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# OUTCOME OF THORACIC VERTEBRAL BURST FRACTURES BY LIGAMENTOTAXIS AND FIXATION

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### Abstract

Ligamentotaxis is a known method in the management of spinal burst fractures but the indications and efficacy are controversial. In the present study we evaluated the outcome of ligamentotaxis without fusion.

Thirty five patients with single-level thoracic burst fractures with intact PLL were selected for treatment with this method. The analysis of the outcome was with the help of Frankel neurological grading system, radiographic measurements, and Visual analog scale and Oswestry disability index was used to evaluate the pain and functional outcome. The average follow-up period was 28.5 months. There was a statistically significant correction of anterior vertebral height from 53.9% to 96.2% postoperatively; and that of the posterior vertebral height increased from 86.6% to 98.1% postoperatively. Preoperative canal compromise which averaged to 34.96% improved to 5.52% at latest follow up. Neurological status was improved in all patients except one patient with Frankel grade A. The ODI and VAS score improved significantly in all patients.

Among the broad spectrum of treatment options for thoracic burst fractures ligamentotaxis with screw fixation falls in mid range of the spectrum, providing less aggressive surgery and beneficial clinical and technical outcome.

**Keywords:** Thoracic, burst fracture, ligamentotaxis, indirect reduction, instrumentation

## Introduction:

The management of thoracic burst fractures have included conservative as well as direct decompressive procedure and fixation, which can be performed from anterior, posterior or combined approach. Though conservative management can be undertaken in some thoracic burst fractures, still surgical management plays a crucial role in many.

Short as well as long segment instrumentation and indirect reduction is a known technique in the management of thoracic burst fractures<sup>2,8,11</sup>. But there is limited role of short and long segment instrumentation in the management of fractures apart from Dennis Type-B fractures<sup>4,5</sup>. As well the need of performing laminectomy and decompression of dura and cord is not needed; hence the chances of dural tear and iatrogenic cord compression can be avoided.

Thus we conducted a study to evaluate the outcome of thoracic burst fractures managed with indirect reduction by ligamentotaxis and posterior long segment pedicle screw fixation, having intact posterior longitudinal ligament (PLL), which included all types of Dennis fractures.

## Materials and Methods:

### Patient data:

This is a prospective study was conducted from April 2015 to March 2019, which included 35 patients with thoracic burst fractures. All of which were managed surgically with indirect reduction by posterior long segment instrumentation without fusion, by single team of surgeon and at a single centre.

Dennis three column theory was used to classify the fractures. All patients with thoracic burst fractures

that involved either two or three column and kyphotic angle more 20deg were included in the study. Patients with damaged PLL, previous spine surgery, associated with any other fractures and age more than 70 years were excluded from the study.

Average follow up of all patients was about 28.5 months (range 18-36 months). It included 23 male and 12 female patients, with average age of 44 years (range 22-70 years). 12 fractures were motor vehicle-related, 19 due to fall from a height and 4 patients with history of trivial fall. All the patients included had a single level fracture, and distribution of level of involvement is given in Figure 1. 18 patients had neurological deficiency, which was classified using Frankel grading system, Table 2. All the patients underwent radiographic studies: X-ray, Computed Tomography (CT) scan and Magnetic Resonance Imaging (MRI). Average time from the day of injury to surgery was on average of 4 days.

### Surgical technique:

All patients underwent the standard posterior midline approach, positioned prone on Wilsons frame under general anaesthesia. The incision was centered at the level of injury, with two adjacent levels above and two levels below were exposed. Pedicle screws were then placed under fluoroscopy guidance. Ligamentotaxis was achieved by distraction with the help of the connecting rods placed. Posterior longitudinal ligament was stretched and fracture fragments reduced. No laminectomy and decompression of cord was performed.

Goal was to achieve the normal thoracic kyphosis, and then the screws were tightened. Serial X-rays were taken, one immediate postoperative

and at 6 weeks, later at 3 monthly intervals. Fracture healing was determined by comparing the density of the vertebral body with that of the adjacent vertebral bodies. All the patients underwent a CT scan at one year follow up, to check the healing and remodelling of the vertebral canal.

