The Effect of Ligamentotaxis on Clinical and Radiological Outcomes in Thoracolumbar Burst Fractures with High McCormack Grade

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ABSTRACT

The aim of this study was to investigate the effect of ligamentotaxis performed in combination with the posterior surgical approach in thoracic and lumbar burst fractures due to high-energy trauma with high McCormack scores (≥7). This observational study was conducted at the University of Health Sciences from January 2015 to December 2020. Medical records of 16 patients were retrospectively evaluated. The vertebral height measurements, local kyphosis angles, and anteroposterior spinal canal diameter were measured pre- and postoperatively. American Spinal Injury Association (ASIA), McCormack, and thoracolumbar injury classification and severity (TLICS) scores were also evaluated. All postoperative measurements showed a significant change. There was no statistical significance in the pre- and postoperative ASIA grades. No screw breakages were observed within a mean follow-up period of 35.50±11.79 months. Ligamentotaxis effectively increased the spinal canal diameter and provided vertebral height restoration and kyphosis angle correction in thoracolumbar burst fractures with a high McCormack score. However, no significant neurological improvement was observed in cases with neurological deficits, although laminectomy was performed with ligamentotaxis.

Key Words: *Ligamentotaxis, Lumbar vertebrae, Spine, Thoracic vertebrae, Thoracolumbar burst fractures, Trauma*.

How to cite this article: Secer M, Gurbuz H, Gulcu A. The Effect of Ligamentotaxis on Clinical and Radiological Outcomes in Thoracolumbar Burst Fractures with High McCormack Grade. *J Coll Physicians Surg Pak* 2023; **33(03)**:355-357.

Thoracic and lumbar burst fractures are common spinal injuries caused by affecting the anterior and middle vertebral column after axial loading with or without flexion. Its classic findings are crash of the vertebral corpus, kyphotic deformity, compression of the spinal canal by retro-pulse bone fragments, and neurological deficits due to this compression. Ligamentotaxis is a method that provides restoration of the bone structure with the help of solid distraction force transferred to sturdy ligament and capsular structures. Ligamentotaxis in spinal fractures shows its efficacy by transferring the distraction force applied to pedicular screws to the posterior longitudinal ligament (PLL). As a result, it provides the restoration of the vertebral height, the acquisition of lordosis, the correction of kyphosis and, in some cases the expansion of the spinal canal.[1]

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Received: June 04, 2022; Revised: November 02, 2022; Accepted: December 02, 2022
DOI: https://doi.org/10.29271/jcpsp.2023.03.355

This study aimed to investigate the effect of ligamentotaxis performed in combination with the posterior surgical approach in thoracic and lumbar burst fractures due to high-energy trauma with high McCormack scores (≥7).

The medical records of the patients who underwent ligamentotaxis in addition to the posterior approach due to thoracic and lumbar single-level burst fractures between January 2015 and December 2020 were retrospectively evaluated. Patients who were operated on in the first 72 hours for high-energy post-traumatic thoracic and lumbar burst fractures with McCormack scores ≥7 were included in the study. Patients with osteoporotic or pathological fractures and McCormack score <7 were excluded. American Spinal Injury Association (ASIA) and Thoraco-Lumbar Injury Classification and Severity (TLICS) scores were used for neurological evaluation.

The posterior ligamentous complex and PLL were evaluated with magnetic resonance imaging. Multiplanar computed tomography imaging taken at the first admission to the emergency department and within the first 24 hours postoperatively were used for the measurements. Vertebral heights were measured from the anterior, midline, and posterior parts of the fractured vertebral corpus, both pre- and postoperatively, in sections passing through the sagittal midline.

Table I: Comparison of pre- and postoperative measurements of vertebral heights, local kyphosis angle, and anteroposterior diameter of the spinal canal.

		Preoperative; Median (25 – 75P)	Postoperative; Median (25 – 75P)	Hodges-Lehmann; (95% CI)	z	p
Vertebral height	Anterior; cm	1.73 (1.38 – 2.03)	2.14 (1.86 – 2.26)	0.37 (0.23 – 0.51)	-3.517	<0.001
	Midsagittal; cm	1.42 (0.95 – 1.88)	1.83 (1.50 – 2.17)	0.29 (0.18 – 050)	-3.517	<0.001
	Posterior; cm	2.24 (2.10 – 2.60)	2.49 (2.35 – 2.68)	0.16 (0.09 – 0.28)	-3.517	<0.001
	Kyphosis angle; °	15.55 (13.05 – 20.90)	12.55 (11.18 – 15.95)	-2.95 (-4.10 – -2.15)	3.517	<0.001
	Spinal canal diameter; mm	10.00 (8.00 – 12.50)	12.75 (11.25 – 14.86)	2.63 (1.50 – 4.00)	-3,413	<0,001
		The postoperative rise in the vertebral height, correction in the kyphosis angle, and increase in the spinal canal diameter				
		Measurement Median (25 – 75P)	**Percentage Median (25 – 75P)**			
Vertebral height	Anterior; cm, %	0.38 (0.15 – 0.59)	24.94 (6.89 – 41.35)			0.026*
	Midsagittal; cm, %	0.26 (0.10 – 0.48)	19.09 (6.69 – 51.71)			
	Posterior; cm, %	0.14 (0.04 – 0.27)	5.66 (2.01 – 12.96)			
	Kyphosis angle; °, %	2.85 (1.93 – 4.05)	18.39 (9.14 – 24.74)			
	Spinal canal diameter; mm, %	2.25 (1.00 – 4.63)	25.00 (7.63 – 55.21)			

*CI: Confidence interval; P: Percentile. *p-value is significant with the Kruskal-Wallis test. The difference was between anterior and posterior vertebral height rise percentage with post hoc analysis.*

The local kyphosis angle was obtained by measuring the angle between the upper endplate of the intact vertebra above the fractured vertebra and the lower endplate of the intact vertebra below the fractured vertebra. The anteroposterior diameter of the spinal canal was measured in the sagittal sections.

