INTERNATIONAL JOURNAL OF INTEGRATIVE AND MODERN MEDICINE

Optimization of Surgical Treatment for Traumatic Injuries of the Thoracolumbar Spine Complicated by Neurological Deficit

Khudayberdiyev K. T
Andijan State Medical Institute.

Isakov B. M.
Andijan State Medical Institute.

Abstract: Complicated thoracolumbar spine injuries accompanied by spinal cord damage remain a significant challenge in clinical practice due to their high rates of long-term disability and the complexity of managing them. Often resulting from high-energy trauma such as motor vehicle accidents or falls from height, these injuries can lead to severe neurological deficits including paraplegia or quadriplegia depending on the level and severity of the injury. The optimal treatment strategy is controversial as it requires careful consideration of the balance between spinal stabilisation, neural decompression and functional recovery. Against this backdrop, the present study sought to evaluate the surgical outcomes of 176 patients with complex thoracolumbar spine trauma who were treated at a specialised neurosurgical centre over a defined period. Patients were stratified into distinct groups according to the surgical approach chosen, including transpedicular fixation, decompressive laminectomy and combined procedures incorporating both stabilisation and decompression techniques. Adjunctive postoperative electrical stimulation was employed in selected cases. Neurological assessment was systematically performed using the ASIA/IMSOP scale, enabling objective quantification of motor and sensory recovery. The study findings indicate that patients undergoing combined surgical interventions demonstrated significantly greater neurological improvement and enhanced functional outcomes compared to those treated with stabilisation or decompression methods alone. Furthermore, the results suggest that early and comprehensive surgical management, particularly when combined with adjunctive therapies, may facilitate favourable long-term recovery, reduce the risk of secondary complications and improve quality of life. These observations emphasise the importance of personalised, multidisciplinary treatment planning in managing complicated cases.

Furthermore, the results suggest that early and comprehensive surgical management, particularly when combined with additional therapies, may lead to a more favourable long-term recovery and reduce the risk of secondary complications. This approach can also improve overall quality of life. These findings highlight the importance of personalised, multidisciplinary treatment planning in managing complicated thoracolumbar spine injuries.

Keywords: thoracolumbar spine, complicated injury, spinal cord trauma, transpedicular fixation, decompression, electrical stimulation.

Introduction

The rapid development of minimally invasive surgical technologies in recent decades has revolutionized abdominal surgery. In particular, laparoscopic cholecystectomy has become the most frequently used surgical method in the treatment of cholelithiasis and has almost completely supplanted open cholecystectomy in practice. Currently, millions of patients worldwide undergo gallbladder removal annually, the majority of which are performed laparoscopically. The reason for the widespread use of this method is the small extent of the surgical trauma, the relative mildness of the postoperative pain syndrome, the short length of hospital stay, and the patient's ability to return to work more quickly[1].

Traumatic spinal injuries, particularly those involving damage to the spinal cord and its roots, remain one of the most challenging issues in modern neurosurgery. Such injuries carry a high risk of permanent neurological impairment, long-term disability and a significant socio-economic burden[1]. Not only does the loss of motor and sensory function reduce patients' quality of life, it also imposes considerable demands on healthcare systems and rehabilitation services. Therefore, the search for optimal, evidence-based surgical strategies that promote early functional recovery and prevent secondary complications is highly relevant[2].

Injuries to the thoracolumbar region occupy a special place within the overall structure of spinal trauma due to their distinct anatomical and biomechanical characteristics. The thoracolumbar junction is a transitional zone between the relatively rigid thoracic spine and the more mobile lumbar segment. This structural transition leads to the concentration of mechanical loads, particularly during high- energy trauma, thereby increasing this region's susceptibility to unstable and complex injuries. Consequently, fractures and fracture-dislocations at the Th12–L1 level are among the most frequently encountered lesions in clinical practice[3].

According to both domestic and international studies, thoracolumbar injuries account for 35–55% of all spinal injuries. Notably, more than half of affected patients exhibit neurological deficits of varying severity, ranging from mild sensory disturbances to total motor impairment. Such impairments significantly worsen the functional prognosis and complicate the rehabilitation process. Furthermore, delayed or inadequate treatment can result in progressive spinal deformity, chronic pain syndromes and irreversible neurological damage[4].

