Neurological outcome following delayed fixation of unstable thoracolumbar spinal injuries with short segment posterior fixation

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ABSTRACT

الأهداف: من أجل تقييم أهمية الاختلال العصبي عقب إزالة الضغط المتأخر والتثبيت لكسر العمود الفقري الصدري.

الطريقة: في الفترة ما بين يناير ٢٠٠١ و أغسطس ٢٠٠٤م، أجريت دراسة عصبية على ١٢٠ كسرا في العمود الفقري الصدري القطني بعد إجراء عملية التثبيت الخلفي بمستشفى العظام وجراحة المفاصل بمدينة سريناجار بالهند. شملت الدراسة ٨٨ ذكراً و٣٢ أنثى. تعرضوا للسقوط من مكان مرتفع، عادة من على شجرة، وكان هذا السبب شائعاً بنسبة (٩٠٪). ٧٦ مريضا (٦٣٪) تعرضوا لاختلال عصبي عند وقت الحضور الى المستشفى. تم تثبيت العمود الفقري غير المستقر، بين أربعة الى ثمانية أيام بعد الإصابة بواسطة قطعة قصيرة خلفية (ستيفي). تم تسجيل الشفاء للمرضى في فترة المتابعة. تم استخدام درجة فرانكيل لتقييم الحالة العصبية. بلغ متوسط فترة المتابعة ٢٥ شهراً (تراوحت ما بين ٨ الى ٤٤ شهراً) وبلغ متوسط العمر ٣٤ عاما (١٨– ٥٤) عاماً.

النتائج: كان هنالك ٤٠ مريضاً (٣٠٪) يعانون من اختلال عصبي غير كامل. على سبيل المثال، المرضى الذين يعانون من فرانكيل من الدرجة ب، ج، د. تبين وجود درجتين من التحسن لدى ثمانية من المرضى ودرجة واحدة من التحسن لدى ٣٢ مريضاً يعانون من وجود آفة غير مكتملة. فقط ثلث المرضى تحسنت حالة الاختلال العصبي لديهم بشكل كامل عند آخر متابعة. كانت النتيجة العامة لجراحة الآفات الجزئية متحسنة على الأقل لدرجة واحدة من فرانكيل لدى جميع الحالات. ولكن لا يوجد هنالك تحسن في معظم الحالات التي تعاني من وجود آفة كاملة.

خاتمة: تؤكد هذه الدراسة على وجود علاقة واضحة بين مستوى الإصابة ودرجات فرانكيل، الإصابات مرتبطة بالدرجة العصبية الأكثر شدة ويظهر التدخل الجراحي لتحسين النتيجة العصبية. حتى لو تم تأخير التدخل الجراحي (متوسط ٩ر٧ أيام).

Objective: To evaluate the improvement in neurological deficit following late decompression and stabilization of the fractured thoracolumbar spine.

Methods: Between January 2001 and August 2004 neurological recovery in 120 thoracolumbar fractures was studied after posterior stabilization at the Hospital for Bone & Joint Surgery, Srinagar, India. There were 88 male and 32 female patients. Fall from a height, usually a tree, was the most common (90%) cause of injury. Seventy-six patients (63%) had neurologic deficit at the time of presentation. The unstable spine was fixed, between 4-18 days after trauma, by posterior short segment instrumentation (Steffee). Neurological recovery for the patients was recorded in the follow-up period. Frankel grade was used to assess the neurological status. The average follow-up period was 25 months (range 8-44 months), and average age was 34 years (18-54).

Results: There were 40 patients (30%) with an incomplete neurological deficit, namely, patients with Frankel grade B, C, and D. Two grades of improvement were found in 8 patients, and one grade improvement in 32 patients with incomplete lesion. Only one third of the patients with complete neuro deficit improved at the final follow-up. The overall result of the surgery for partial lesions was an improvement of at least one Frankel grade in all cases, but no improvement in most of the cases with complete lesion.

Conclusion: This study demonstrates a clear relationship between the level of injury and Frankel grades, translational injuries are associated with a more severe neurologic grade, and surgical intervention appears to improve the neurological outcome, even when the intervention is inadvertently delayed (average 7.9 days).

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Spinal cord injury due to traumatic accidents of the thoracolumbar spine is a major cause of disability throughout the world. Whereas motor vehicle accidents account for the bulk of these injuries in the developed world, fall from height is the usual mechanism in our setup. Debate over the management of these injuries is far from over. The choice of treatment, operative or non-operative, remains controversial as is the role of decompression of neural elements,[1-5] and whether an anterior or posterior decompression is useful in cases of spinal canal compromise.[3,6-8] The purpose of this study was to evaluate neurological recovery following inadvertent delayed decompression and stabilization of the fractured spine.

