Comparison of the Instrumentation Systems with Hook - Rod, Transpedicular Screw - Rod and Reverse Hook - Transpedicular Screw - Rod Combination)

**Serhan ÖZLÜ, Erbil AYDIN, Mehmet ÇITAK,
Mert TÜZÜNER, İ. Teoman BENLİ, Serdar AKALIN**

Conservative treatment of unstable thoracal and lumbar vertebral fractures results in severe local kyphosis or changes in sagittal contours in long term follow up. This study evaluates 89 thoracolumbar vertebral fractures operated between December 1989 and May 1993 in the Orthopaedic Clinics of Ankara Social Security Hospital. The mean follow up was 30.2 months with a minimum of 12 months. The stabilization of fractures were maintained with hook - rod construction in 28 patients in whom Cotrel - Dubousset instrumentatiton (CDI) was used. Thirty patients had AO Fixator Intern; a transpedicular screw - rod construction. The vertebral fractures in the remaining 31 patients were stabilized with transpedicular screw - reverse hook - rod construction by using Texas Scottish Rite Hospital (TSRH) system. Preoperative sagittal index at the fracture level was $24.7^{\circ} \pm 6.5^{\circ}$ in patients treated with CDI, $25.1^{\circ} \pm 8.2^{\circ}$ with AO Fixator Intern and $28.7^{\circ} \pm 3.4^{\circ}$ with TSRH system. Postoperative correction rates for CDI, AO FI and TSRH system are $66.8 \% \pm 26.7$, $68.4 \% \pm 23.2$ and $79.3 \% \pm 19.5$ in the same order. Postoperative sagittal index at the thoracolumbar junction were in physiologic limits in all of the patients treated with TSRH system, while this rate was 68 % for the AO FI and 65 % for CDI. Because that the best spinal canal decompression and the lowest complication rate is achieved by TSRH system, it is concluded that tranpedicular screw - reverse hook combinations is the best construction type for the stabilization of unstable thoracolumbar fractures.

REHABILITATION OF VERTEBRAL FRACTURE PATIENTS WITH PARAPLEGIA

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Neurologic deficit is a devastating complication of vertebral fractures which is often permanent.

Neurologic recovery may not be achieved even when the continuity of the spinal cord has not been disturbed but only some compression is present, despite adequate surgical techniques.

In these patients an effective rehabilitation program is necessary, aimed at gaining a self-sufficient patient.

The management of these patients requires; 1. Stabilization of the vertebral column, 2. Psychotherapy and 3. Rehabilitation.

4 patients with Frankel A neurologic deficit were treated. The patients and surgical treatment methods were as follows:

1. 28 years old male. Fall from height, L2 fracture-dislocation.

Transpedicular screws-rod instrumentation.

2. 24 years old female. Fall from height (Suicide), L2 burst fracture.

Anterior decompression-anterior instrumentation-fusion.

3. 23 years old male. Motor vehicle accident, T7-8 compression fracture.

Posterior decompression-posterior instrumentation (Hook-rod system).

4. 57 years old female. Motor vehicle accident, L1 burst fractures.

Anterior decompression-anterior instrumentation-fusion.

The patients were seated in a wheel chair in the first week. Abdominal muscles were strengthened for 3-4 weeks. Then walking braces with abdominal corsets were applied and standing and walking exercises were started in a parallel bar. After 6-8 weeks, a walking program using crutches without assistance was applied.

The results were successful except for last patient. The success and the duration at the rehabilitation program changes according to the psychological status of the patients and full cooperation of the patients is essential.

A NEW METHOD FOR DIFFERENTIATION OF HUMAN LUMBAR VERTEBRAE.

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A better understanding of the anatomy and morphometry of lumbar vertebrae is very important for lumbar vertebral surgery, selection of proper implants and the study of isolated vertebrae by investigators. Morphometrical differentiation of lumbar vertebrae would not only help for the selection and development of proper implants, but would also be useful to investigators who study isolated vertebrae because of the difficulties in obtaining complete sets of vertebrae. In this study, we have developed a new morphometrical method for the differentiation of lumbar vertebrae. Direct Urinary System (DUS) radiographs were used to take a total of 5520 measurements from 2760 lumbar vertebrae in 552 patients. The ratio of the distance between superior articular facets to the distance between corresponding inferior articular facets was calculated for each lumbar vertebra. It was found that these ratios showed a steady decline from L1 to L4. Additionally, it was shown that the levels of an isolated vertebrae can be differentiated by 88.38% accuracy using the critical values characteristic for each vertebra.

MORPHOMETRY OF LOWER THORACIC AND LUMBAR VERTEBRAE (A clinico-anatomical study).

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Instrumentation techniques of the spine, especially lower thoracic and lumbar region, have become increasingly popular as a form of spinal fixation. Because many implants have been devised. or are being developed, it is important to have detailed knowledge of vertebral anatomy and morphometry. Since vertebrae have varying characteristics, selection of appropriate surgical techniques and implants becomes crucial. This study, which was used in many vertebrae by direct measurements, aims to determine more detailed anatomical and morphometrical data on the lower thoracic and lumbar vertebral surgery than could be found in the existing literature. A total of 22464 measurements were taken from 702 human vertebrae between T11-L5. We obtained detailed data which can be used in vertebral surgery, selection of appropriate implants and desing of surgical instruments.

MORPHOMETRIC EVALUATION OF LOWER THORACIC AND LUMBAR
VERTEBRAE BY CT ANALYSIS

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In Ankara University İbn-i Sina Hospital, between The Clinics of Orthopaedics & Traumatology and Radiology a prospective study was performed, in a study group of randomized 20 patients that were evaluated by CT Scan. Some parametres important for transpedicular fixation including cancellous and bicortical transverse pedicle diameters, sagittal pedicle diameter, transverse and antero-posterior diameter of the spinal canal, distance between the pedicle and anterior border of the corpus vertebrae, anteroposterior, transverse, sagittal diametres of corpus vertebrae and angle of between pedicle and corpus vertebrae were investigated.

Between T-8 and L-5, each vertebrae was analysed and evaluated according to age, sex and localization, in the purpose of minimizing the difficulties during transpedicular fixation.

THE RESULTS OF BIOMECHANICAL EXPERIMENTS IN DIFFERENT APPLICATIONS OF ALICI SPINAL SYSTEM

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The Alici Spinal System, which is used for the treatment of different spinal deformations, and for the reduction and stabilizations of traumatic spinal lesions, has been analyzed biomechanically on bull spines.

Five segments of bull spines which were identical age and including the same levels has been obtained freshly. In Group 1 anteriorly screw, in Group 2 posteriorly transpedicular screw, in Group 3 postero-superiorly hook postero-inferiorly transpedicular screw and in Group 4 posteriorly hook application has been performed. In Group 2, 3 and 4 transvers connections has been applied. After the compilation of stabilization, anterior and middle columns of intermediate vertebra was destroyed by means of osteotom. In all groups, top and bottom vertebrae were put in polyester blocks which makes force application possible without destruction in two ends.

The samples were put in Instron 1114 type machine for pressing test. The results were recorded as graphically. Each group was tested 7 times and results were analyzed statistically.

EFFECT OF AUTOCLAVING ON MECHANICAL STRENGTH OF ALICI SPINAL RODS AND TRANSPEDICULAR SCREWS -MECHANICAL EXPERIMENT-

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High temperature affects carbon bound of metals and their mechanical properties change.

ALICI Spinal Instrumentation system is offered to the surgeon as an set of different size implants. After each operation missed ones are completed. Therefore one can find different times autoclovised implants in the same set.

A mechanical study was performed to evaluate if autoclaving has any effect on mechanical strength of ALICI Spinal Implants.

A total of twelve 15 mm ALICI rod and twelve 45 mm transpedicular screw obtained from factory were divided in groups, two screw and two rod in each. Group were autoclovised 0, 5, 10, 15, 20, 25 times. Each autoclavisation was performed at separate days.

At 'TSE', tensile strength of transpedicular screws and 3 point bending strength of rods were checked on Instron ® machine by applying load 5 cm/min. Stress - strain graphs of each implant was drawn. Ultimate loads were found to be between 135 - 140 kgs for rods and 1240 - 1300 kgs for transpedicular screws.

There wasn't any significant difference between the groups. In conclusion autoclaving doesn't change mechanical strength of ALICI Spinal Instrumentation.

Call for A Consensus on Vertebra Tests

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In recent years, the number of tests performed on vertebrae and the number of related papers have reached such a large number that a proper assesment of all the data that have been gathered seems to be difficult. There is now a need for standardization studies. The problems are (i) the determination of the criteria to be followed in the material selection, (ii) the choice of the parameters to be studied and (iii) the interperation of the test results.