Despite significant advances in spinal surgery, including the development of modern fixation systems and minimally invasive techniques, the optimal treatment strategy for complicated thoracolumbar injuries remains debated. Contemporary surgical approaches focus not only on achieving stable fixation of the damaged spinal segment, but also on effectively decompressing neural elements, restoring the sagittal alignment of the spine and preventing secondary post-traumatic deformities. These objectives are essential for creating favourable conditions for neurological recovery and functional restoration[5].

An important factor influencing treatment outcomes is the timing of surgical intervention. Early stabilisation and decompression have been shown to reduce the risk of secondary spinal cord injury caused by ongoing compression, ischaemia, and inflammatory processes. Furthermore, combining different surgical techniques, such

as transpedicular fixation, decompressive laminectomy and anterior or combined approaches, plays a crucial role in achieving optimal results[6]. In recent years, increasing attention has also been given to adjunctive methods, such as postoperative electrical stimulation, which has shown promise in enhancing neural regeneration and improving functional recovery by activating residual neural pathways.

Given these considerations, the present study aims to evaluate the clinical and neurological outcomes of surgical treatment in patients with complicated thoracolumbar spine injuries using various methods of stabilization and decompression. By analyzing the effectiveness of different surgical approaches, this research seeks to contribute to the optimization of treatment strategies and improvement of patient outcomes in this complex and clinically significant field of neurosurgery[7].

Material and methods of research

The study included 176 patients with complicated injuries of the thoracolumbar spine, who were treated in the specialized neurosurgical department of the Andijan branch of the RSCEMP.

The age of the patients ranged from 18 to 65 years. Men constituted 114 (64.8%) patients, women - 62 (35.2%). The duration of the injury at the time of admission ranged from 3 hours to 3 days.

The main mechanisms of injury were catatravma (125 cases), road accidents (47 cases), and criminal trauma (4 cases).

The examination included clinical and neurological examination, spinal radiography, computed tomography and magnetic resonance imaging, as well as ultrasound examination of the abdominal organs to exclude combined injuries. The degree of neurological deficit was assessed on the ASIA/IMSOP scale.

The distribution of patients by injury level is presented in the table. 1.

Table 1.

Distribution of patients by injury level

Pol bolnых	Uroven povrejdeniya pozvonochnika						Vsego
	Th9	Th10	Th11	Th12	Th12-L1	L1	
Mujchinы	4	4	9	27	12	58	114 (64,7%)
Jenщinы	2	3	12	26	6	13	62 (35,2%)
Vsego:	6	7	21	43	18	71	176

As can be seen from the data presented in Table 1, patients with damage to the Th12 spine constituted 43 (24.4%), the L1 spine - 71 (40.3%), the transitional Th12-L1 spine - 18 (10.2%) victims.

Kifotic spinal deformity was determined by lateral radiographs using the Cobb method: deformation from 0 to 10° was detected in 51 (38.9%) patients, 11-20° - in

62 (44.3%), above 20° - in 18 (13.7%).

A B

Figure 1. Kyphotic deformity with spinal canal stenosis (A - direct projection, B - lateral projection).

Indicators of the reserve spaces of the spinal canal were determined by MSCT and calculated according to the formula: (A+S/2-V) / (A+S/2)

where A - channel indicators above the fracture zone; V - channel indicators at the level of overlap; S - indicators below the level of spinal fracture.

