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Original article

The effect of laminae lesion on thoraco-lumbar fracture reduction



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ABSTRACT

Introduction: The treatment of fractures involving the lumbar spine has been controversial. Laminae lesion may be complete or of the greenstick type (incomplete). Dural tears and nerve root entrapment may accompany these laminae fractures. The aim of this study is twofold, to assess the effect of different types of laminae fractures on the anteriorvertebral height restoration in upper lumbar burst fractures and to determine the incidences of the intraoperatively detected dural tear and neural entrapment in complete and incomplete laminae fractures to choose the optimal treatment.

Materials and methods: A retrospective review was conducted on 112 patients with 114 lumbar burst fractures treated operatively, age ranged from 17 to 55 years (mean age 32). Male to female ratio was (93%/7%), 8 females. Patients were divided into three groups, group 1 patients without lamina fracture, group 2 patients with complete type lamina fracture and group 3 patients with (percutaneous) incomplete type lamina fractures. All clinical charts and radiologic data of these groups were analyzed for their association with dural tears, neural entrapment and the impact of lamina fracture (complete and incomplete types) on the efficacy of anterior vertebral height restoration. The severity of injury was determined using the ASIA (Modified Frankel scale).

Results: Out of 114 upper lumbar burst fractures, lamina fracture occurred in 34 patients (29.8%), complete lamina fracture occurred in 21 patients (61.7%), whereas incomplete lamina fracture occurred in 13 patients (38.3%). Dural tear was detected in 16 patients (47%) and was predominantly higher in complete type lamina fracture 12 patients (57%) when compared to 4 dural tears (30%) in incomplete lamina fractures. Analysis of the data revealed no significant difference in the preoperative anterior vertebral height loss and local kyphotic angle between the three groups. However the anterior vertebral height and local kyphotic angle restoration were found to be affected by the presence of complete lamina fracture when compared to other groups with incomplete lamina fracture and without lamina fracture ($P=0.001$).

Conclusion: In upper lumbar burst fractures, complete lamina fracture is an indicator of injury severity. When detected preoperatively on CT or MRI scanning, it should be operated by open book laminectomy even if the patient is neurologically intact since it carries a high risk of neural entrapment, and its presence affects the intraoperative postural and instrumental trials for anterior vertebral height restoration.

Level of evidence: Level IV. Retrospective study.

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1. Introduction

Lumbar burst fractures Denis type A, B, C and D often result from a combination of acute hyper-flexion and rotational forces, and are usually unstable [1,2]. The posterior fragments from the fracture usually enter the canal to some degree, which can sometimes

result in neurological deficits. Laminae fractures may be complete or of the incomplete (greenstick type). Dural tears and nerve root entrapment may accompany lamina fractures, but it is not possible to determine their existence unequivocally by clinical and radiological methods before surgical treatment [3–6]. To these patients, one of the goals of the operative treatment of spinal fractures is the restoration of the anatomy of the spinal column, including the spinal canal. Using the dorsal midline approach, all fractures were explored if lamina fracture is present to release entrapped neural structures, and treated by postural reduction, instrumental angular reduction and stabilization with a long segment transpedicular

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Table 1
Patients' related data.

No. of patients	112
Men [n (%)]	104 (93)
Women [n (%)]	8 (7)
Age [year (range)]	32 (17–55)
Follow-up	46 months (32 months to 5 years)
Aetiology	
Fall from height [n (%)]	98 (87.5)
Motor vehicle accident [n (%)]	14 (12.5)

internal fixators. Both postural reduction and instrumental reductions perform important roles in the operative treatment [7,8]. Nonetheless, the exact impact of an associated laminar fracture as an isolated severity marker remains unknown. An associated laminar fracture is a main contributor to the severity of injury and should be included in the treatment plan [9,10].

Our study on the upper lumbar burst fractures series was designed to assess the incidences of lamina fractures with its both types (complete and incomplete), the dural tear and the neural element entrapment, and the correlation between the presence of the two types of laminae fractures and the efficacy of postural and instrumental reduction manoeuvres on anterior vertebral height restoration.

2. Materials and methods

2.1. Clinical data

This retrospective study was carried out for 112 patients (8 females and 104 males) with 114 lumbar burst fractures, mean age was 32 years. Mean age seems to be low due to the fact that the vast majority of patients were young people working in the border tunnels present between Gaza strip and Egypt, in which all tunnel workers were exposed to the risk of fall from height. Average follow-up period was 46 months. The aetiology of injury was falling from height in 98 (87.5%) and traffic accident in 14 (12.5%) (Table 1). The type of lamina fracture was also predicted from the CT scan and was recorded. The anterior vertebral height (AVH) was measured on lateral radiographs taken pre- and postoperatively. The normal height of the fractured vertebra was determined by averaging the heights of vertebrae at adjacent levels.