Experimental studies are mainly performed on calf spines, polyester imitations and fresh cadaveric specimens. It is commonly stated that calf spines exhibit uniform stiffness among specimens. There is, however, no definition of uniformity. In addition, there is no universal consensus on the number of samples and the number of vertebrae to be tested. Accordingly, we need a standard describing "determination, verification and application of precision data" and "the requirements for laboratories". The temperature and the humidity of the laboratory and the pre-test freezing temperature of the spinal specimens should be standardised. Cross head speeds, number of cycles, maximum applied load values, upper and lower limits of loads or displacements in cyclic loading, preload values, measures taken to decelerate biological deterioration during tests, test time, etc. largely differ. In order to see the affect of the above mentioned parameters in axial and cyclic loading of vertebrae, we have performed a series of tests in our laboratory. We believe that if a consensus is reached for (i) the criteria for the selection of the test materials, (ii) the test conditions, the interpretation of test results will be more uniform and the conclusion will be more realistic.

EVALUATION OF THE PATHOLOGY IN IDIOPATHIC SCOLIOSIS BY USING 3-D COMPUTERIZED TOMOGRAPHY

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One way to observe the deformity of the scoliosis spine is to assess each anatomic unit, vertebra and vertebral disc separately.

Aim: In this study, three dimensional deformities of scoliotic vertebrae were quantified by three dimensional computerized tomography (CT).

Material and Method: 30 patients (10 males and 20 females) underwent CT analysis in axial plane. Six congenital scoliosis and three left thoracic scoliosis were excluded. Average age was 14,5 years (10-29). AP and lateral radiograms, selected plane radiograms and CT examinations were done (GE 9800 scanner) in axial plane with 5 mm. continued slice thickness from C7 to S1.

There were 16 right thoracic; 7 right thoracic-left lumbar; 3 right thoracolumbar, 1 double thoracic, 3 left thoracic curves. Curve magnitudes both in frontal and sagittal planes (Cobb method), convex and concave side height differences in frontal plane, anterior and posterior wall height differences in sagittal plane were measured. On CT images: vertebral rotation, convex and concave side height measurements, angle of scoliosis of individual vertebrae on coronal reconstruction images, anterior and posterior vertebral body height measurements, determination of lordotic or kyphotic nature of individual vertebra, apical and adjacent vertebral analysis on 3-D reconstruction images were done.

Results: Mean frontal plane Cobb angle measurement was 40 degrees (16° to 88°). Although kyphosis was noted on lateral radiograms, lordosis was evident in thoracic apical segment in selected plain radiograms. This was confirmed on 2-D and 3-D reconstructions of the spinal column. Apical and adjacent vertebrae were significantly wedged on frontal plane, convex side being 3 to 6 mm higher than the concave side. Wedging of the vertebra increased as curve magnitude increased. When coronal plane though the superior and inferior end plates analyzed, either lordosis or neutral vertebral bodies were noted.

Conclusion : Spine was lordotic at sagittal profile in idiopathic scoliosis, Apical one or two vertebrae were observed to be distinctly wedged in coronal plane, and wedging is proportional to the curve magnitude; this lordotic component was evident in minor forms of idiopathic scoliosis; the degree of the deformity at axial and frontal planes were directly proportional between each other. On the other hand the degree of the sagittal plane deformity was not related with the degree of the axial and frontal plane deformity, left thoracic curve pattern did not show the characteristic properties of the idiopathic scoliosis; all vertebrae in the deformity showed structural changes.

EARLY RESULTS OF ALICI SPINAL INSTRUMENTS IN THE TREATMENT OF IDIOPATHIC ADOLESCENT SCOLIOSIS

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34 cases of idiopathic scoliosis have been treated surgically with ALICI Spinal Instrumentation in our clinic during the period between January 1991 and December 1993.

There were 19 female and 15 male with an average age of 15.6 (12 - 23) years. Thirty-five percent of the curves were type I, 25.6 % were type II, 29.5 % were type III, 9 % were type IV according to King Moe classification.

On preoperative radiographs mean thoracic Cobb angle was found to be 63.5 (42 - 86) degrees and mean lumbar Cobb angle 33.2 (22 - 48) degrees. On sagittal plane analysis mean 21.5 degrees of thoracic khyphosis were measured.

Postoperatively mean thoracic curve were measured 31.3 degrees. The average correction was 32.2 degrees (50.7 %).

COMBINED ANTERIOR AND POSTERIOR SURGERY FOR THE TREATMENT OF RIGID IDIOPATHIC SCOLIOSIS

Şükrü SOLAK, İ. Teoman BENLİ, Erbil AYDIN,
Mahmut KIŞ, Mert TÜZÜNER, Serdar AKALIN

Posterior instrumentation isn't sufficient generally for the correction of rigid idiopathic thoracal or lumbar curves; over correction invites the neurological complications, anterior release is absolutly necessary for this reason. Twenty-one rigid idiopathic scoliosis cases have been treated by combined anterior and posterior surgery. With TSRH instrumentation from November 1991 to May 1994 with a mean of 12.4 months. Twelve patients underwent combined surgery in two operative times while 9 others patients have been operated for two stages in the same operative time. Preoperatively mean frontal plane Cobb angle of the curves was 74° and mean postoperative Cobb angle correction was 49.7 %. Physiological thoracal kyphosis has been obtained on 16 cases. There was no early or late postoperative complications except one patient. This patient had incomplet paraplegia postoperatively and had been improved completely during follow-up period. We concluded that anterior release for idiopathic scoliosis curves could be performed in the same operative time with posterior instrumentation and fusion an protection of segmental vertebral vessels reduce neurological deficit rish during anterior surgical procedure.

RESULTS OF SURGICAL INSTRUMENTATION OF ADULT IDIOPATHIC SCOLIOSIS

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Mahmut KIŞ, Serdar AKALIN, Serhan ÖZLÜ

When compared with the adolescent patients surgical treatment of adult idiopathic scoliosis is a challenging problem. In adults, curves are more rigid and risk of neurologic deficit is higher. In this study, 23 patients, treated in 1st Orthopaedics and Traumatology Department of Ankara Social Security Hospital, between December 1989 and December 1993 were evaluated. 11 of the patients were instrumented with Cotrel - Dubousset (CDI) system and the remaining 12 were instrumented with Texas Scottish Rite Hospital (TSRH) system. Preoperative mean Cobb angles were $56.6^{\circ} \pm 10.7$ CDI group and $68.8^{\circ} \pm 11.4^{\circ}$ in TSRH group. Postoperative correction percentages in Cobb angles were 51.5 ± 7.7 % CDI and 58.1 ± 6.8 % for TSRH group. When all patients are taken into consideration mean correction of major curves was 54.9 ± 12.1 %. Relief of pain was seen in 82.6 % of the patients. In light of these data, we concluded that both of these systems are efficient in the treatment of selected adult idiopathic scoliosis cases.

THE RESULTS OF THE SALVAGE AND THE REVISION PROCEDURES OF SPINAL DEFORMITIES TREATED WITH VARIOUS INSTRUMENTATION SYSTEMS

Serdar AKALIN, İ.Teoman BENLİ, Mahmut KIŞ,
Mert TÜZÜNER, Erbil AYDIN, Mehmet ÇITAK

In the recent years, the improvement in the instrumentation systems and perfection of the treatment strategies have led to decrease a great deal in pseudoarthrosis and implant failure rates in the surgical treatment of spinal deformities. In this study, 313 cases were evaluated whom were surgically treated with various spinal implant systems due to their spinal deformities at the Orthopaedic and Traumatology Clinics of Ankara Social Security Hospital between December 1989 and December 1993. Of all these 212 patients had idiopathic scoliosis and 101 had vertebral fractures. It was determined that 101 patents had Cotrel - Dubousset Instrumentation (CDI), 151 patient had Texas Scottish Rite Hospital (TSRH) System, 30 patients had Hartshill Rectangle Sublaminar Wiring (HR - SSW) and 31 patients had AO Internal Fixator (AOIF). In the follow - up period, 14 patients had superficial and deep wound infection, 19 patients had rod breakage and hook dislodgement and 7 patients had pseudoarthrosis and revision surgery. The superficial infection have been eradicated without implant removal in 5 patients. The implants were removed in 9 patients whom had deep wound infection and any other instrumentation weren't performed as any pseudoarthrosis area have not been observed during surgery. These patients whom had implant failure were revised with TSRH crosslinked plates or CDI dominos without implant removal. In 10 patients, a one stage posterior instrumentation or anterior release followed by posterior instrumentation has been performed after implant removal and correction losses were significantly restored. In the patients whom had pseudoarthrosis, a solid fusion mass has been obtained after revision surgery. It is suggested that with appropriate planning and adequate fusion, implant failures and pseudoarthrosis rates can be reduced, theremore with use of easily revised systems, an advantage can be obtained.

