Anterior or Posterior Instrumentation in the Treatment of Unstable Thoracolumbar Fractures: A Retrospective Analysis of 30 Cases

İnstabil Torakolomber Fraktürlerin Tedavisinde Anterior veya Posterior Enstrümantasyon: 30 Olgunun Retrospektif Analizi

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Abstract: Surgical procedures designed to decompress and stabilize unstable trauma-related thoracolumbar fractures are primarily anterior or posterior operative approaches combined with anterior or posterior instrumentation. Our goal is to identify patients that are likely to benefit from either fixation system. Two treatment groups were studied. The first group of 20 patients underwent posterior instrumentation and fusion. Also, eighteen patients with evidence of neural compression were treated with posterior decompressive surgery. The second group, consisting of 10 patients with neurological deficits, was managed with single-stage anterior decompression, interbody strut grafting, and anterior instrumentation. There were no statistically significant differences between the groups with regard to postoperative neurological outcome (Mann-Whitney U, P>0.05), pain assessment and ability to return to work (Chi-square, P>0.05), rate of instrument failure (Chi-square, P>0,05), rate of solid fusion (Chi-square, P>0,05) and loss of reduction (Mann-Whitney U, P>0.05). When surgery is indicated, the operative approach (anterior or posterior) and type of instrumentation used (anterior or posterior) are determined by the location and characteristics of the fracture (e.g., neural compression and instability) and the surgeon's familiarity with the various techniques. Based on the results of this study, we conclude that posterior spinal instrumentation is as effective as anterior instrumentation in the treatment of unstable thoracolumbar fractures.

Key Words: Fusion, instrumentation, stabilization, thoracolumbar fractures

Özet: Travma ile meydana gelen instabil torakolomber fraktürleri dekomprese ve stabilize etmek için planlanan cerrahi yöntemler esas olarak anterior veya posterior enstrümantasyonla kombine edilen anterior veya posterior operatif yaklaşımlardır. Amacımız anterior yada posterior fiksasyon sisteminden yararlanması olası görünen olguları tespit etmektir. İki tedavi grubu çalışıldı: 20 hastadan oluşan birinci gruba posterior enstrümantasyon ve füzyon yöntemi uygulandı; nöral kompresyon bulgusu olan 18 hasta aynı zamanda posterior dekompressif cerrahi ile tedavi edildi. Nörolojik defisitli 10 hastadan oluşan ikinci grup tek seans cerrahi girişimle anterior dekompresyon , interkorporal greft ve anterior enstrümantasyon uygulaması ile tedavi edildi. Postoperatif nörolojik iyileşme (Mann-Whitney U, P>0.05), ağrı derecesi ve işe dönme kabiliyeti (Chi-Square, P>0,05), enstruman yetersizliği oranı (Chi-Square, P>0,05), solid füzyon oranı (Chi-Square, P>0,05) ve redüksiyon kaybı (Mann-Whitney U, P>0.05) değerlendirildiği zaman iki grup arasında istatistiksel olarak önemli bir fark bulunmadı. Cerrahi tedavi endikasyonu olduğunda, seçilecek yaklaşım (anterior veya posterior) ve kullanılacak enstrüman (anterior veya posterior) fraktürün lokalizasyonuna, özelliğine (fraktür tipi, nöral kompresyon ve instabilite gibi) ve cerrahın çeşitli tekniklerdeki tecrübesine göre tayin edilir. Bu çalışmada, instabil torakolomber fraktürlerin tedavisinde posterior spinal enstrümantasyonun anterior enstrümantasyon kadar yararlı olduğu sonucuna varıldı.

Anahtar Kelimeler: Füzyon, enstrümantasyon, stabilizasyon, torakolomber fraktürler

INTRODUCTION

Spinal instability exists when the spinal column can no longer support physiologic loads in all degrees of freedom. Surgical procedures designed to decompress and stabilize thoracolumbar instability caused by trauma are primarily anterior or posterior operative approaches combined with anterior or posterior instrumentation. The anterior approach involves resection of the fractured vertebral body, followed by strut grafting combined with anterior instrumentation. The posterior approaches include laminectomy, lateral extracavitary decompression (modified costotransversectomy) and posterolateral decompression via the pedicle, combined with posterior instrumentation.