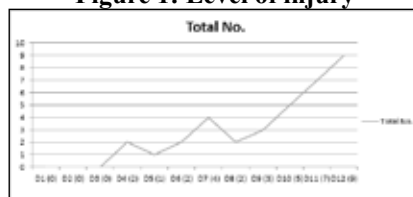
Radiological evaluation was done by measuring the Anterior Vertebral Height (AVH) and Posterior Vertebral Height (PVH) on the lateral view, which was taken preoperatively, postoperatively and at the latest follow up, Table 3. This was compared to the height of the adjacent vertebral body. The Vertebral Body Angle (VBA) at the level of injury was measured from the endplates, Table 3.

Spinal canal diameter was measured on the axial cuts of CT scans at the level of injury, pre and post-operatively, at 1 year (X). The calculated vertebral spinal canal diameter (Y) was determined by averaging spinal canal diameters of the adjacent vertebrae above and below the injury level (Y1 and Y2). The spinal canal narrowing percent (NR) was thus calculated as  $(Y - X)/Y \times 100\%$ . Oswestry Disability Index (ODI) was used to determine thoracic function at the latest follow-up<sup>12,17</sup>.

All data analysis was done by SPSS. The paired t test was used for test statistics between continuous variables, and the accepted alpha-error was set at 0.05.

**Table 1: Patient details**

|                         |                              |
|-------------------------|------------------------------|
| Number of patients      | 35                           |
| Average follow up       | 28.5 (range 18-36 months)    |
| Male : Female           | 23:12                        |
| Age                     | 44 years (range 22-70 years) |
| Mode of injury          |                              |
| Motor vehicle-related   | 12                           |
| Fall from a height      | 19                           |
| History of trivial fall | 4                            |

**Figure 1: Level of injury****Table 2: Neurological status**

| Frankel Grade | No. of patients | Latest follow up |   |          |           |           |
|---------------|-----------------|------------------|---|----------|-----------|-----------|
|               |                 | A                | B | C        | D         | E         |
| A             | 1               | 1                |   |          |           |           |
| B             | 7               |                  |   | 2        | 5         |           |
| C             | 6               |                  |   |          | 4         | 2         |
| D             | 4               |                  |   |          | 1         | 3         |
| E             | 17              |                  |   |          |           | 17        |
| <b>Total</b>  | <b>35</b>       | <b>1</b>         |   | <b>2</b> | <b>10</b> | <b>22</b> |

## Results

All the 35 patients were followed up for a minimum period of 2 years. The AVH, PVH, VBA, Table 3, showed significant difference in all the groups between the preoperative and postoperative numbers, which was tested using paired t test significance ( $P < 0.01$ ). There was a statistically significant increase in vertebral correction postoperatively and even in the latest follow up.

The normal canal diameter at the injury level (Y) averaged at 16.3 mm, and that of the injured level (X1) was 10.6 mm, amounting for a spinal canal narrowing percent (NR1) of 34.96%. At the latest follow up it was seen that the average canal diameter at the injury level was restored to 15.4 mm (X2), amounting the spinal canal narrowing percent (NR2) of 5.52% and canal diameter increasing by 4.8mm post surgery.

At latest follow-up, all the 35 cases were neurologically assessed. One patient with neurological status of grade A showed no improvement.

Whereas all the remaining patients with grade below E showed improvement at

**Table 3: Injury level vertebrae AVH and PVH reduction (average %, minimum to maximum) and VBA (average degrees, minimum to maximum)**

|     | Pre-op           | Post-op            | Latest follow up  |
|-----|------------------|--------------------|-------------------|
| AVH | 53.9 [12.4–81.7] | 96.2 [71.2–111.4]  | 89.9 [69.2–104.8] |
| PVH | 86.6 [69.4–96.4] | 98.1 [82.5–107.5]  | 92.8 [73.1–100.3] |
| VBA | 19.2 [3.7–36.8]  | 3.7 [-4.4 to 14.3] | 6.7 [0–19.6]      |

**Table 4: Postoperative analysis**

|                                         |         |
|-----------------------------------------|---------|
| Canal diameter                          |         |
| Normal (Y)                              | 16.3 mm |
| Injured level (X1)                      | 10.6mm  |
| spinal canal narrowing percent (NR1)    | 34.96%  |
| Canal diameter at latest follow up (X2) | 15.4 mm |
| Spinal canal narrowing percent (NR2)    | 5.52%   |
| Oswestry Disability Index (ODI)         | 19.5%   |
| VAS                                     |         |
| Preop                                   | 8.2     |
| Postop                                  | 2.6     |

## Discussion:

In the current literature, it is believed that for the treatment of thoracic fractures, fusion is not considered the standard of care because it is not strong and stable enough. This method of indirect reduction by ligamentotaxis without fusion,

follow up of at least one grade, Table 2. The Oswestry Disability Index (ODI) at the latest follow up averaged at 19.5%. The average VAS score was 8.2 preoperatively and postoperatively significant pain reduction was seen with average score of 2.6 at one month follow up.