**ORIGINAL ABSTRACT FORM FOR 3RD INTERNATIONAL
CONGRESS ON SPINE SURGERY**

DESMOPRESSIN IN SCOLIOSIS SURGERY

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To decrease blood loss in scoliosis surgery we studied the effect of desmopressin (1-deamino-8-D-arginin vasopressin) in operated patients. Fifteen minutes prior to the operation, 0.3--- desmopressin in 100 ml of %0.9 NaCl solution or only 100 ml of %0.9 NaCl solution was infused to the patients who were randomized to the desmopressin (Idiopathic 4, congenital 3, neuromuscular 5, n=12) or placebo (Idiopathic 8, congenital 1, n=9) groups. During the operation, the amount of bleeding, blood transfusion, and fluids were measured every 30 minutes. the patients. The number of fused vertebrae were more in the desmopressin group but this was not statistically significant.

The total blood loss was 700 ml in the desmopressin group and 335 ml in the placebo group ($p=0.13$). When the amount of blood loss per vertebra was calculated, there was no difference between the two groups (75 ml/vertebrae in the desmopressin group, 59 ml/vertebrae in the placebo group, $p=0.28$). The amount of urine collected in the postoperative first 24 hours was 31.6 ml/kg in the desmopressin group and 46.1 ml/kg in the placebo group. There was no statistical difference ($p=0.16$).

Conclusion: Desmopressin does not reduce blood loss in patients undergoing scoliosis surgery and it does not have a clinically important effect on the diuresis.

SURGICAL MANAGEMENT OF CERVICAL SPINE STENOSIS SYNDROME

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Between the years of 1990 and 1994, 19 patients were operated on for cervical spine stenosis in the Department of Neurosurgery of Marmara University Medical School.

Eleven of these patients were male and 8 were female. The mean age was 51.

Computerized tomography was obtained in all cases and Magnetic Resonance Imaging (MRI) scans in 11 cases. All patients were evaluated by MRI in the late postoperative period.

Posterior laminectomy without dural opening was performed on 2 patients. Additionally anterior discectomy was performed on 2 patients.

In this presentation, neuroradiological findings, surgical technique and results are discussed together with a review of the literature. On the postoperative MRI investigations, widening of the subarachnoidal space with an increase in the anteroposterior diameter of the cervical spinal cord were determined. Therefore, in our opinion, simple laminectomy is the technique of choice in the surgical management of cervical spinal stenosis.

ROY-CAMILLE POSTERIOR FIXATION IN CERVICAL TRAUMA

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Lateral mass Roy-Camille posterior fixation technique was performed on 3 patients with cervical trauma admitted to the Department of Neurosurgery of Marmara University Medical School, between January 1993 and April 1994.

Two of these 3 cases were suffering from bilateral facet dislocation and the other patient had unilateral facet dislocation together with lateral mass fracture.

In this presentation, posterior plate stabilization in cervical fracture-dislocations is discussed together with a review of the literature.

POSTERIOR CERVICAL ARTHRODESIS WITH LATERAL MASS PLATING FOR MULTILEVEL CERVICAL DISEASE. Michael Swank, MD, Bill E. Dials, MLA, Chester E. Sutterlin, III, MD

The purpose of this study was to evaluate the results of difficult cervical reconstructions involving three or more levels to determine the applicability, safety, and clinical efficacy of the AXIS™ Fixation System (Danek Medical Inc., Memphis, TN) for lateral mass plating in complex spinal disorders. All patients who received lateral mass plates as an adjunct to posterior cervical fusion using the Axis Fixation System for three or more levels were included regardless of the diagnosis and concomitant additional procedures were included in the study. Twenty patients were enrolled in the study and retrospectively reviewed. The average follow up was 19 months (range: 12 to 26 months). The clinical outcome was known for all patients. The clinical results revealed that 89% of patients stated they were significantly improved, 5.5% stated they were the same, and 5.5% stated they were worse than preoperatively. Three patients, all of whom underwent simultaneous anterior corpectomy and reconstruction, had an increased neurologic deficit postoperatively. One patient who had a C5 motor deficit and one patient who had a C-5 and a C-6 motor deficit postoperatively had no CT evidence of hardware malposition of either the anterior or posterior instrumentation. One patient who had a C-6 sensory radiculopathy had a lateral mass screw which penetrated the cortical margin by 2 mm. Radiographic evaluation of lordosis by the method of Gore revealed an average lordosis of 28.6 degrees (range: 4 to 50) preoperatively and 26.3 degrees postoperatively (range: 2 to 48). The average lordosis over the levels involved in the fusion measured 14.4 degrees preoperatively (range: -6 to 50) and 9.7 degrees postoperatively (range: -12 to 48). All measurements were taken in maximum active extension and the differences were not statistically significant (student's t-test, $p>0.05$). No patient had 2 mm or more on flexion extension radiographs at most recent follow up and all were considered to have radiographic union. There were no plate or screw breakages.

The AXIS Fixation System provided rigid immobilization without the need for a halo orthosis, allowed restoration and maintenance of spinal alignment, and had a low incidence of device related complications in these complex multilevel cervical reconstructions.

EARLY EXPERIENCE WITH CERVICAL LATERAL MASS PLATING FOR POSTERIOR STABILIZATION OF CERVICAL SPINE DISORDERS. Chester E. Sutterlin, III, MD Florida Foundation For Research In Spinal Disorders, Gainesville, Florida.

Posterior cervical fusion is indicated in a number of clinical situations. Current methods for posterior cervical fusion include use of wiring techniques, sublaminar hook-plate devices, and lateral mass plates. Wiring techniques are sub-optimal when rotary, extension or lateral bending forces are applied. In an effort to provide a better method for fixation of the cervical spine from the posterior approach, cervical lateral mass plates were utilized. These new plates are made of titanium and allow for versatile screw positioning and angulation, contouring without effecting screw seating, and minimal post-operative CT/MRI distortion. Forty-three consecutive patients (29 male, 14 female) were retrospectively reviewed. Average age was 52 (range: 28 to 82). Average follow-up was five months (range: 1 to 13 months). Post-operatively, 84% (n=36) of the patients had neurologic improvement, 9% (n=4) stayed the same, and 7% (n=3) got worse. Pain improved in 81% (n=35) of the patients after surgery, 14% (n=6) stayed the same, and 5% (n=2) got worse. There was one case of pseudoarthrosis; 22 patients have solid fusions and 21 are maturing. All plates are intact; none have broken or become dislodged. Based on the results of our early experience one can expect improvement in neurologic function and a reduction in pain in most patients. Complications have been low. Cervical lateral mass plates can be used successfully in treating a variety of cervical spine disorders. The method and technique appear to be safe and effective. Further study is needed to determine the long term efficacy of the system.

ORIGINAL ABSTRACT FORM FOR 3RD INTERNATIONAL CONGRESS ON SPINE SURGERY

We measured the peripheral latency (PL), central motor conduction time (CMCT), and averaged long loop reflex elicited with taps in intrinsic hand muscle (abductor pollicis brevis muscle) of the nine cervical spondylotic myelopathy patients before and one month after cervical laminoplasty. And we counted the grasp-release times of the hands (grasp-release test) during 10 seconds regarding as a neurological sign of the damage on pyramidal tract. PL were not changed between pre- and post- operation. CMCT that was 12.6 ± 4.9 ms before laminoplasty was shortened to 11.4 ± 5.8 ms. Patients whose CMCT were under 12ms were rated good in grasp-release test but those whose CMCT were delayed rated poor. Peak latency of segmental reflex(T1-wave) was 33.9 ± 3.5 ms and that of long loop reflex(T2-wave) was 59.5 ± 3.7 ms before operation. At one month from operation, peak latency of T1-wave was 34.7 ± 3.5 ms and that of T2-wave was 58.8 ± 3.3 ms. Peak latency difference between T1-wave and T2-wave was 25.9 ± 3.6 ms before operation and that was 24.7 ± 2.3 ms. This peak latency difference between T1-wave and T2-wave was related well with CMCT. Good recovery after operation was found in 7 patients (14 hands) with T2 wave before operation, but in two patients (4 hands) without T2-wave recovery was poor.

CRANIOSERVICAL STABILIZATION WITH MODIFIED
ISOLA INTERNAL FIXATION SYSTEM: CASE REPORT

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Orthopaedics

New radiological techniques enable us to diagnose the cranioservical instabilities. For stabilization, various methods have been used including bone grafts, wire loops and Halifax interlaminar clamps. Modified isola internal fixation method was successfully used in one case in the Department of Neurosurgery University of Ankara. A significant improvement was observed.

In this report, the causes of cranioservical instability, posterior fixation methods, their indications and surgical techniques are discussed according to literature.

Surgical Treatment of Spinal Stenosis.

