SURGICAL TREATMENT OF 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.

Key Words: *Lumbar spine, burst fractures.*

The treatment of burst fractures of the lumbar spine (L2-L5) have usually been conservative in the past. With the improvement of pedicular screw systems and anterior spinal instruments, surgical approaches aiming especially to correct the deformities in the sagittal plane gained popularity. Patient's age and activity level, mechanical and neurologic stability, deformities in the sagittal plane and accompanying laminar fractures are important parameters which should be taken into consideration while planning the therapy.

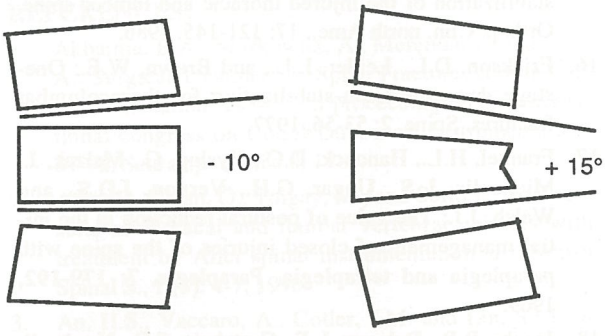
An important achievement was established with Denis' three-column model of the spine in evaluating the mechanical stability of burst fractures (4, 5, 6). Farcy improved Denis' classification and reported his six-element system, including both the bone and the ligamentous structures (7, 19). Farcy also described the sagittal index (SI), an important parameter in determining the true sagittal deformity (Fig. 1). This classification has been developed to identify burst fractures at risk for progression and to refine spesific indications for surgery. The true sagittal deformity as reflected by the SI appears to be directly related to the amount of trabecular bone destroyed.

In this study, results of surgical therapy in burst fractures of the lumbar spine are evaluated.

PATIENTS AND METHOD

Indications for surgical therapy are the presence of neurologic deficit and kyphotic deformity of 15° or more in the sagittal plane with instability greater than grade III.

Figure 1. Sagittal index.



Kyphotic deformity - Normal contour = Sagittal index
15° - - 10° = 25°

While posterior fusion and stabilization suffices in cases with a sagittal deformity between 15 to 25 degrees, the anterior placement of a strut graft is indicated in cases with a sagittal deformity more than 25 degrees, due to a greater amount of trabecular bone loss.

21 cases meeting the criteria mentioned above were surgically treated between 1990 and 1993. Fractures were located between L2 and L4. Average age was 32.4 years (range 18 to 50) and mean follow-up was 21.2 months (range 40 to 8).

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Surgical methods applied are:

12	cases	posterior fusion and Cotrel-Dubousset Instrumentation (CDI)
3	cases	posterior fusion and CDI with posterolateral decompression
1	case	posterior fusion and CDI with anterior strut grafting
3	cases	anterior decompression and fusion with Kaneda Instrumentation (Fig. 2)
2	cases	anterior decompression and fusion, posterior fusion and CDI

In all cases, the segments proximal and distal to the fracture site were included in the fusion area.

In four cases with vertical laminar fractures, dural injury was observed during the exploration and repaired.

The preoperative neurologic statuses of the patients are listed in Table 1.

Table 1: Neurologic deficits of the cases (Frankel)

	Preop	Postop
A	-	-
B	2	-
C	3	1
D	3	2
E	13	18

RESULTS

The preoperative sagittal index values and corrections are listed in Table 2.

Superficial infection responding to medical therapy was observed in one case and correction loss occured in another. This case had received only posterior fusion although the sagittal index was 32°. In our opinion, this correction loss is due to deficiency of trabecular bone in the vertebral body. Another patient who had received posterolateral decompression and posterior instrumentation presented in the postoperative 12th month with a broken pedicular screw.

All cases with neurologic deficits improved with therapy (Table 2). Spinal fusion was achieved in all cases.

Table 2. Sagittal index values

	Preop	Postop
Post. surgery	19.5°	-3°
Post.+ant. surgery	26.5°	-5°

DISCUSSION

The management of lumbar spinal injuries presents some distinct considerations that are different from fractures of the thoracic and thoracolumbar spine. In part, the technical difficulties of restoring alignment and obtaining solid arthrodesis in the low lumbar spine have hindered attemps to treat traumatic lesions in this region adequately. As a result of this, many investigators have suggested that limited treatment goals should be attempted and achieved in low lumbar spine trauma. In fact, "benign neglect" has become a method of treatment of these low lumbar spine injuries with less than satisfactory results achieved in many patients. However, the advent of more accurate imaging studies and advances in spinal instrumentation, such as pedicular screws, anterior instrumentation systems, have opened new possibilities for treatment of these injuries.