Stabilization has two phases; early and late. Early stability is achieved with internal fixation, whereas late stability results from bony fusion. The goals of spinal instrumentation are several: to support the failed column until bony fusion occurs, to reestablish and maintain sagittal curves, to decompress the neural canal via distraction and lordosis, to encourage and allow early mobilization, and to establish a milieu that promotes fusion. It is also important to safely achieve these goals without risk of neurological injury. Significant advances in the understanding of the biomechanics of spinal stability, together with a revolution in methods of spinal fixation, enable the surgeon to achieve these aims.

This retrospective study analyzed the short-term clinical and radiological results of 30 patients who underwent anterior or posterior instrumentation for unstable thoracolumbar spinal fractures. Our goal is to identify patients who are likely to benefit from either fixation system. This study also reports the authors' initial clinical experience using anterior or posterior instrumentation in the treatment of unstable thoracolumbar fractures.

PATIENTS and METHODS

Between January 1995 and January 1998 at the Department of Neurosurgery at Çukurova University Hospital, 30 consecutive patients who had unstable thoracolumbar fractures underwent surgical treatment. The patient population, included 18 men and 12 women, with mean age of 42 years (range, 17 to 69 years) who were followed for an average of 18 months. All patients had clinical and radiographic evidence of spinal instability, with 10 cases classified as flexion compression, 9 as fracture-dislocations, 8 as burst fractures, and 3 as flexion-distraction fractures. All patients suffered severe back pain; however, surgery was never performed solely to treat isolated back pain. Twenty-eight patients presented with neurological signs and symptoms due to spinal cord-conus medullaris compression (24 cases) or nerve root-cauda equina compression (four cases). The two patients who did not have neurological deficits presented with severe back pain from failed therapeutic fusion attempts.

Two treatment groups were studied. The first group of 20 patients underwent a posterior instrumentation (rod hook or screw rod systems) and fusion procedure (Figure 1). Eighteen patients with evidence of neural compression were treated with decompressive surgery via a posterior midline or

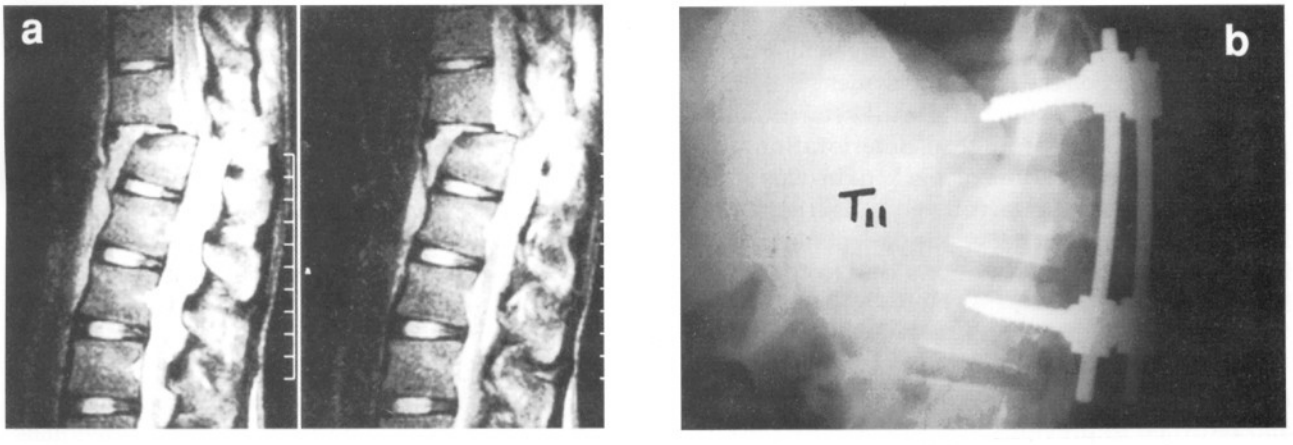


Figure 1: A fracture dislocation at T10-T11, with destruction of the T11 vertebral body, (a) Magnetic resonance imaging shows the obliteration of the spinal canal, (b) A postoperative lateral film shows the fracture reduced and stabilized with posterior instrumentation using pedicular screws.