M Caniklioğlu, C Mirzanlı, N Azar, M Mert, M Karamehmetoğlu (TÜRKIYE)

It is defined as spinal stenosis that spinal canal , neural canal and foramina lose their normal width by bone , soft tissue or both ; and surgical indication exists only , if neurologic deficit and its progression present . In vertebral degenerative cases , decompressive surgery does not prevent degenerative development and its aim is only to release . By continuation of stenozan factor , in the long period spinal canal or lateral stenosis repeatation is possible .

In SSK Istanbul Hospital 2nd Orthopaedic and Traumatology Department between May 5 , 1992 , and August 3 , 1993 in ten cases (9 female - 1 male) , for treatment of their spinal stenosis ' s neurologic symptoms , posterior - postero - lateral decompression + posterior instrumentation + posterior and posterolateral fusion have been performed . Preoperatively , all cases had had neurologic deficit , and spinal stenosis was established by CT or / and MRI . Average patient age is 56.3 years (youngest 35 , oldest 63) . In all cases etyology is degenerative stenosis . Spondylolisthetic patients were excluded from this study .

Seven cases which can be followed had been evaluated in May 1994 . Average follow - up time is 13 months (between 9 and 24 months) . Evaluation have been made according to Oswestry , Katz , Frankel criterias and Dennis pain - work scale . By the end of follow - up , in three cases , all neurologic symptoms had been improved . In three cases had been improved according to preoperative sypmtoms , but they have rarely nerve root irritation findings . one case have been stating no difference in her complaints.

Some authors think that posterior decompression (laminectomy or laminotomy) is enough in spinal stenosis , but we consider that it is necessary to add posterior instrumentation and posterior fusion to this procedure for prevent posterior instability which may be developed in the end of this method .

The Clinical Characteristics of the Patients with Spinal Cord Lesion Treated at Our Department in the Last Two Years.

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In this study 24 paraplegic cases rehabilitated at our department in the last two years have been retrospectively analysed.

The cases were examined with respect to their age, sex, etiology, period of illness, operation, in the light of which clinical findings were administered, therapy offered to them and functional conditions. In the assessment of the cases the Frankel scale has been used.

14 of the cases (58.33 %) were male, and 10 of them (41.67 %) female. Their average age was 37.63 ± 11.82 and their ages were ranging from 17 to 60. The average period of paraplegia was 80.42 ± 135.54 days, and varied from 9 to 600 days. The cases, when etiologically viewed were as follows: 17 cases (70.83 %) traumatic, 2 cases (8.33%) tumorous; 2 cases (8.33%) suffered from vascular causes, 1 case (4.17 %), from multiple sclerosis, 1 case (4.17 %), from cervical disk hernia (C6-C7), 1 case (4.17%) was linked to myelitis. The functional level difference among the cases was statistically studied.

Diastematomyelia.

S Pedükcoşkun (TÜRKİYE)

From 1992 to 1994, 3 patients with diastematomyelia were treated. This anomaly is very rare and characterized by a duplication of the spinal cord with a band or a spur, which is attached to the corpus of the vertebra.

Because of the difference between the growth rates of the bony vertebral canal and the spinal cord, in the neurologic signs appear and become serious.

The surgical treatment must be done as soon as the diagnosis is made.

We've done laminectomy, posterior fusion, spur excision and applied Harrington instrumentation for one patient.

Lumbar spinal canal stenosis in osteopoikilosis

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Nadir ŞENER**

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Osteopoikilosis which is unusual bone dysplasia is usually detected as an incidental roentgenographic finding. Osteopoikilosis, which has characteristic radiologic appearance, normally requires no treatment. Recently some pathologic conditions and developmental disturbances coexisting with osteopoikilosis has been described. One of them is lumbar spinal canal stenosis and may require surgical treatment.

The diagnosis of the patient, with a two year history of low back pain , was made from typical radiologic lesions seen on his intravenous pyelography taken in the Urology clinic . Computerized tomography scanning of the lumbar spine shows narrowing between L1-L5 in both anteroposterior and transvers diameters and in all sections spinal canal diameter was less than 10 mm. Because of the presence of neurogenic claudication, that affected daily activities of the patient recently , decompression was achieved by laminectomy and foraminotomy between L1-L5. The instability hence created was stabilized by Compact CD instrumentation and posterolateral fusion. The complaints were relieved in the postoperative period.

This case shows that osteopoikilosis and spinal canal stenosis may coexist, and that spinal canal should be investigated in patients with osteopoikilosis.

***EXTREME LATERAL DISC HERNIATIONS and
PARALATERAL DECOMPRESSION***

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Recent advances in imaging techniques have made possible to diagnose extreme lateral disc herniations more frequently. Herniated disc material causes to compression to root in the foramen. Majority of these herniations are seen at the L4-5 level, and characterized by sudden onset of severe leg pain. Back pain is usually minor. Straight leg raising is mildly positive, but femoral stretch test is highly positive. Conservative treatment usually fails in these patients. Surgical decompression is difficult by using classical hemilaminectomy. Because of herniated material is in the "hidden zone of Macnab", it is necessary to perform complete facetectomy which is undesirable. The paralateral muscle splitting approach enables surgeons to remove disc herniation without entering the spinal canal. It saves pars interarticularis and the inferior facet. In this paper, we would like to present two typical cases of extreme lateral disc herniations treated by paralateral approach.

(Key words: Extreme lateral disc herniation, paralateral approach)

Surgical Treatment of Scheuerman Kyphosis.

C Mirzanlı, M Caniklioğlu, N Azar, M Karamehmetoğlu, M Mert

Scheuerman Kyphosis, which is one of the most commonly seen thoracic and thoracolumbar structural kyphosis, may efficiently be treated and of which progression may effectively be stopped by conservative treatment methods. Nevertheless, pain and cosmetic appearance of deformity refer orthopaedists to choose surgical treatment modalities.

Fourteen patients (8 male, 6 female) treated surgically from October 1991 to May 1994 in SSK İstanbul Hospital 2.nd Orthopaedics and Traumatology Clinic. Average follow-up period was 17 months (Shortest 6 months, longest 30 months), and mean age was 16.8 years. (Youngest 12 years, oldest 36 years)

Occurance of unacceptable cosmetic deformity and pain were the criterion for the surgical treatment in our series. Posterior instrumentation and fusion in 9 patients, both anterior release along with posterior fusion and instrumentation in 3 patients and one or two level posterior wedge osteotomy, posterior instrumentation and fusion operations in 2 patients were performed.

Preoperative mean kyphosis angle using Cobb method was 78 degrees, and average postoperative correction was 38 degrees. Fusion was detected approximately within 26 weeks. Ten degrees or more correction loss was measured in latest follow-up radiographic control of four patients. Dislodgment of hooks placed in upper end vertebrae in two patients, and loosening and pull-out of screws in lower vertebra in two patients, of whom operations were revised later on, were detected.

Short term follow-up results showed us that, although in patients with uncompleted skeletal maturity, posterior instrumentation and fusion is sufficient for surgical correction of deformity; in patients with mature skeleton, since deformity is rigid, combined anterior and posterior fusion operations should be performed. While selecting the level of fusion, problems in maintaining and preservation of correction should be kept in mind.

EGG-SHELL PROCEDURE IN CORRECTION OF NEGLECTED CASES OF POTT'S KYPHOSIS

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Residual kyphosis secondary to old and healed cases of spinal tuberculosis causing disability are still encountered. The standart double stage operation with anterior osteotomy and posterior instrumentation and correction has its drawbacks. We planned to employ the Egg-shell procedure to treat lumbar Pott's kyphosis in a single stage operation.

Three patients with lumbar Pott's kyphosis (at L1, L2-3 and L5 respectively) were operated with a single stage posterior approach by evacuation of the wedged vertebral body via the transpedicular route. After the insertion of pedicular screws above and below, correction was obtained by collapse of the Egg-shelled segment. There were no neurological complications. The pre- and postoperative kyphosis angles were as follows: 97° - 37° , 95° - 42° , 37° - (-10°) respectively. The average correction was $53,3^{\circ}$ mean. The patients were mobilized carefully within the first postoperative week with light orthoses. They healed uneventfully and returned to active social life within six to nine months.

Conclusion: The Egg-shell procedure is a safe and reliable method in the correction of short segmented, sharp kyphosis like the deformities seen in Pott's disease. In this single stage operation the patient encounters less morbidity and early fusion is usually obtained.

FREE PAPER

PEDIATRIC INTRASPINAL TUMORS

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Intraspinal tumors in infancy and childhood create diagnostic problems different than those of adults. Muscle weakness, back pain, gait disturbance, rigidity, and sphincter dysfunction are the most common presenting symptoms. In all intraspinal tumor cases the clinical signs and symptoms are progressive, and the neurological deficits due to cord compression are almost irreversible; but in the pediatric group, the patient has a high chance of being ambulatory with early diagnosis and appropriate treatment.