The anatomic characteristics of the lumbar spine differentiate it from the remainder of the spine. First characteristic is sagittal alignment, lordosis of 30-60° is present in this area. A corollary to that anatomic feature is the extreme mobility of the lumbar spine. This extreme range of mobility adds to the technical difficulty of restoring anatomical alignment, and maintenance of rigid fixation in low lumbar injuries. Furthermore, this mobility requires the fusion area to include the least amount of segments possible.

Progression of kyphosis together with the neurologic deficits result from the combination of initial deformity and instability. Since sagittal plane deformities appear to most closely correlate with prognosis, quantification of segmental deformity is important. Accordingly, the sagittal index was introduced. Suggested by Farcy, this index 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. This measurement represents the total net deformity at a given level (7, 19).

Recent investigations have resorption of retropulsed fragments can be possible with conservative therapy in time, in patients presenting with 66% spinal canal stenosis but no neurological symptoms (3, 17). Thus, conservative therapy can prove to be sufficient in neurologically intact cases with no disruption of the saggital contour (SI<15).

It has been demonstrated that the degree of local kyphotic deformity is well correlated to the destruction of the bony substance of the involved vertebral body following fracture. Bony healing does not occur even after

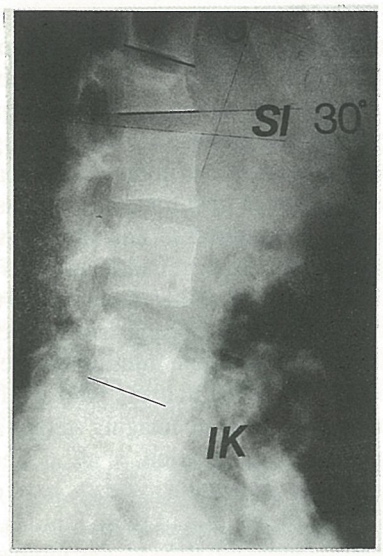

Figure 1.a.

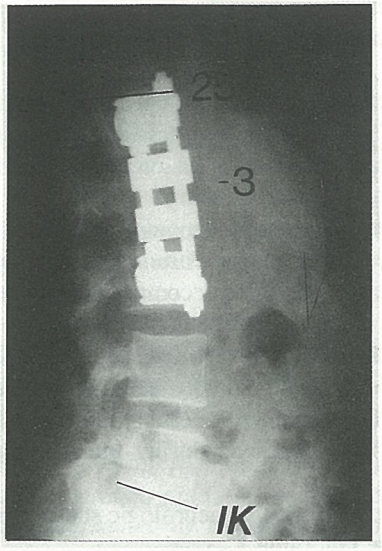

Figure 1.b.

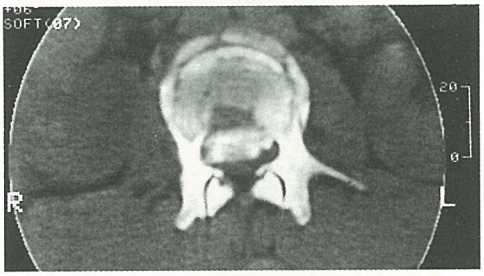

Figure 1.d.

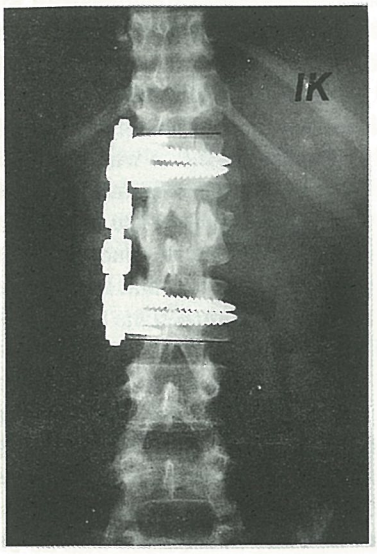

Figure 1.c.

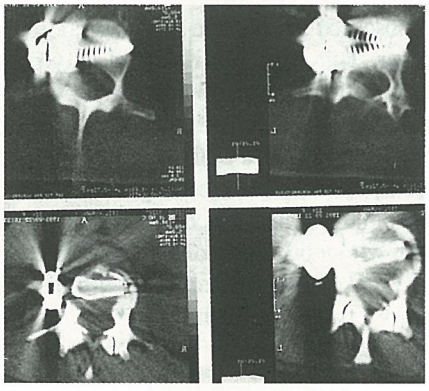

Figure 1.e.