posterolateral approach. The mean extent of fusion was 2.8 motion segments (range one to six motion segments). Fourteen patients had either two or three motion segments instrumented and fused. The second group was made up of 10 patients, all of whom had neurological deficits. They were managed with single-stage anterior spinal decompression, interbody strut grafting, and anterior spinal instrumentation (Figure 2). Of the 10 patients with evidence of anterior neural compression, 5 were decompressed via a transthoracic approach, 3 via a thoracoabdominal approach, and 2 via a lateral retroperitoneal approach.

We used White and Panjabi's (23,29,30) checklist to assess the instability caused by trauma to the thoracolumbar spine. Clinical instability was considered to exist when the relative point value of items on the checklist totaled more than five. In addition, we used the American Spinal Injury Association (ASIA) Impairment Scale (8) to measure the patient's functional status on admission and at the last follow-up visit. All patients were studied using pre- and postoperative plain X-ray films, computerized tomography (CT) scanning, or magnetic resonance imaging. To compare the correction of sagittal deformity, we calculated the Sagittal Index (SI) for each patient, quantifying segmental sagittal deformity before surgery and at the last follow-up exam.

For statistical analysis, we used the Chi-square and Mann-Whitney U tests.

RESULTS

Group 1:

After posterior decompression and stabilization, the neurological function of 12 (66%) of the 18 patients with deficits improved an average of 1 grade, based on the ASIA Impairment Scale. Four of these patients recovered normal function. No patient suffered neurological deterioration after surgery. The resolution of back pain was more variable than neurological recovery. The criteria used for evaluation were based on the patients' subjective responses regarding limitations due to their back symptoms.

At follow-up, six patients with normal neurologic function had excellent relief of back pain and returned to previous levels of activity. Twelve had moderate back pain, and two had severe, persistent pain. Eighteen (90%) of the 20 patients developed osseous union. These individuals