Although plain roentgenography and myelography are suggestive, CT and MRI must be performed for accurate diagnosis and follow-up of these patients. In addition to microneurosurgical dissection, intra-operative ultrasonography, SEP monitoring, CUSA, and lasers may be used to achieve maximal tumor removal with minimal neurologic deficit. When total removal of the tumor will result in additional neurological deficits, it should be avoided.

Between the years 1965-1994, 103 patients younger than 15 years of age were operated in Ankara University, Department of Neurosurgery. Most of the tumors were located extradurally, in the thoracic region. Primary spinal tumors constituted the major histopathological group. Nearly 2/3 of the patients' clinical condition improved post-operatively.

To obtain the best results in the treatment of pediatric intraspinal tumors, we advocate early surgical intervention followed by radiotherapy and/or chemotherapy combined with a physical rehabilitation programme.

Benign Tumors of the Spine Children.

H Ağuş (TÜRKİYE)

We would like to present three kinds of the benign tumors of the spine.

From 1988 to 1994 3 patients with benign tumors of the spine were treated in our clinic.

Osteochondroma, aneurysmal bone cyst, and osteoid osteoma were treated with laminectomy and resection of the tumor. Stabilisation was obtained with bone grafts and recurrence wasn't seen in the follow up period up to this time.

**VERTEBRAL HEMANGIOMA
PRESENTING WITH INTERMITTENT WEAKNESS AND PARESTHESIA
AT THE LOWER EXTREMITIES**

Muharrem YAZICI, MD, Ömer L IYIGUN, MD, Birol GULMAN, MD

Cemil RAKUNT, MD

Study Design : A patient with vertebral hemangioma and unusual clinical presentation is reported.

Objectives : The report describes and attempts to explain these unusual clinical complaints.

Summary of Background Data : Vertebral hemangioma is a common and often asymptomatic tumor. The neurologic symptoms may appear with the pressure on the neural tissue caused by extraosseous extension.

Method : The patient presented with intermittent weakness and paresthesia at the lower extremities. Conventional radiographs, CT and MRI slices revealed vertebral hemangioma at the T 5 vertebra and extraosseous extension compressing the spinal cord. Gravity related vascular dilatation may induce further compression of the spinal cord and, thus, is thought to be the underlying event in the induction of the intermittent clinical symptoms.

Result : Lesion was treated with subtotal corpectomy after embolization and fusion with strut iliac crest graft. Post-operative 4 month follow-up of the patient is without complaints.

Conclusion : Vertebral hemangioma should be thought of in cases with intermittent neurological symptoms at the lower extremities.

ANTERIOR OR POSTERIOR STABILIZATION FOR PRIMARY AND METASTATIC SPINAL TUMORS

E. Faruk MUMCU, İ. Teoman BENLİ, Serdar AKALIN,
Mahmut KIŞ, Hakan ARSLAN

Vertebral column is one of the most frequent sites that metastatic malignant tumors are seen. Primary spinal tumors and metastatic tumors decreases the resistance of vertebral column to trauma and frequently causes pathologic fractures prone to progressive painful spinal deformities. In this study a sum of 9 patients with 2 primary vertebra tumor, 5 metastatic tumor and 2 medulla spinalis originated tumors are evaluated. Five patients were female and 4 were male. Seven patients had pathological fracture and two of these had bilateral fasetectomy and complet laminectomy after medulla spinalis tumor. Posterior instrumentation was performed in 6 (CDI : 1, Hartshill : 1, TSRH : 4) patients and 3 had anterior instrumentation (AO-CLP : 1, Keneda : 1, TSRH : 4). The mean sagittal index which was 28.3° was corrected by 59.9 %. Physiological sagittal contours were provided in all patients and their functural capacities were significantly increased.

In light of these findings it is thought that posterior or anterior instrumentation is very important in the treatment of painful instabilities to provide a functional life without pain in the primary or metastatic spinal tumors.

OSTEOCHONDROMA OF THE CERVICAL VERTEBRA: A CASE REPORT:

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Osteochondroma is rarely seen (0.86-3.1 %) in the axial skeleton. This incidence rises to 7 % in Multiple Hereditary Exostosis patients. Vertebral osteochondroma is usually localized in the arches and spinous processes of the cervical and thoracic vertebrae. In our clinic we treated a case with an osteochondroma at the first cervical vertebrae. The lesion was in the posterior part of the C1 vertebrae and was localized closely to the occiput and C2 vertebra narrowing the foramen. The lesion was lobulated. The tumor was excised completely. There were no complications in the early postoperative period. At two years follow-up, the patient had no recurrence and neurologic deficit. This case was a great challenge to the surgeon because of its localization.

VERTEBRAL OSTEOLASTOMA: REPORT OF THREE CASES.

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Osteoblastoma of the spine is rare, accounting for 5 to 10.6% of primary bone tumors of the spine other than myeloma. About 25 to 40% of the osteoblastomas occur in the axial skeleton. They are most often in the lumbar, thoracic, cervical spine and sacrum in that order. Here, we report three cases of osteoblastoma that occurred in the first, second , and fourth lumbar vertebrae. The patients were sixteen, fourteen, and fifteen years old respectively. The follow up was more than one year for all patients. Low back pain was the most prominent symptom. All three were treated with marginal surgical excision. At last follow up, no evidence of recurrence was observed.

POSTOPERATIVE SPINAL INFECTIONS

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Süheyla Öztürk M.D. Cem Gökçe M.D.

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One hundred and five patients had surgical spine operations. Nine patients who had wound infections were studied microbiologically.

Among nine patients, K(+) staphylococcus were isolated in four cases (44 %), Klebsiella in two cases (22 %), E.coli in one case. In two cases, no growth were seen.

The postoperative wound infection after spine surgery was seen 8.5 % and we noticed that coagulase (+) staphylacoccus was the most common patogen.

TUBERCULOSIS OF THE LOWER CERVICAL SPINE (C2 TO C7)

**Mehmet DEMİRHAN, Azmi HAMZAOĞLU, Cüneyt ŞAR,
Mustafa ŞENGÜN, Cengiz ŞEN**

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Since 1987, over 150 patients with tuberculosis of the spine have been examined in our clinic. The cervical spine was affected in 6 of them. We report here 4 of these patients. The remaining 2 had tuberculosis of the atlanto-axial joint.

Pain and stiffness were important and dominant symptoms. In the adult type, the disease is much more localized and produces pus. Often, it presents as a destructive lesion in a single vertebral body which may be difficult to differentiate from metastatic disease in the elderly.

The age of patients at the time of presentation ranged from 18 to 43 years. The average number of vertebral bodies involved was 2.5. The fifth cervical vertebra was most commonly involved. Cord compression particularly in adults is common. The incidence of cord compression was 75 percent (3 out of 4) in our series.

The commonest method of treatment was with antituberculous drugs, anterior excision of the diseased bone and grafting. The anterior operation was done through the simple Southwick-Robinson anterior approach which effectively and rapidly relieved pain. It was also effective in the rapid resolution of cord compression.

There was full recovery in cases with neurologic deficit at the end of the treatment.

Classification and Treatment of Tuberculous Sacroiliitis

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Involvement of the sacroiliac joint has been reported up to 9.5% of patients with skeletal involvement. we could not find any classification of the sacroiliac tuberculosis for clinical use in the literature.

The purpose of the study was to classify tuberculous sacroiliitis newly by radiologic studies and clinical findings and to suggest the appropriate treatment according to each group. For this study, 13 patients who were treated with tuberculous sacroiliitis were reviewed. Radiological findings from the anteroposterior and oblique plain films of the lesion site were compared with those of unaffected site. We also reviewed the computerized tomographs and clinical features for classification and disease progression after treatment. In all patients, the follow up period was more than two years.

The classification was as follows; type I (widening of sacroiliac joint space and blurring of the margin of sacroiliac joint); one case, type II (mild erosion of the sacroiliac joint); three cases, type III (severe destruction of the sacroiliac joint with cyst formation and sclerosis); four cases, type IV (lesion of sacroiliac joint with inguinal or gluteal abscess and/or other spinal tuberculosis); five cases. Cases of the type I and type II had been treated with only antituberculous medication and the cases of the type III and type IV had been treated with curettage, arthrodesis, and antituberculous medication. The fusion of sacroiliac joint was obtained at 23 months after treatment in the patients with type I or type II lesion, and at 22 months after operation in the patients with type III or type IV lesion. There was no recurrence. The site of the lesion was located lower portion of the sacroiliac joint. The destruction and sclerosis of ilium was more severe than that of sacrum in all cases. The drainage of abscess, curettage, and arthrodesis were appropriate treatments for type III and type IV lesion of the our new classification. The surgery increases the local effect of the antituberculous medication and offers pathological diagnosis. In conclusion, the new classification was suggested to be helpful to decide the treatment regimen.