Methods. Between January 2001 and August 2004, 120 patients of unstable spinal fractures in the age group of 20-54 (mean age 33) underwent short segment fixation (Steffee VSP)[9] at the Hospital for Bone & Joint Surgery, Srinagar, India. There were 93 male and 34 female patients. Fall from height, usually a tree, was the most common (90%) cause of injury. Patients were brought to the hospital between 1-7 days (mean 3 days) and were operated upon at an average of 7.9 days after admission (range 4-18). The D12 and L1 level formed the bulk of the injured vertebrae (60%). The patients were graded neurologically according to the method of Frankel et al,[10] and the classification of McAfee[11] was used to describe the fracture patterns. The presentation of neurological deficit was uniform and not patchy. If neurologic involvement was present, the lesion was considered to be a spinal cord injury if the fracture was at D10 or above. If the fracture was between D11 to L2 this was considered a mixed conus medullaris and cauda equina injury, and if the level was L2 or below, the lesion was considered to be a purely cauda equina injury. Radiographs were performed pre-operatively and all patients were subjected to a CT scan to ascertain the amount of retropulsion of bony fragments into the spinal canal, status of posterior elements, and pedicles of the adjacent vertebrae. All patients underwent posterior short segment fixation (Steffee) and decompression and posterolateral fusion. A mechanical distractor was used to perform indirect ligamentotaxis in an attempt to reduce the retropulsed fragments, and transpedicular decompression was carried out in cases where more than 50% of the cross-sectional area of the spine was involved. Prophylactic antibiotics of a second-generation cephalosporin were initially used for 5 days postoperatively. A thoracolumbar orthosis was prescribed to all patients post-operatively, and we encouraged use for approximately 3 months. Frankel grade was used to assess the neurologic recovery in the follow-up. The board of studies of Govt. Medical College Srinagar approved the study on posterior instrumentation in unstable thoracolumbar spinal injuries in 2001. Our hospital is one of the several specialist hospitals associated with the said college.

Results. Seven patients were lost to follow-up and were excluded from the study and only 120 patients were available for final assessment. There were 36 patients with Frankel grade A, of whom 12 improved. All 8 patients with Frankel grade B improved to grade D. Out of 20 patients with grade C preoperatively, 12 improved to grade D and 8 to grade E. All the 12 patients with grade D improved to grade E. Forty-four grade E patients had no neurological deficit. No patient's neurological condition deteriorated after surgery, and the Frankel grade did not worsen in any case. There were 68 burst fractures, 24 flexion distraction, and 28 translational injuries. Burst fractures resulted in Frankel grade D and E primarily, as was the case with most flexion distraction injuries, whereas the translation component of the injury produced mainly Frankel grade A (**Table 1**). The level of fractures clustered at the thoracolumbar junction (**Table 2**). Of the 104 patients with conus medullaris lesion, 36 were Frankel grade A, 8 grade B, 20 grade C, 8 grade D, and 32 grade E, and of the 16 patients with pure cauda equina lesions, 12 were Frankel grade E, and 4 Frankel grade D. There were 40 patients who presented with incomplete spinal

Table 1 - Fracture type versus Frankel grade.

Grade	Burst n=68 (%)	Flexion distraction n=24 (%)	Translational injury n=28 (%)
A	8 (12)	4 (16.6)	24 (86)
B	4 (6)	4 (16.6)	0
C	12 (18)	4 (16.6)	4 (14)
D	12 (18)	0	-
E	32 (46)	12 (50.0)	-

Table 2 - Fracture level related to intradural contents.

Fracture level	No. of cases	Intradural contents
D 11	12	Mixed conus medullaris and cauda equina
D 12	40	
D 12-L 1	8	
L1	24	
L 2	20	
L 3	12	Cauda equina
L 4	4	

cord damage, that is patients with Frankel grade B, C, and D. Two grades of improvement were found in 8 patients and one grade improvement in 32. The outcome of treatment in all 40 patients with incomplete neuro deficit was a neurological improvement of at least one Frankel grade. The most satisfying part of the study was that no neurological deficit was seen in any case, fortunately not even in those with less than acceptable placement of pedicle screws.

Discussion. Literature is replete with opinion concerning the surgical management of fractures of the thoracolumbar spine, the outcome of intervention, and consequent neurologic recovery.[1] Apart from restoring the sagittal plane alignment and correcting translation, surgical treatment decompresses the neural structures and may facilitate neurologic improvement. Both anterior and posterior approaches have been used. Anterior procedure allows direct decompression of the spinal canal as well as restoring the anterior and middle columns with a structural graft.[12] Advocates of this approach have claimed equal or even more successful results as compared to the posterior approach.[13] However, posterior stabilization and decompression with ligamentotaxis (indirect) or a transpedicular approach (direct) is the most frequent mode of surgical management for these fractures. The posterior approach is relatively easy, has the advantage of realigning the spinal column and allows indirect decompression of the spinal canal by postural reduction or with the help of a mechanical distractor. Timing of surgery may be an important factor when indirect decompression by ligamentotaxis is contemplated. A successful reduction of the retropulsed fragment in 85% of cases has been reported, when surgery was performed early (within 3 days of injury).[8] Herndon et al[14] made no specific attempt to decompress neural elements in 24 patients with incomplete spinal cord injuries, and most of the patients had posterior instrumentation and fusion for spine realignment and stabilization. The amount of neurologic recovery in each patient was compared to the final area of the spinal canal as determined by CT scan. They concluded that there was no correlation between neurologic improvement and the amount of spinal canal encroachment. In their opinion, posterior instrumentation restores canal patency more than 50%.