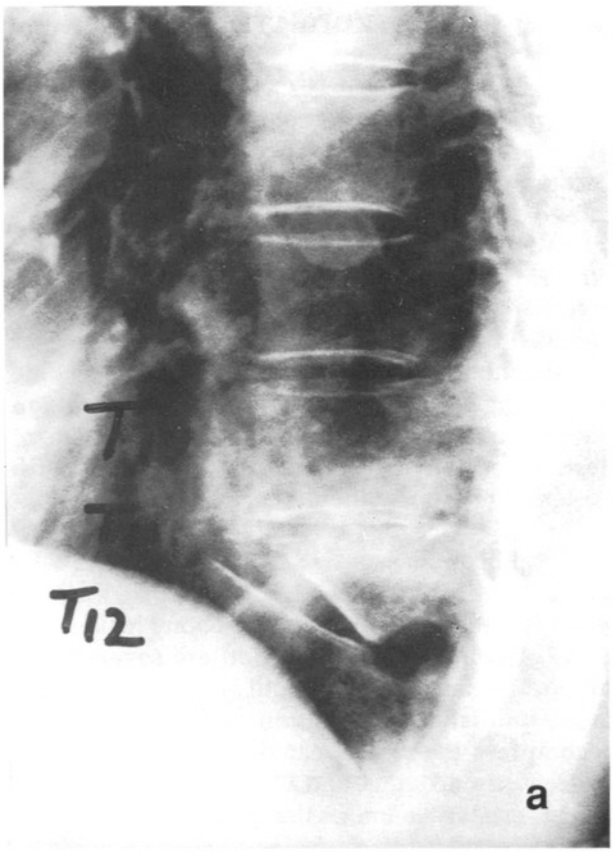
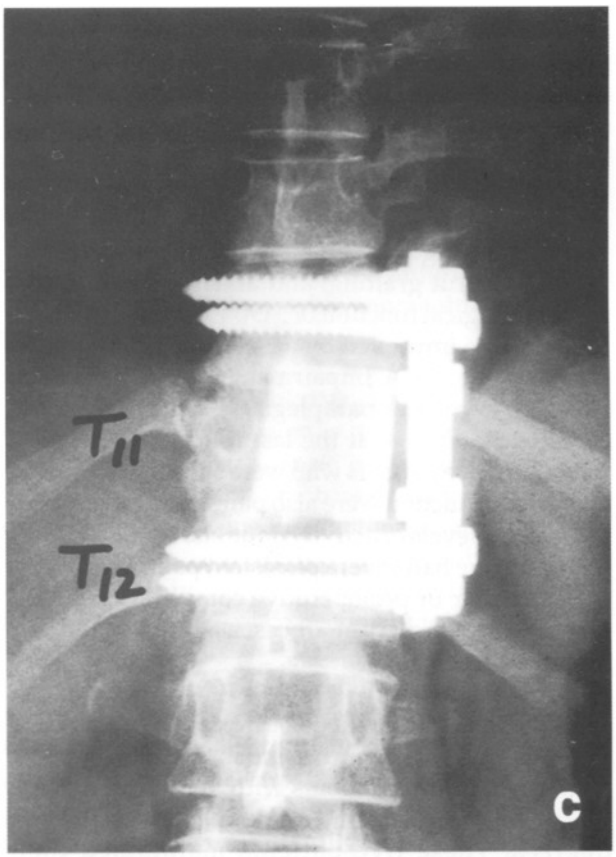
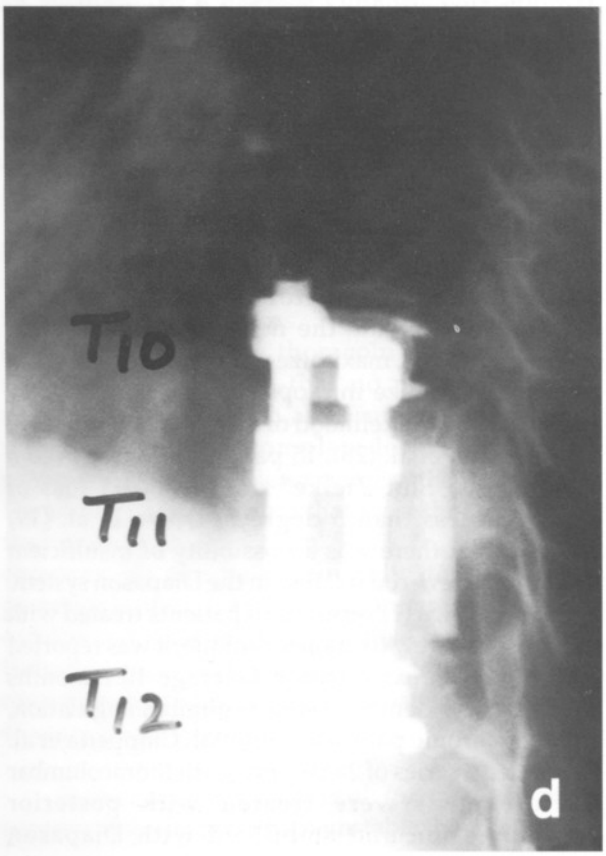