TUBERCULOSIS OF SPINAL COLUMN

ALTINMAKAS,M,MD, AYDOĞAN,N,MD, ŞEHİRLİOĞLU,A,MD, SOLAKOĞLU,C,MD.

Tuberculosis primarily effects the corpus and disc space of spinal column. The increased incidence of Pott disease and complications related to this disease have driven more attention to this situation lately.

Back pain, radicular pain and cold abcess formation are the common features of this disease.

We operated 11 patients with Pott disease in the Orthopaedics and Traumatology Department of Gülhane Military Medical Academy between 1988 and 1994. 8 of the patients were male and 3 were female. Average age of the patients was 21(Range 18-25)..

There was decrease in anterior corpus height in 5 of the cases, and narrowing of the disc space in 3 of the cases, and psoas abcess in 3 of the cases. The damage in the corpus and the size of abcess is determined with the preoperative CT and MRI.

Abcess drainage, clearance of necrotic bone, anterior bone graphing together with anti-tb. treatment was applied to the cases with degeneration of corpus.

While the bodycast was applied in first 3 months postoperatively, the anti-tb. treatment was discontinued until 9 months.

The best surgical treatment in Pott disease could not be achieved until all the necrotic tissue is removed and abcess is drained completely. Also on anterior fusion is necessary in this particular condition.

THE RESULTS OF SURGICAL TREATMENT IN SPINAL TUBERCULOSIS

Tuğrul Berkel (1), Hasan Dermesin (2), Mehmet Ünalı (3), İsmail Yedek (4),
Bülent Kavaklı (4)

SUMMARY

10 patients with spinal tuberculosis were treated surgically in the Orthopaedics and Traumatology Clinic 1 of the Kartal Education and Research Hospital between 1989 and 1993. 2 of 10 patients were women and 8 were men. Average patient age was 37, ranging from 16 to 58.

Localization of the lesions were as follows; in 3 patients thoracic, in 2 patients thoracolumbar, in 4 patients lumbar and in 1 patient thoracic and lumbar (two segments involvement). 5 patients had neurologic deficits.

Anterior drainage and fusion procedures were used in 8 patients and the remaining 2 patients were treated by anterolateral drainage.

After an average 33.5 months (9-62) follow up time the radiological, clinical, laboratory and neurological improvements were analyzed. 4 of 5 patients who had neurologic deficits completely resolved and 1 of them returned from Frankel C to Frankel D.

Anterior fusion was obtained average 10 months later after the surgical procedure in 7 of 8 patients. Delayed union and progressive kyphosis were seen in 1 patient because of graft resorption.

In the treatment of the spinal tuberculosis chemotherapy is mandatory and although in surgical treatment anterior radical procedure is superior, anterolateral drainage may be effective in selected cases.

Key words: Spinal Tuberculosis, Surgical Treatment.

TUBERCULOSIS OF THE THOROCOLUMBAR SPINE

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ÖZCAN, Z., M.D., AKDAL, R., M.D.

Treatment of Pott's disease has not been clarified until recently. In our country, the incidence of tuberculous spondylitis is relatively high. Between 1988 and 1993, in 18 tuberculous spondylitis we treated with bed rest and / or operative treatment with antituberculous drug therapy. 10 of the patients were female, 8 of them were male and average age being 50. The average follow-up period was 19 months. (range 6 to 38) All patients were evaluated according to laboratory findings, A-P and lateral vertebra roentgenograms and Magnetic Resonance Imaging. The levels of Pott's disease were determined from T6 to T10. Incomplete paraplegia was recorded which all cases are operated. In operative treatment we preferred anterior fusion without spinal instrumentations after radical debridement. Antituberculous therapy as usually streptomycin, rifampicin, isoniazid and ethambutol in standard dosages is started 15 days at least before surgery. Bony fusion occurred substantially earlier and there was no increase in kyphosis. In operated cases paraplegia was decreased in the postoperative period. In nonoperative treatment included bed rest for three months with TLS orthoses.

Nowadays, tuberculosis of the spine is the significant disease which caused highly morbidity in developing countries. For this reason, it's treatment is very important.

POSTERIOR FUSION AND INSTRUMENTATION AFTER ANTERIOR RADICAL DEBRIDMENT AND FUSION IN THE SURGICAL TREATMENT OF POTT'S DISEASE

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Immobilization and progressive kyphosis are the major postoperative problems encountered after anterior radical surgical treatment for tuberculosis of the spine. Posterior fusion and instrumentation can be the effective solution for these problems. In this study, the indications and clinical results of posterior stabilization operations following anterior surgery are discussed and the importance of posterior stabilization is emphasized.

Eighty-five cases of tuberculosis of the spine were surgically treated between 1987 and 1993. In 57 of these cases was only the anterior radical procedure used. Eight cases younger than 8 had anterior procedure and posterior fusion without instrumentation. Remaining 20 cases had anterior procedure and posterior fusion with Cotrel-Dubousset instrumentation. Follow-up period ranges from 6.2 years to 12 months (mean 39.2 mo.).

Our results suggest that posterior spinal fusion and posterior stabilization following anterior debridement is superior to anterior surgery alone. The advantages of this technique are the achievement of better sagittal and coronal balance, minimal risk of loss of correction and pseudoarthrosis, early ambulation and return to daily activities and early discharge from the hospital.

THE USE OF INTRAOPERATIVE AUTOTRANSFUSION IN ORTHOPAEDIC PATIENTS

Mahmut KILIÇ, Erbil AYDIN, Mert TÜZÜNER,
Mahmut GİDER, Şükrü SOLAK, Tibet ALTUĞ

The use of homologous blood transfusion should be minimized to reduce the risks of transfusion including transfer of HBV and HIV. This aim can be achieved by hypotensive anesthesia or autolog blood transfusion either by predeposited blood or intraoperative autotransfusion. This study evaluates the results of intraoperative autotransfusion in 134 patients who were operated between June 1991 and April 1994. Twenty one of the operations were revision surgery of total hip replacement while 12 of them were primary cementless total hip replacement, 20 were posterior vertebral instrumentation for vertebral fractures, 15 were anterior discectomies either for infection or treatment of scoliosis, 4 were one - stage anterior discectomy and posterior instrumentation, 62 were correction and posterior instrumentation for scoliosis. The average amount of blood saved during surgery was 768.6 ± 52.8 cc. and the amount of blood used for homolog transfusion was 1.5 ± 0.823 units. At the same time period 62 patients were operated for primary total hip arthroplasty and 18 patients had spinal instrumentation without having autotransfusion. 2.94 ± 0.728 units of homolog blood was used. The results show that the difference between the preoperative and postoperative values of hematocrit are significant in the second group while difference in the autolog transfusion group was observed. The need for homolog transfusion was 45 % less in the autotransfusion group.

LUMBOSACRAL TEST BRACING

T.YAZAR, S.SÖZEN, M.ÖZDEMİR, H.KINIK

It is known that in western countries 70% of people in any time in their life and 10% of people still have discomfort by low back pain. One of the etiologic factor of the low back pain is named " Clinical Instability ". The patients we indicate the lumbosacral fusion, to show the prognosis to the patients and us, we have used test brace for 3 years. We have performed lumbosacral brace to 28 cases. We considered the patients in 3 groups. Pain decreased more than 75%, pain decreased between 25-75%, pain decreased less than 25%. We advised fusion operations whose pain decreased more than 75% with brace. We performed fusion operations 24 cases, there was evident decrease of pain in all of the cases. We think that test bracing is useful.

CERVICAL VERTEBRECTOMY AND STABILIZATION

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**University of Ankara, Faculty of Medicine, Avicenna
Medical Center, Department of Neurosurgery**

A fifteen year old boy suffering from pain and motor weakness in his left upper extremity due to eosinophilic granuloma of the C5 vertebra is presented. Radiological studies, especially MRI was suggestive of a typical eusinophilic granuloma of C5 causing dislocation and spinal cord compression. Following a few days of traction, he was operated through the anterior route and in addition to C4-C5 and C5-C6 discectomy, the lytic body of C5 and tumoral tissue were also removed. After achieving a sufficient decompression of the spinal cord, an acrylic graft was prepared and placed between the bodies of C4 and C5 vertebrae. Later on, the vertebral column was stabilized by means of a titanium cervical spine plate screwed to C4 and C6 bodies. The postoperative period was uneventful and his neurological state was improved when he was transferred to a radiotherapy unit. In this case quite a satisfactory result was achieved using acrylic graft and titanium cervical spine plate.

THE VALUE OF MRI IN SPINAL PATHOLOGIES:

Recent advances and new clinical applications

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Clinical manifestations of spinal pathologies are often nonspecific. Conventional X-ray evaluation may be negative in early stages of the diseases and delay in the correct diagnosis increases the likelihood that complications will develop. Computed tomography (CT) and more recently, magnetic resonance imaging (MRI) permit both earlier detection and greater specificity in various diseases of the spine.