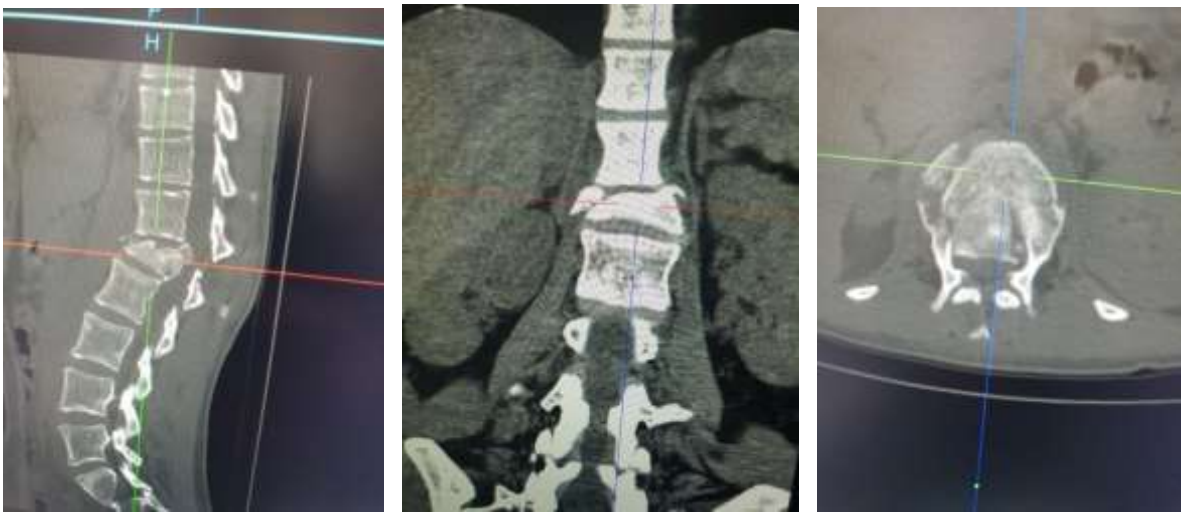

Fig.2. MSCT of the thoracolumbar spine: a) compression-fragmented fracture of the body of the spine, post-traumatic stenosis of the spinal canal.

The obtained results of changes in the reserve spaces of the spinal canal are presented in the table. 2.

Table 2.

Changes in the reserve spaces of the spinal canal.

Sujenie pozvonochnogo kanala (v %)	Kolichestvo bolnых	V % otnoshenii
0 – 25	74	42,0%
26 – 50	62	35,2%
51 – 75	29	16,4%
76 - 100	11	6,2%

As can be seen from the data presented in Table 2, in 102 (57.9%) patients, a decrease in the reserve spaces of the spinal canal was detected, more than 26% of the calculated normal value.

Results and Discussion

This study was conducted based on retrospective and prospective clinical analysis and studied the treatment outcomes of 120 patients with iatrogenic complications after laparoscopic cholecystectomy. The study was conducted at the clinical bases of the Andijan State Medical Institute, taking into account the age, sex, type of operation, time of occurrence and severity of complications.

Analysis of injury localisation revealed a clear predominance of lesions at the Th12- L1 level, confirming the biomechanical vulnerability of the thoracolumbar junction as the transitional zone between the rigid thoracic spine and the mobile lumbar spine. Post-traumatic kyphotic deformity of varying severity was identified in the majority of patients, with angular deformities being quantitatively assessed using the Cobb method. The degree of kyphosis was found to correlate with the extent of vertebral body destruction and posterior column involvement[8][9].

According to multislice computed tomography (MSCT) data, a reduction in spinal canal reserve space of over 26% was observed in 57.9% of patients. This degree of stenosis was considered clinically significant, serving as the primary indication for decompressive surgical intervention due to the high risk of persistent spinal cord compression and neurological deterioration[10].

Patients were stratified into three groups based on the surgical approach. The first group comprised 112 patients who underwent isolated posterior stabilisation using a transpedicular fixation system without decompression of the spinal canal. The second group consisted of 47 patients who underwent decompressive laminectomy combined with transpedicular stabilisation to achieve both neural decompression and restoration of spinal stability[11]. The third group comprised 17 patients who underwent combined surgical treatment supplemented with postoperative electrical stimulation to enhance neurofunctional recovery[12].

Comparative evaluation of treatment outcomes revealed that the most favorable clinical and neurological results were achieved in the third group. Improvement in neurological status, as assessed by standardized scales, was observed in 75% of patients receiving combined therapy. This suggests that the integration of decompressive, stabilizing, and neuromodulatory techniques provides a synergistic effect, contributing to improved restoration of neural conduction and functional

outcomes. These findings underscore the importance of a multimodal and individualized surgical strategy in the management of complicated thoracolumbar spine injuries[13].

Figur.3 Stabilization of the damaged spinal segment with TPF

The obtained results confirm the literature data on the key role of early stabilization and adequate decompression in the prevention of secondary spinal cord injury. Transpedicular fixation provides reliable stabilization of the damaged segment, and decompressive interventions contribute to the elimination of compression of nerve structures[14].