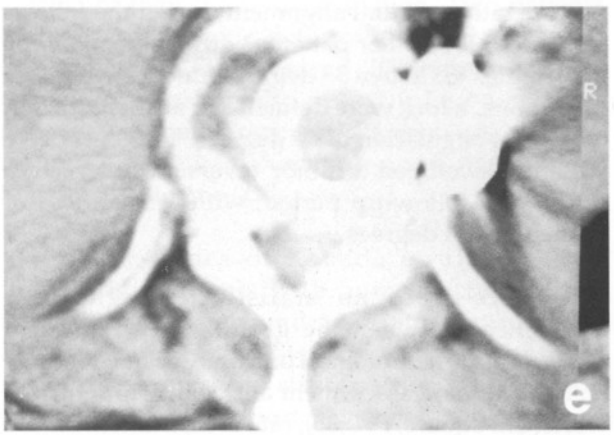
Figure 2: A flexion-compression fracture of T11 with retropulsion of bone into the spinal canal. (a) A lateral film shows severe wedging of the T11 vertebral body. (b) Magnetic resonance imaging shows the retropulsion of bone into the canal. (c) Postoperative anteroposterior and (d) lateral films show a femoral allograft and anterior instrumentation used in the reconstruction of the fracture after anterior decompression via an anterolateral approach. (e) The reconstruction as seen on computed tomography scan.

demonstrated continuous radiographic fusion masses on radiological studies, and had no clinical or radiographic evidence of instability. Instrument failure occurred in four cases (two cases each of screw breakage and rod displacement). Of these, two patients were asymptomatic with solid fusions, and required no therapy. In the other two individuals, the instrument failure was symptomatic or associated with a pseudoarthrosis, and required surgical revision.

In all 20 patients, we attempted to reduce the spinal deformity to some degree. Twelve individuals with SI between 15 degrees and 25 degrees underwent a mean reduction of 18 degrees, and had a mean loss of correction of 5.5 degrees at the last







follow-up exam. Eight patients with SI between 25 degrees and 35 degrees underwent a mean reduction of 29 degrees, and had a mean loss of correction of 6.7 degrees at the last follow-up check. Two patients who suffered neurological complications developed new postoperative radiculopathy. In both, the radiculopathy resolved spontaneously with no radiographic evidence of root impingement, and was attributed to intraoperative root manipulation during foraminotomy. In another two cases, a superficial wound infection developed postoperatively and cleared with local wound debridement, packing, and

antibiotic therapy. The instrumentation was not removed in these cases, and no recurrent infections developed. Subsequently, both patients attained successful arthrodesis.

Group 2:

After single-stage anterior decompression, interbody strut grafting, and anterior stabilization, the neurological function of 9 (90%) of the 10 patients with deficits improved by an average of 1.6 grades, based on the ASIA Impairment Scale. One patient who had complete paraplegia preoperatively, had revealed no change at the last follow-up check. At follow-up, five patients who were showed recovering neurologic function were also pain-free and returned to previous levels of activity; four had moderate back pain, and one had severe persistent pain. There were no neurologic or perioperative complications. Solid fusion was achieved in all cases at an average of 3 months.

Two patients with SI between 15 degrees and 25 degrees underwent a mean reduction of 20 degrees, and three patients with SI of 25 degrees to 35 degrees underwent a mean reduction of 30 degrees. These five patients maintained their postoperative sagittal alignment during the follow-up period. Five other patients with severe kyphotic deformities (SI above 35 degrees) underwent major reductions, which were defined as a mean reduction of sagittal angulation of 40 degrees. Two of the five patients developed a minor reversal of correction during the follow-up period, with a mean loss of reduction of 4 degrees.

There were no statistically significant differences between the groups with regard to postoperative neurological outcome (Mann-Whitney U, P>0.05), pain assessment and ability to return to work (Chi-square, P>0,05), rate of instrument failure (Chi-square, P>0,05), rate of solid fusion (Chi-square, P>0,05), and loss of reduction (Mann-Whitney U, P>0.05).

DISCUSSION

The spinal column is a unique osteoligamentous structure comprised of integral components. The indications for spinal stabilization following the destruction of these structures depend on the contribution or structural value of the destroyed parts (15). Through biomechanical studies of cervical, thoracic, and lumbar spine cadaver specimens, White and Panjabi (23,29,30) made observations that are helpful for evaluating clinical instability. They incorporated these data with information from a review of the clinical literature to develop checklists for each spinal area. Under their scheme, relative point values are assigned to different criteria. If the sum of relative points on a patient's checklist sum of more than five, then clinical instability is considered to exist (23,24,29,30).