The neurologic status was determined according to ASIA modification of the Frankel classification at the time of injury and the follow-up. The Frankel method, which grades neurological function impairment, was used to compare preoperative and latest follow-up patient status. In this retrospective study 112 patients with 114 upper lumbar burst fractures were treated from February 2007 through August 2012. Each patient had anteroposterior and lateral radiographs, computed tomography and/or magnetic resonance imaging scans. Anteroposterior and lateral radiographs were used for the determination of loss of anterior vertebral height. The type of lamina fracture was also predicted from the CT scan and was recorded.

According to the preoperatively obtained CT scanning, patients were divided into three groups. Group 1 consisted of 78 patients who had upper lumbar burst fractures without lamina fracture, group 2 involved 21 patients who had burst fractures with complete type lamina fractures, and group 3 consisted of 13 patients with incomplete (percutaneous type) lamina fractures. Fracture types and their demographic distribution were explained in (Table 2).

All patients underwent surgery in the prone position and under general anesthesia. The midline incision was centered at the injury level and completely exposed the injury with two adjacent levels above and two levels below. All the patients with lamina fractures were carefully explored using the open book laminectomy

Table 2
Patients' data related to complete and incomplete lamina fractures with respect to dural tear and neural entrapment.

	Dural tear	Neural entrapment	Dural tear with neural entrapment	Without dural tear
Incomplete	4	2	2	9
Complete	12	7	5	9

technique with the posterior approach; if there was any dural tear and nerve root entrapment, it was then reduced and repaired [11,12]. After insertion of the pedicle screws, postural reduction was performed by creating hyperextension by the Hall-Relton frame. The connecting rods were placed, distraction of the levels above and below the fracture was used to create tension on the posterior longitudinal ligament, to reduce the fracture by ligamentotaxis. Pedicle screw insertion and reduction were guided by fluoroscopy, and the goal was to get the angles between the two pedicle screws and rods above a combined 180° in order to ideally restore correct lordosis and vertebral alignment. The screws were then tightened in a divergent manner and posteriolateral fusion was performed (Fig. 1). Fractures were classified according to the three-column theory of Denis [13].

The Frankel method, which grades neurological function impairment, was used to compare preoperative and latest follow-up patient status [14,15]. The Frankel method is a scale used by the American Spine Injury Association (ASIA) and graded from A to E. Functional results for all patients were based on comparison of the patient's occupational and recreational status before and after the injury (Tables 3 and 4). These results were classified as excellent, good, fair or poor according to the Smiley-Webster Scale.

3. Results

Lamina fracture was detected in 34 (29.8%) out of 114 upper lumbar burst fractures, complete lamina fracture was detected in 21 patients (61.7%) and incomplete lamina fracture (greenstick fracture) was detected in 13 patients (38.3%). In group 2 in our upper lumbar burst fractures series complete lamina fracture was detected mostly at the level of L2 in 57% (12 patients), in L1 complete lamina fracture was detected in 9.5% (2 patients), and it was detected in 28% of the L3 burst fractures (6 patients), dural tear was detected in 57% (12 patients) mostly at the level of L2 (38%) (8 patients) and neural entrapment was detected in 33% mostly at the level of L2 (19%) (4 patients). Whereas in group 3 of the incomplete lamina fracture it was detected mostly in L2 (61.5%) (8 patients), L3 (23%) (3 patients) and in L1 (15.5%) (2 patients). Dural tear was detected in 30% (4 patients) mostly at the level of L2 (23%) (3 patients) and neural entrapment was detected in 15% one in L2 level and another one in L3 level (Table 2).

3.1. Anterior segmental height

Anterior segment height measurement was done preoperatively by measuring the anterior body height on a true lateral decubitus thoraco-lumbar views for all patients. And it was measured one week postoperatively in the same position.

The preoperative mean of anterior vertebral height loss was (42%) in all patients range (24–69%). All data were analysed using SPSS v. 15 (SPSS, Inc., Chicago, IL.). The non-parametric Man Whitney *U* test was used for categorical comparisons. The statistical significance was set at $P=0.05$, there was no statistically significant difference between group 1 and group 2, between group 1 and group 3 and between group 2 and group 3, *P* values were 0.545, 0.554, 0.532 respectively. However, the mean anterior vertebral

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