Supplementing surgical treatment with post-operative electrostimulation methods allows for the activation of restorative processes and improvement of functional outcomes, which makes the combined approach the most promising[15]. Vivodi

1. The most common mechanism of complicated trauma in the thoracolumbar spine is catatravma.
2. Transpedicular fixation effectively prevents the development of secondary spinal deformity.
3. Decompressive interventions contribute to a more pronounced regression of neurological deficit.
4. A combined surgical approach with the use of electrical stimulation provides better clinical results.

Conclusion

The findings of the present study highlight the critical importance of timely and adequate surgical management for patients with complicated thoracolumbar spine injuries. The prevalence of high-energy trauma, particularly catatrauma, highlights the severity of these injuries and their link to substantial neurological impairment. The results show that transpedicular fixation reliably stabilises the injured spinal

segment, preventing the progression of post-traumatic deformities and maintaining spinal alignment.

Meanwhile, decompressive surgical interventions play a pivotal role in alleviating spinal cord and nerve root compression, facilitating a more pronounced regression of neurological deficits. The improvement in clinical and functional outcomes observed highlights the necessity of integrating decompression procedures in patients with radiologically confirmed spinal canal compromise.

Notably, the addition of postoperative electrical stimulation significantly accelerates recovery by promoting neural conductivity and activating regenerative mechanisms within the spinal cord. The

superior outcomes observed in patients undergoing combined treatment suggest that a multimodal surgical approach has clear advantages over stabilisation or decompression techniques alone.

In summary, the optimal management of complicated thoracolumbar spine injuries should be based on an individualised strategy combining stable fixation, adequate decompression and neurostimulation methods. This approach improves neurological recovery and contributes to better long-term functional outcomes, reducing the risk of disability and improving quality of life for affected patients.

References

[1] R. Yu. Abdullaev and A. A. Grin, Povrezhdeniya pozvonochnika i spinnogo mozga. Moscow: GEOTAR-Media, 2021.

[2] A. V. Alekseev and V. N. Merkulov, Diagnostika i lechenie travm pozvonochnika. St. Petersburg: SpesLit, 2020.

[3] A. N. Belova, Neyroreabilitatsiya. Moscow: MEDpress-inform, 2019.

[4] A. A. Grin and V. V. Lebedev, "Xirurgicheskoe lechenie oslojnennykh povrezhdeniy pozvonochnika," Voprosy Neyrokhirurgii, no. 2, 2018.

[5] N. A. Konovalov and V. A. Shabalov, Xirurgiya pozvonochnika. Moscow: GEOTAR-Media, 2017.

[6] N. E. Polishchuk, Spinal Cord Injury. Kyiv: Zdorov'ya, 2016.

[7] A. R. Vaccaro et al., "AOSpine thoracolumbar spine injury classification system," Spine, vol. 38, no. 23, pp. 2028–2037, 2013.

[8] M. G. Fehlings et al., "Early vs. delayed decompression for traumatic spinal cord injury," PLoS ONE, vol. 12, no. 1, p. e0170718, 2017.

[9] A. F. Joaquim and A. A. Patel, "Thoracolumbar spine trauma: Evaluation and surgical decision-making," J Craniovertebr Junction Spine, vol. 7, no. 1, pp. 3–9, 2016.

[10] S. Harkema et al., "Effect of epidural stimulation of the lumbosacral spinal cord," The Lancet, vol. 377, no. 9781, pp. 1938–1947, 2011.

[11] G. Taccola, D. Sayenko, and P. Gad, "Spinal cord neuromodulation," Brain Research, vol. 1697, pp. 1–18, 2018.

[12] C. S. Ahuja et al., "Traumatic spinal cord injury," Nature Reviews Disease Primers, vol. 3, p. 17018, 2017.

[13] B. Aarabi et al., "Surgical decompression for traumatic spinal cord injury," Neurosurgical Focus, vol. 33, no. 1, p. E11, 2012.

[14] C. G. Fisher et al., "Reliability and validity of a classification system for thoracolumbar injuries," Spine, vol. 30, no. 20, pp. 2325–2333, 2005.

[15] F. C. Oner et al., "AO spine classification of thoracolumbar injuries,"