For both clinical and research purposes, neurological status after spinal cord injury and the outcome of medical treatment and rehabilitative measures must be described accurately (2,7). The modified Frankel grading system is used to measure the patient's functional status (4,8,11). In our study, the ASIA Impairment Scale (8), which is a modification of the Frankel scale (11), was used to measure patient functional status on admission and at the last follow-up visit. This system of functional grading readily allows comparison of admission status and final outcome. Sagittal plane deformities appear to most closely correlate with prognosis, and quantification of segmental deformity is important. To compare the correction of sagittal deformity in our study, each patient's SI was calculated. In this way, we were able to quantify segmental sagittal deformity before surgery and at the last follow-up exam. The SI is defined as the measurement of segmental kyphosis at the level of a mobile segment, that is, one vertebra and one disc, adjusted for the baseline sagittal contour at that level in the normal spine (10). This measurement represents the total net deformity at a given level.

Optimum fixation should minimize the length of fusion, achieve anatomic reduction of the deformity, eliminate the need for postoperative external supports, maximize potential for neurologic recovery, minimize intraoperative neurologic risk, and enhance the likelihood of solid fusion. In a study by Van-Loon et al. (28), 15 patients who received a double-rod "Slot Zielke" device had a loss of correction less than 5 degrees. Izawa et al. (19) reported that there was a possibility of insufficient rigidity of screw-rod fixation in the Diapason system. In Benzel et al.'s (1) series of 10 patients treated with the crossed-screw fixation technique, it was reported that follow-up examination (average 10.1 months after surgery) demonstrated negligible angulation, and that chronic pain was minimal. Ciappetta et al. (5) studied a series of 28 patients with thoracolumbar fractures that were treated with posterior decompression and stabilized with Diapason

instrumentation. They reported that 22 patients (78.5%) with neurological deficits improved, 26 (92.8%) developed osseous union, and 5 patients with spinal deformity (SI>15 degrees) had a postoperative SI of less than 5 degrees after long-term follow-up. Instrument failure occurred in four of their cases, but only one required reoperation.

Stambough (25) reviewed the outcomes for 55 patients treated with posterior Cotrel-Dubousset instrumentation for unstable thoracolumbar fracture, and reported that 31% of cases improved an average of 0.5 Frankel grades (range, 0-2). Also, comparison of the radiographic findings at 1 month postsurgery and at final follow-up showed little or no deterioration. It was concluded that short-segment fixation with posterolateral fusion was effective for treating unstable thoracolumbar fractures. The method prevented progression of kyphotic deformity and neurologic deterioration, resulted in stable fusion, and preserved uninvolved motion segments above and below the fracture site (25).

Stovall et al. (26) evaluated the results of short-segment pedicle screw instrumentation in 54 patients who had unstable thoracolumbar fractures. Based on a mean follow-up period of 25 months, they reported an average of 7 degrees kyphosis correction at surgery, average 5 degrees loss of correction at the end of follow-up, average 57 % canal compromise preoperatively and 33 % postoperatively on CT, and achievement of solid fusion in all cases after an average of 3 months.

Korovessis et al. (22) evaluated the results of posterior Texas Scottish Rite Hospital hook-rod instrumentation in 40 patients who had unstable thoracolumbar fractures. They reported that the sagittal profile of the thoracolumbar spine was significantly restored, that no patient suffered neurologic deterioration after surgery, and that all individuals with incomplete lesions improved postoperatively by at least one Frankel grade (11). Hamilton et al. (16) found that most thoracolumbar fractures with less than 50 % to 60 % canal compromise can be adequately dealt with by posterior surgery through the inherent powerful correction of short-segment pedicle screw systems. However, there was a higher incidence of loss of correction due to screw pullout in patients older than 45 years due to poorer bone quality.

In the series of Danisa et al. (6), made up of 49 nonparaplegic patients with unstable thoracolumbar burst fractures, 16 individuals underwent anterior decompression and fusion with instrumentation, 27 underwent posterior decompression and fusion, and 6 had combined anterior-posterior surgery. There were no significant differences between the groups with regard to postoperative kyphotic correction, neurological function, pain assessment, or ability to return to work. They found that posterior surgery was as effective as anterior or anterior-posterior surgery in treating unstable thoracolumbar burst fractures (6).