MRI provides superior anatomic localization and characterization. MRI also allows for multiplanar direct visualization of the spinal cord, subarachnoid space, extradural soft tissues and spinal column noninvasively without the injection of intrathecal contrast media.

Recently, improvements in surface coil technology and an improved signal-to-noise ratio from high field strength imaging units have optimized the technique so that thin sections with high spatial resolution and contrast to noise can be obtained with relatively short imaging times.

In this presentation, the diagnostic value of MRI in different type of spinal pathologies including the traumatic, degenerative, infectious and neoplastic lesions will be discussed and recent advances in the examination techniques and protocols of spine will be presented.

Prosthetic replacement surgery for the spine affected with cancer metastasis.

Kazuo Yonenobu, MD, Kansai Rosai Hospital and Keiro Ono, MD, Osaka Kosei Nenkin Hospital

Spinal metastasis often involves the vertebral bodies, of which pathological fracture causes intractable pain and paresis. Conventionally laminectomy or irradiation were indicated for the conditions. However results of the treatment were not consistent and sometimes reverse. To restore spinal stability, we applied a vertebral replacement surgery using our biocompatible ceramic prosthesis, which is fixed to the adjacent vertebrae with bone cement.

Materials: From 1972 to 1993, 90 ceramic prostheses were used in 84 patients with symptomatic spinal metastasis. An average follow-up period was 26.1 months. The primary tumor was thyroid cancer in 17 procedures, breast cancer in 12, and myeloma in 10.

Results: Pain relief was achieved in 94% of the procedures, motor function improved in 82%, and ambulation recovered in 73% of non-ambulatory patients. Surgical complications encountered in this study were posttransfusion hepatitis, pleural effusion. The surgical benefit was maintained until the terminal stage in the vast majority of patients unless local recurrence occurred. Local recurrence was noted in 22 procedures (24%) and especially frequent in the patients with relatively long life-span and with primary tumors resisting to radiotherapy.

Conclusion: Vertebral replacement surgery with a ceramic prosthesis provided spinal stability as well as decompression of the spinal cord. When indications were carefully followed, patients suffering for severe spinal pain and/or neurological deficits secondary to vertebral body destruction are benefitted from the surgery.

ANTERIOR CERVICAL FUSION WITH FIBULAR ALLOGRAFT AUGMENTED WITH AUTOLOGOUS BONE PARTICLES

For 20 years, anterior cervical decompression and fusion has been widely accepted for cervical disc disease and bony disease affecting the spinal canal. There has been controversy regarding whether fusion with autologous bone or allograft is most appropriate. In the past it has been shown that iliac crest autograft had a tendency to fail against compressive forces. It has also been shown that fibular graft by itself over time might fail to incorporate if one chose to use iliac crest autograft. The use of iliac crest autograft would, however, submit the patient to additional incision, blood loss and possibly chronic pain at the bone graft donor site. From October 1991 until May 26, 1993, 117 patients have undergone anterior cervical discectomy and/or corpectomy involving 199 disc levels with fusion being performed by fibular allograft augmented with autologous bone particles. It was felt that by combining the strength of fibular strut graft with its ability to resist compression and the early healing promoted by autologous bone particles, that the patient would benefit.

Indications for surgery were intractable cervical radiculopathy or myelopathy with MRI or myelogram consistent with neural element compression. A modified Caspar technique was utilized. Spondylitic spurs and bone particles obtained in performing the decompression were saved. These were obtained also in performing the foraminotomy and partial drilling of the end plates in preparing the ends of the vertebral body for grafting. The autologous bone particles were placed in the center of the reconstituted fibular allograft. Postoperatively the patients were immobilized in a Miami J collar for at least 6 weeks, until such time as radiologic evidence of bony fusion was seen. Anterior cervical instrumentation was performed in patients where there was a preoperative horizontal subluxation or posterior splay, more than 2 disc levels being done at the same time or revision of a previous anterior cervical discectomy and fusion. Three patients were placed in a halo early in the course of the study, before Morscher plates were available. One patient late in the study was placed in a halo because he had associated vertebral fractures at other levels besides the operative site, so that he had both a halo and a Morscher plate. Seven of the patients were revisions of previous surgery. Anterior cervical instrumentation was performed in 29 patients (25%). No patient demonstrated anterior or posterior extrusion of a bone graft. There were no deep wound infections. One patient had a question of a failure to fuse and was suggested to undergo revision. He was subsequently seen by 2 other doctors and felt not to require revision. Eighty percent of the patients showed radiologic signs of fusion at 6 weeks postoperatively after wearing a Miami J collar or Philadelphia collar. Patients were instructed not to smoke--not all were compliant. Twenty percent of patients required up to 10 weeks in a cervical collar until radiologic evidence of bony fusion was seen.

It was quite common to see settling, which is described as protrusion of the bone graft into the adjacent vertebral body in a progressive manner seen from the initial x-ray. However, this was not seen to be detrimental. No patient developed an intractable radicular syndrome or severe malalignment from settling.

It was felt that settling may be of benefit in securing the bone graft. There were no deep wound infections.

All patients have been followed up for at least one year, and no patient has been lost to follow-up. To promote early incorporation and prevent delayed failure, autologous bone from the operative site as an adjunct to the use of fibular allograft appears to benefit fusion. The performance of anterior cervical fusion with fibular allograft augmented with autologous bone particles is equal to or superior to anterior cervical fusion with iliac crest autograft, in our experience. The rates of fusion, complication and the time at which it takes fusion to occur are similar to or superior to that of our previous experience with iliac crest autograft.

In our practice, the performance of anterior cervical fusion with fibular allograft augmented with autologous bone dust has become the preferred technique.

A Proposal for a Semi-automatic Procedure for Percutaneous Discectomy

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Percutaneous discectomy is nowadays a well established treatment for lumbar radiculopathy due to herniated discs. The main advantage of this technique is that it offers a less invasive alternative treatment to traditional laminectomy and microlumbar discectomy. Percutaneous discectomy is an indirect approach which eliminates the need for entry into the spinal canal. It offers a number of advantages, including avoidance of epidural bleeding and perineural fibrosis, elimination of reherniation into the spinal canal, through the intraoperatively induced anular fenestration and preservation of spinal stability. Furthermore it may decrease operating room and hospitalization time. That is why our group considers this intervention as a future widespread application. Unfortunately, as such an intervention is performed under the assistance of fluoroscopy, the patient and also the surgical staff are exposed to a large amount of radiation.

We propose here a semi-automatic approach to avoid this problem and so increase the possibility of an accurate percutaneous treatment of such a disease. This approach is based on the possibility of using a robot manipulator under fluoroscopy for introducing the guide wire which acts as a precise reference for all the successive tools to be introduced in the lumbar spine to reach the prolapsed disc. This possibility derives from the fact that the surgical gesture, even if it has to be carried out very carefully, is conceptually very simple: in fact it consists just of a linear trajectory, whose position and direction is chosen on a preoperative CT planning.

Our present experiments do not aim at modifying the current surgical technique, but only at finding a safer and more reliable implementation. The semiautomatic percutaneous discectomy is planned in the standard way by the surgeon. During the preoperative analysis the insertion point and the right slope of the needle is chosen and measured on CT images of the patient. Then, in the operating theatre, the surgeon marks the starting point on the patient's skin, in the usual way. These first operations do not require X-rays, but at this point the guide wire must be inserted to reach the target, and the automatic procedure starts, with the surgeon standing at a safe distance. The robot which will work in the operating theatre (Puma 260) is equipped with a force/torque sensor, mounted between the last joint and the guide wire. Holding the guide wire, the surgeon can drive the manipulator just pulling or pushing it in every direction and orientation he needs. After the tip of the wire has been positioned at the

chosen insertion point, the robotic manipulator itself arranges its slope, according to the planned trajectory (usually 45 degrees). The trajectory is linear and performed at constant rate, and the cannula is rotated while advancing. However the surgeon can stop, pause or reset the motion whenever he wants to verify the position of the cannula by fluoroscopy. The automatic procedure stops immediately at the surgeon's command, but no other external sensors are used, except for rough thresholds for the force sensor and position control to check the distance from the starting point.

At present the procedure has been tested in vitro with encouraging results both for its reliability and its accuracy compared with the manual execution. This simple system has to be considered as a first step towards a more complex teleoperated and automatically planned intervention, and represents an example of possible future applications and potentialities of advanced robotics in healthcare.

LATE EVALUATION OF ISOLA SPINAL INSTRUMENTATION

Tarık YAZAR, Derya DİNÇER

Metin DOĞAN, Kemal US

IBNİ SINA HOSPITAL, UNIVERSITY OF ANKARA

We have been performing sublaminar wiring with Isola instrumentation since 1992 in scoliosis.