There is still controversy about the timing of surgical decompression. Immediate (within the first few hours) decompression does make sense and is supported by animal studies, but is seldom practicable given the time it usually takes to transport the patient from the trauma site, to address associated injuries, and to assess the spinal trauma. Furthermore, it is associated with higher blood loss and increased transfusion.[1] Early decompression has been reported to produce neurologic recovery relative to later surgery. Gaebler et al[15] reported a positive correlation between early surgical intervention and neurological recovery in patients presenting with neuro deficit. The highest recovery was seen in patients operated within 8 hours of injury. They also reported that there was no significant difference in the neurological outcome in patients operated after 4 days. The earliest we were able to stabilize a spine was 4 days after the initial trauma, primarily due to inadvertent delay in referral and lack of facilities for early stabilization of spine in our hospital. The outcome of treatment though, even in terms of neurological recovery, is not discouraging.

The relationship between the initial canal compromise, due to retropulsion of bony fragments in a burst fracture at the thoracolumbar junction, and neurological deficit has been debated. Kim et al[5] found a positive correlation between the degree of spinal canal encroachment and neurological involvement. Moreover, significant neurological damage was found in association with posterior element disruption. Kilcoyne et al,[16] however, could not define the relationship between initial canal compromise and neurological deficit in most of their cases. Likewise, the effect of decompression of the neural elements on ultimate neurological recovery is controversial. In the series of Gertzbein et al,[17] at least one Frankel grade improvement was observed in 81% of patients by anterior decompression, and each of them had more than 50% preoperative canal compromise. On the contrary, the effect of posterolateral decompression on the neurological outcome could not be established in another study.[3] The finding of Denis[18] suggested that neurological involvement depends on the anatomical level involved, namely, the type of neural tissue related to the level of injury. Therefore, a smaller retropulsion produces more neurological damage in the conus than in the cauda equina region. Similar observations were made by Hashimoto et al.[19] We relied on indirect ligamentotaxis for reduction of the retropulsed fragment and used transpedicular decompression in a limited number of cases only, but cannot confirm the advantage of the individual procedure. We did not, however, use the anterior approach for decompression that has been claimed to yield favorable results in terms of neurologic recovery.[20]

A neurological recovery rate between 65-70%, by at least one Frankel grade, has been reported with non-surgical treatment of spinal injuries with incomplete neurological damage.[5] In patients who underwent posterior surgery, the recovery rates are somewhat higher.[21,22] In our series we observed at least one Frankel grade improvement in 100% of cases of partial lesion. As both anterior and posterior approaches have similar

results in terms of the neurological outcome,[23] it may be that recovery occurs independent of treatment. It has also been shown that the fragments of bone retropulsed into the spinal canal can resorb over a period of 1-2 years.[24] Therefore, the most important factor determining the extent of a neurologic recovery could be the severity of damage sustained by the nerve tissue at the time of injury.[25,26]

Research over the past several decades has focused on elucidating the mechanism of spinal cord injury, unraveling the complex pathophysiologic processes involved, and the possibility of pharmacological intervention in preventing/reversing the damage process.[7] The consistent improvement in the neurological outcome resulting from early decompression in animal models[27-29] has not been reproduced in human clinical studies.[20,30] The achievement of functional recovery in adult animals after partial or complete neurological damage with certain neurotrophic factors, albeit limited, has raised hopes for pharmacological intervention in the future.[31]

Whereas nearly half of the spinal injuries result from motor vehicle accidents and from falls[32] in the developed countries, the bulk of the spinal injuries in the developing countries is due to fall from height.[22] The lack of specialist treatment and poor rehabilitation facilities in the poorer countries makes life miserable for the patients with neuro deficit. There is a need for community education to prevent or at least minimize the incidence of such injuries. In Kashmir, for example, 80% of spinal injuries occur due to fall from trees during fruit season (autumn).[6] The role of an independent prevention unit as advocated by Toscano[33] would be of tremendous significance in our circumstances in educating the general public, paramedics, nursing staff, and medical practitioners about traumatic cord paralysis. This would minimize the trauma level, improve referral, transportation, and post-op rehabilitation of injured ones.

In conclusion, this study demonstrates a clear relationship between the level of injury and Frankel grades, namely, lesions at a higher level tend to be more severe than lesions in the cauda equina. The translation injuries are associated with a more severe neurologic grade, and surgical intervention appears to improve the neurological outcome, even when the intervention is delayed (average 7.9 days in our case). The results show definite improvement in outcome when compared with those in the literature in patients treated non-operatively for complete neurological deficit.

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