In the study by Kirkpatrick et al. (21), anterior decompression and fusion, supplemented with the Kaneda device, was done on 20 patients with thoracolumbar burst fractures. All patients with deficits recovered one Eismont grade after surgery. The average correction of kyphosis was approximately 50% acutely, with loss of approximately 50% of correction at follow up.

In Ghanayem et al.'s (14) study, 10 of 12 patients who underwent anterior arthrodesis using the Z plate thoracolumbar plating system after a one-stage anterolateral decompression and reduction procedure for burst fractures from T9-L3 maintained their postoperative sagittal alignment or a significant portion of their kyphosis reduction. Two patients with severe kyphotic deformities greater than 50 degrees lost 10 degrees and 20 degrees of their reduction, respectively, at last follow-up. All 3 patients with neurologic deficits recovered, and 11 of the 12 patients achieved a good or excellent functional outcome (14).

In the series of Kaneda et al. (20), 150 consecutive patients with burst fracture of the thoracolumbar spine and associated neurological deficits were managed with single-stage anterior spinal decompression, strut grafting, and Kaneda spinal instrumentation. At a mean of 8 years postsurgery, 140 patients (93%) had successful fusion of the injured spinal segment, and 142 (95%) of the patients exhibited at least one grade of improvement in neurological function, as measured with a modification of the Frankel grading scale (11). There were no iatrogenic neurological deficits, and the percentage of the canal obstructed, as measured on CT, improved from a preoperative mean of 47% (range, 24% to 92%) to a postoperative mean of 2% (range, 0 to 8%) (20).

The question of whether anterior or posterior decompression provides a superior neurological

outcome is not completely resolved at this time. Anterior surgery plays a role in the correction of severe disruption, late deformity, and chronic anterior cord compression. Some authors recommend anterior decompression in cases where there is greater than 25% compromise of the spinal canal (3). Humphries et al. (18) were of the opinion that anterior grafting favored fusion because of better blood supply and bone contact, and the fact that the graft is under compression. Esses et al. (9) reported superior decompression with the anterior approach compared to the posterior approach. The findings of the Scoliosis Research Society, which completed the largest prospective study, had revealed that anterior surgery was no more effective than posterior surgery for improving neurological outcome when neurological function was assessed using the Frankel or ASIA scales (13).

An ideal spinal construct should immobilize only the unstable spinal segments. After anterior decompression and strut grafting are done, the spine can be aligned and fixed with anterior instrumentation. The advantages of the anterior approaches are that they provide adequate anterior decompression, short fusion, good reduction, and secure stabilization in one surgical procedure. Unlike posterior decompression, little manipulation of neural elements is necessary during anterior decompression. The disadvantage of the anterior approaches is that they entail a greater magnitude of surgery. Posterior segmental instrumentation provides rigid internal fixation with solid purchase immediately adjacent to the fracture level. This allows deformity correction and preservation of three-dimensional position, while minimizing fusion levels. Spinal alignment and the reduction of fragments through posterior distraction provides adequate neural decompression (12,17,27). However, some failures with posterior instrumentation have been reported (1).

When surgery is indicated, decisions must be made about operative approach (anterior or posterior) and the type of instrumentation to be used (anterior or posterior). The choices are made based on the location and characteristics of the fracture (e.g., neural compression and instability), and the surgeon's familiarity with the various techniques. In our study, there were no significant intergroup differences with regard to neurological outcome, postoperative pain, the ability to return to work, the rate of instrument failure, the rate of solid fusion, and loss of reduction. We conclude that posterior spinal instrumentation is as effective as anterior instrumentation in the treatment of unstable thoracolumbar fractures.

Note: This study was presented in part as a poster at the May 15-19 1998, XIIth Annual Scientific Congress of Turkish Neurosurgical Society.

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