Figure 2. Kaneda instrumentation is used in this case of burst fracture.

the preinjury vertebral height is restored by reduction and stabilization (11, 12). The gap is filled with fibrous tissue that cannot restore structural integrity to the vertebral body. These studies have indicated that a 15° (SI>25) kyphotic deformity represents the point at which the corresponding bony destruction requires anterior stabilization. Anterior bone grafting alone, however, is subject to settling and some loss of reduction prior to incorporation and healing. Recent experimental studies in the calf spine have demonstrated that instrumentation with CD rods or Kaneda device in combination with anterior bone grafting afforded significantly greater immediate stability than bone graft alone (12, 13, 14). Our results also confirm these views, showing no kinds of correction loss in either the Kaneda instrumentations or anterior bone grafting plus posterior instrumentation.

Long instrumentations are well tolerated in the thoracic spine and at the thoracolumbar junction. However, long instrumentations cause increasing problems near the sacrum. A fusion from T12 to L5 concentrates forces crossing the lumbar spine on the only remaining L5-S1 interspace. Although the incidence of future symptoms is unknown, the likelihood of future problems is certainly increased by overload of this joint. Therefore, instrumentations including the proximal and distal segments adjacent to the fracture level are suggested. Pedicular screws, being a more stable fixation device, are preferred in posterior instrumentation.

Burst fractures of L5 are rare. Fredericson proposed that the deep position of L5 within the pelvis helps to protect it from injury (8). Conservative management of these fractures has been satisfactory, perhaps because of the relatively small amount of associated loss of vertebral height or kyphotic deformity. Surgical approaches have been complicated by difficulties in sacral fixation, high incidence of dural tears, pseudoarthrosis, failure of fixation and loss of lumbar lordosis (15).

The procedure of decompression that is to be applied in patients with neurological symptoms is still a subject of debate. Universally approved is that laminectomy has no indications for decompression in burst fractures (1, 4, 5, 6, 7, 16, 19). Garfin (9), Abitbol (1) and Mc Afee (16) have described a posterolateral approach to gain access to the posterior aspect of the vertebral bodies, permitting reduction of the bone fragments. Other investigators prefer the anterior approach, assuring better visualization and perhaps a more reliable and complete decompression (10, 13, 14). This procedure should be supplemented with instrumentation, either anteriorly if available or posteriorly to prevent loss of correction. With anterior surgery, the reported incidence of significant pain is low (13, 14). However, despite the low morbidity in experienced hands, the anterior approach inherently has more potential surgical risks. Since posterolateral decompression requires resection of the pedicle, diminished bone mass may result in increased instability and insufficiency of especially the short lumbar instrumentations. We recommend anterior decompression in lumbar burst fractures with incomplete neurological deficits, since postorelateral decompression applied to one of our patients resulted in screw breakage while no such complications have been observed in patients in whom anterior decompression has been established.

Burst fractures are correlated most commonly with laminar fractures. Dural laceration, observed with laminar fractures, has been reported in 32% of burst fractures and is associated with motor deficits (2, 18). The importance of recognizing the presence of nerve root entrapment in the laminar fracture is that this entrapment, rather than the retropulsion of bone or soft tissue from the associated burst fracture, may be responsible for neurologic compromise. Dural laceration may occur more commonly at L4 and L5, although burst fractures in these locations are rare (2). Therefore, in the presence of incomplete neurological deficits, we recommend dural exploration through a laminotomy on the contralateral side of the laminar fracture and performance of the anterior decompression following dural repair.

During posterior reduction and retraction in neurologically intact patients with SI 15-25 in whom posterior stabilization alone is planned, posterior longitudinal ligament is the most important element in reducing the fragments present within the spinal canal; therefore, preoperative evaluation of its unity is essential. In case of its disruption, after instrumentation development of neurologic deficits due to the posterior displacement of the fragments within the spinal canal is possible. Therefore, we believe that investigation of the continuity of this ligament by MRI would be appropriate. Besides, in the presence of a developing neurological deficit during the postoperative follow-up, anterior decompression should also be added. In the relatively well-aligned spine, decompression as a prophylactic measure in the neurologically intact patient is not a strong argument.

CONCLUSION

SI is a reproducible measurement of sagittal deformity for preoperative and postoperative evaluation.

Anterior strut grafting without decompression should be performed in addition to the tension system with posterior pedicle system in cases without neuorologic deficit and presenting with excessive kyphotic deformity (SI≥25°).

Because of the high incidence of dural tears in cases with neurologic deficit and vertical laminar fractures, a preliminary posterior approach and laminotomy from the opposite side of the vertical laminar fracture should be done. Following posterior stabilization, anterior approach should be selected for sufficient decompression.

In cases with neurologic deficit without fractures in the posterior elements, anterior approach should be preferred. It is sufficient to include segments proximal and distal to the fracture level into the fusion area.

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