All of the cases were operated with a posterior approach. In the cases with thoracolumbar junction (Th10 – L2) fractures, unilateral or bilateral short pedicular screws were placed in the two lower and two upper levels of the fractured vertebra if the pedicle was intact. Total laminectomy was performed in cases with neurological deficits. After the rod was placed, the cap of the screw under the fractured vertebra was tightened, and ligamentotaxis was performed on the rod with the help of a distractor.

The statistical data were analysed using SPSS Statistics for Windows version 25.0, 2017 (Armonk, NY: IBM Corp.). Nonparametric tests were used if the assumptions of a parametric test could not be met. The results were expressed as median (25-75 percentiles) for continuous and numbers (percentages) for categorical data. The pre- and postoperative measurements of vertebral heights, local kyphosis angles, and spinal canal diameters were compared using the nonparametric Wilcoxon Signed Ranks test. The Hodges–Lehmann method was used to estimate median differences with 95% confidence intervals (95% CI) for vertebral heights, local kyphosis angle, and spinal canal diameter measurements. The significance of the change of pre- and postoperative matched pairs of the ordinal categorical values of the neurological impairment scores (ASIA grades) was tested using the marginal homogeneity test.

The nonparametric Kruskal-Wallis test was used to compare the three groups of the rising percentage, and *post hoc* Bonferroni correction was performed if there was statistical significance. The correlation of the parameters was analysed with Spearman's correlation test. A p-value <0.05 was considered statistically significant for all statistical analyses.

The mean age of the cases was 37.69 ± 13.04 (19 – 57) years. All postoperative measurements significantly changed compared to preoperative measurements (Table I). There was no statistical significance in the pre- and postoperative ASIA grades (p=0.059). Additionally, correlation coefficients of McCormack score, TLICS score, postoperative ASIA grades, postoperative correction percentage of the kyphosis angle, postoperative increase percentage in the spinal canal diameter, and the postoperative rise percentage in the vertebral height were not statistically significant (p>0.05).

One 46-year male patient with a preoperative ASIA grade A, McCormack score of 9, and TLICS score of 7 died in the hospital after a 1-month follow-up in the ICU due to thoracic trauma (lung contusion, haemopneumothorax), leading to acute respiratory distress syndrome, and sepsis. All 3 patients with neurological deficits showed an immediate neurological improvement in the early postoperative period (ASIA grades from B to D, C to D, and B to E). The mean follow-up period was 35.50±11.79 (20–52) months. None of the patients showed neurological deterioration; additionally, no pedicle screw breakages were observed during the long-term follow-up period.

The main goal of treating thoracic and lumbar burst fractures is to provide neurological recovery by removing the compression of the retro-pulse bone fragments extending into the spinal canal.[2] For decompression, performing either anterior support following corpectomy through an anterior approach or ligamentotaxis using PLL through a posterior approach is recommended.[1] While the discussion of which technique (combined with anterior support or posterior-only) is superior is still inconclusive; a recent meta-analysis reported no significant difference between the two methods in terms of postoperative kyphosis correction, pain scores, and functional outcomes.[3] Additionally, it was suggested that the posterior-only technique offered lower intraoperative blood loss, shorter surgical duration, and hospital-stay time than the combined technique.[3]

The McCormack load-sharing classification system plays an essential role in the decision of the anterior or posterior surgery method.[4] Accordingly, posterior short-segment stabilisation is recommended for burst fractures with <6 points. However, in high-grade burst fractures (≥7), stabilisation with a short-segment pedicular screw is considered dangerous and inappropriate management.[1] Based on these previous suggestions, it was stated in a recent meta-analysis that the McCormack load-sharing score <6 was 100% reliable as an indicator of the applicability of the posterior-only technique.[5] Furthermore, the authors indicated that the risk of implant breakage was low in patients with the McCormack load--sharing score of ≥7 with the posterior-only technique.[5]

It has been shown in many studies that ligamentotaxis increases the spinal canal area and also as presented in this study, restores vertebral height and decreases the local kyphosis angle.[1,2] Laminectomy and posterior stabilisation are the most commonly used techniques in thoracolumbar burst fractures in the presence of neurological deficits. However, some authors believe decompressing neural tissue does not contribute to neurological recovery.[6] Similarly, in this study, although laminectomy was performed in addition to ligamentotaxis in patients with neurological deficits, no significant neurological improvement was observed. The limited number of cases and retrospective nature of the study were the major limitations of this study.

In conclusion, in thoracolumbar burst fractures with a high McCormack score, ligamentotaxis has effectively reduced the kyphosis angle, increased spinal canal diameter, and provided vertebral height restoration. However, no significant neurological improvement was observed in cases with neurological deficits despite laminectomy with ligamentotaxis.

ETHICAL APPROVAL:

The protocol of this study was approved by the institutional ethics committee (decree #07-06).

COMPETING INTEREST:

The authors declared no competing interest.

AUTHORS' CONTRIBUTION:

HG: Drafted the work; analysed and interpreted data for the work.

MS, AG: Drafted the work and finally approved it to be published.

MS: Contributed to the conception/design of the work and revised it critically.

All the authors have approved the final version of the manuscript to be published.

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