Among the complications, no patient had surgical site infection, neurological worsening and no deep vein thrombosis. Two patients of the total 35 had implant failure. In one patient, a screw had breached the medial wall, which was noticed in the immediate postoperative period. Second patient, one screw had broken 3 months postoperatively due to the history of trivial trauma patient had sustained. Both of which had no neurological complications and were managed and corrected with re-instrumentation.

achieved by pedicle screw fixation provides another treatment option in the management of thoracic burst fractures, with a prerequisite of intact PLL. In general these cases can be managed by conventional methods of decompression, reduction, fixation and fusion, either by anterior or posterior

approaches. This may amount to aggressive technique in a patient with intact PLL, and the risk of dural tear and iatrogenic cord compression. Assessing the integrity of PLL may be at times difficult, however fracture displaced out of the canal, a facet joint fracture displaced to another vertebral level, or fracture fragment rotation are indirect means of suggesting damage to the PLL<sup>14</sup>.

After the pedicle screw instrumentation and placement of connecting rods, it produces tension in the PLL and subsequent reduction of the fracture by ligamentotaxis. If fracture fails to reduce it may be because the PLL is damaged, failing to provide the required tension for reduction. Hence the conventional method of treatment should be used, which involves laminectomy resulting in further spinal instability<sup>12,15</sup>. Therefore ligamentotaxis reduces the possibility of soft tissue scarring, which eventually may lead to spinal nerve compression, and the need for laminectomy. The results of which are not compromised and comparable with that of the conventional methods, of decompression and fusion.

In fusion methods there is associated long term complication of adjacent level disease which is reduced with ligamentotaxis indirect reduction method<sup>1,3</sup>. Moreover, this method has fewer complications than conventional anterior approaches and relatively less invasive.

In routine practice it is thought that patients with neurological deficiency direct decompression must occur before reduction, but in present study it demonstrated that ligamentotaxis alone was sufficient and does not worsen neurological status.

Yang et al, showed the improvement of canal diameter by

short segment pedicle screw indirect reduction without fusion within 2 weeks postoperatively<sup>14</sup>.

Limitations in long segment fixation are that this technique cannot be used in patients with ruptured PLL or when the disc has entered the injury level vertebral body. Additionally patient may also implant related complications such as implant breakage, back-out or migration.

Dai et al, a randomised and controlled study, showed beneficial clinical and technical outcome in patients with thoracolumbar burst fractures treated with short segment screw fixation but the study included patients with Denis Type B fractures only<sup>4</sup>. Whereas in the current study consisting of 35 patients included all fractures not just Denis Type B fractures.

Although few of the patients did have adjacent disc injury, none had completely herniated into the vertebral canal or body; hence this method could still be used. As well this does not influence the process of ligamentotaxis as long as PLL is intact. Drawback of the herniated disc is that the discs do degenerate quickly.

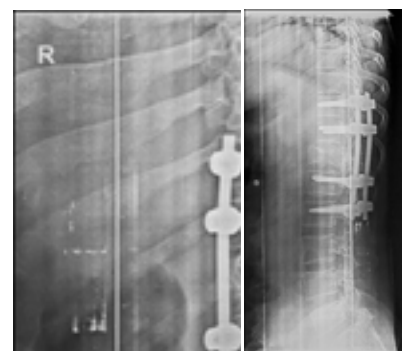
### Conclusion:

There is a broad spectrum in the methods for the management of thoracic burst fractures ranging from simple conservative to anterior and posterior decompression with fixation. Among these ligamentotaxis with long segment screw fixation falls in middle range of the spectrum, providing less aggressive surgery and beneficial clinical and technical outcome. Thus providing a good therapeutic option in the management of thoracic burst fractures. Due to limited number in the current study, we advocate larger studies to be conducted to enhance the

knowledge on this technique.



**Figure 2: Showing AP and Lateral radiograph of a patient with T12 burst fracture with increased vertebral body angle and MRI showing retropulsion of fracture fragment with intact PLL.**



**Figure 3: Showing AP and Lateral radiograph postoperatively with posterior instrumentation and correction of kyphosis.**

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