Material :

Fortyseven of these patients were diagnosed as idiopathic adolescent scoliosis.

Diagnosis Case Mean Cobb Mean post op Mean Corr

Idiopathic 47 65° 33° % 50

Loss of Mean Sagittal Correction of
Correct.Correction Rotation (Pedriolle)

12° 10° % 23 (5.6°)

CD 8° hypokyphosis
CD 4°

Mean correction in kyphosis 19°
Mean follow-up period 1.5 years

Late follow-up X ray controls showed us that isola system was as effective as other universal systems. But late correction loss occurs due to lack of grafting. Factes must be destroyed and after decortication a good cancellous iliac graft must be applied.

Post operative early ambulation is attractive but one must not neglect external bracing at least two months. After consolidation we didn't determine loss of correction. We had no neurological problem as a complication however one case lowgrade infection healed by antibiotics.

We believe that except axial compression, sublaminar wiring is a reliable system to correct and stabilize the spine.

Lumbar Interbody Fusion Using the Ray Threaded Fusion Cage

Abstract

Although the lumbar interbody fusion provides stability in the central axis of the vertebral segment and becomes part of the weight bearing structure, posterior lumbar interbody fusion (PLIF) has been associated with neurologic deficits, collapse or reabsorption of the bone graft, expulsion of the bone graft, and loss of disc height. Allograft bone has also been associated with pseudoarthrosis.

Currently in investigational clinical study, the Ray Threaded Fusion Cage achieves immediate stabilization, increases or maintains the disc height, and promotes rapid fusion through bone to bone contact.

Two hundred patients were operated on for symptomatic lumbar disc disease. Over 90% fusion rate was obtained at one year. No displacement or failure of the implant was observed on long term follow-up (1 - 5 years). Maintenance of disc height was preserved in most cases and re-established in some cases.

No infections or CSF leaks were observed. Clinical data, surgical technique, and postoperative radiological findings will be illustrated.

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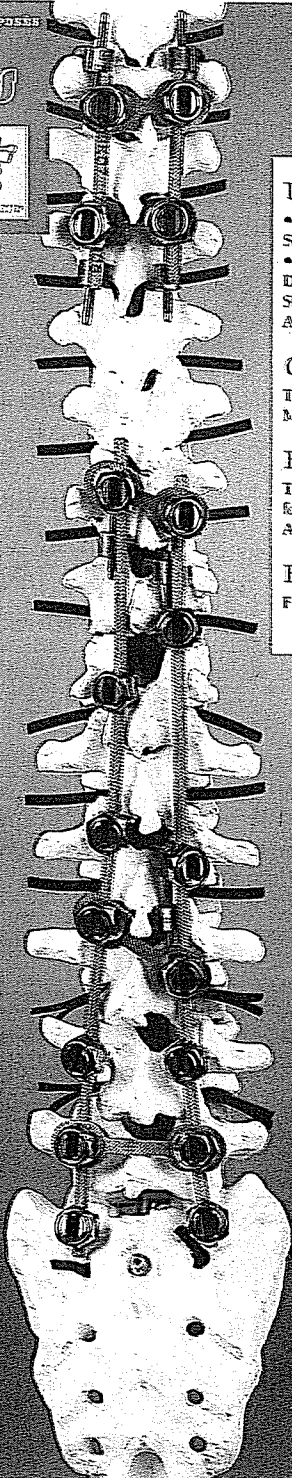
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 - **Location :**
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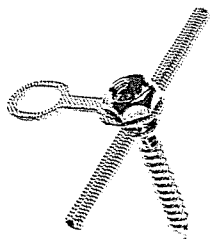
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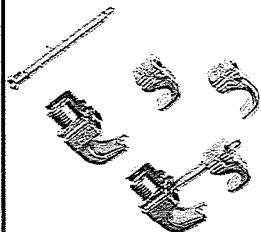
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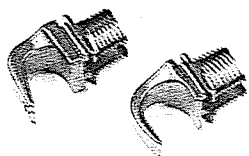
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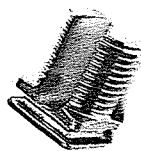
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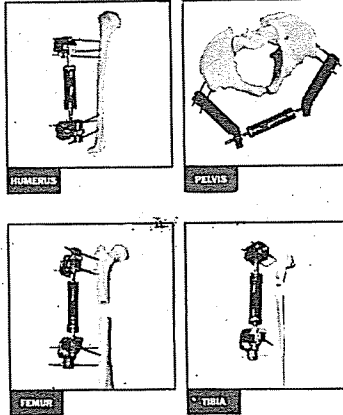
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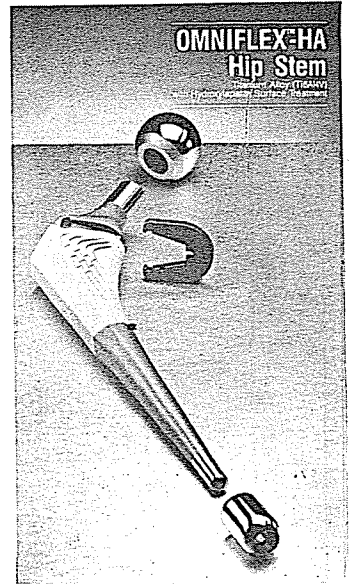
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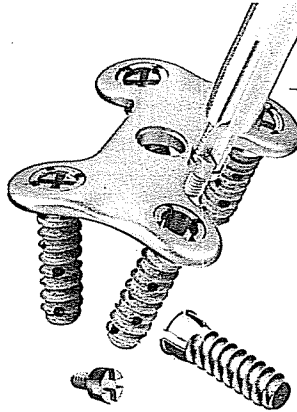
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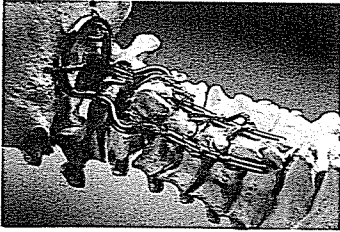


SYNTHES

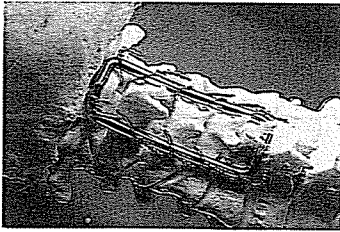


Cervical Spine Locking Plate

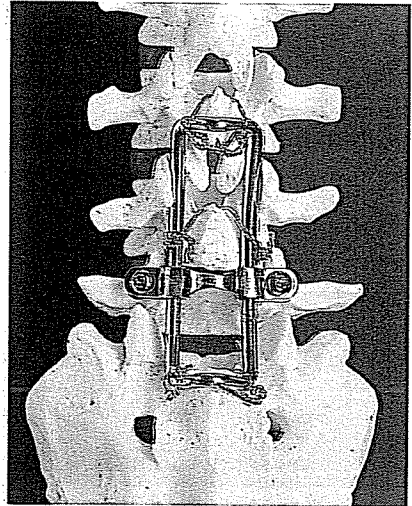
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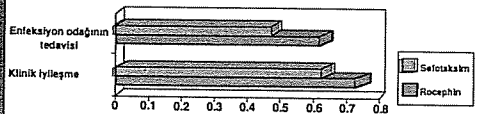
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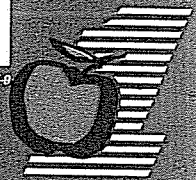


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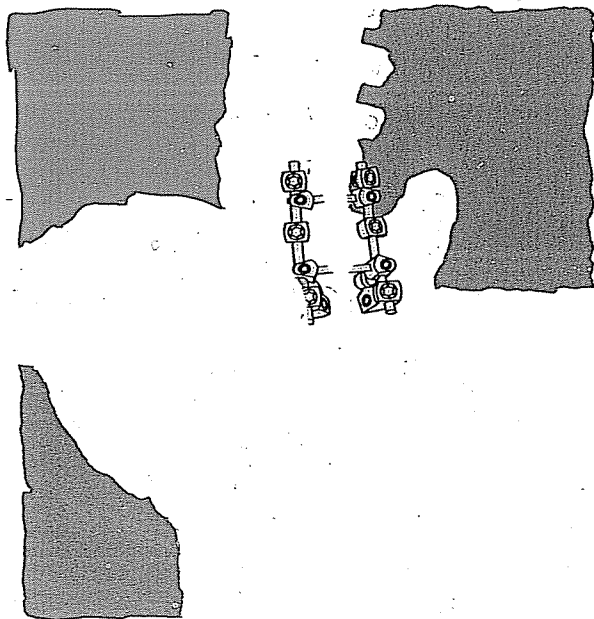


Referans: Ferencz A, Prinz G, Szalka A, Ban E. *Chemotherapy* 1989;35 (Suppl 2):5-8

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