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Surgical Decision-Making in Thoracolumbar Fractures: A Systematic Review of Anterior and Posterior Approach

Shekhar Mishra[1], Pankaj Kumar Mishra[1], Virendra Kumar Verma[1], Mohit Issrani[1], Swasti Sundar Prasad[1], Vishwakarma C Hodigere[1]

Learning Point of the Article:

Posterior approach is relatively safer, and easier for the management of thoracolumbar fracture.

Abstract

Introduction: Fractures in the thoracolumbar region of the vertebral column are very common and often require surgical intervention. Surgery is typically aimed at restoring or maintaining neurological function and correction of the vertebral column.

Systematic Review: There are two commonly used approaches for surgery, the anterior and the posterior approach. Uncertainties remain regarding the best surgical approach for the treatment of traumatic thoracolumbar fractures. The results of studies comparing the anterior and posterior surgical approaches for treating thoraco-lumbar fractures have been compiled in this review. Numerous metrics, including neurological results, Cobb angle recovery, and post-operative complications, have been used. It was observed that both approaches yielded a similar result when considering the improvement in Frankel grades and recovery of the Cobb angle.

Conclusion: We further report that patients undergoing decompression using the anterior approach incurred higher blood loss, longer hospital stays, and higher operating costs; these findings support the posterior approach as being safer and more practical.

Keywords: Thoracolumbar, fracture, outcome, anterior, posterior.

Introduction

The thoracolumbar region, which incorporates four vertebrae from the tenth thoracic vertebra down to the second lumbar vertebra, is the most common area to be injured in spinal trauma [1]. It is where the curve of the spine changes from the well-fixed thoracic spine to the mobile lumbar spine. The information references the fact that 90% of spinal fractures happen in the thoracolumbar region. Among young people, the most common cause of thoracolumbar fractures is high-energy trauma from accidents such as car or motorcycle collisions and falling from an elevation [2]. However, in the elderly population, it may happen with a trivial fall. The cause of these fractures may be osteoporosis and a reduced mental cognition leading to slip and fall [3]. If the patients have experienced severe trauma, it is possible that complications, such as paralysis and deformity may occur after the accident.

Even if the patients do not experience the complications, there is a likelihood that the patient will have to limit their daily activity and that they will end up with chronic pain, which can make it difficult to get back to work or their life before the trauma [3]. The main purpose of thoracolumbar fracture therapy is safeguarding them from fresh neural injures, ensuring firmness

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Dr. Shekhar Mishra | Dr. Pankaj Kumar Mishra | Dr. Virendra Kumar Verma | Dr. Mohit Issrani | Dr. Swasti Sundar Prasad | Dr. Vishwakarma C Hodigere

[1]Department of Orthopaedic Surgery, All India Institute of Medical Sciences Bhopal, Madhya Pradesh, India.

Address of Correspondence:
Dr. Pankaj Kumar Mishra,
Department of Orthopaedics, All India Institute of Medical Sciences Bhopal, Madhya Pradesh, India.
E-mail: drpankajv@yahoo.com

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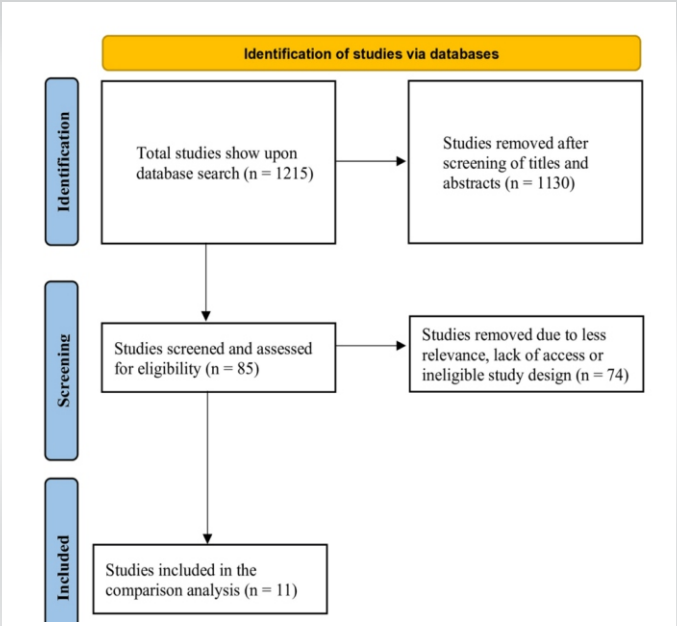

Figure 1: Study flow chart according to the PRISMA guidelines.

Selected studies	Number of patients		Male		Female	
	Anterior	Posterior	Anterior	Posterior	Anterior	Posterior
Zhang et al. [12]	2	17		19		12
Danisa et al. [18]	16	27	11	19	5	8
Wood et al. [19]	20	18	12	13	8	5
Sasso et al. [20]	40	13	29	10	11	3
Hitchon et al. [21]	38	25	26	19	12	6
Lin et al. [22]	32	32	14	16	18	16
Wu et al. [23]	14	28				
Jiang et al. [24]	40	40				
Shin et al. [25]	22	24	17	13	5	11
Yao et al. [26]	40	40				
Tan et al. [27]	25	83	18	41	7	42

Table 1: The variation in demographic details of the patients in selected studies.

by creating back bone's anatomical arrangement during surgical procedures, and exposing the sufferers to fast mobilization recovery, which can facilitate their quick return to employment.

The AO classification is recognized as the most prevalent system for categorizing thoracolumbar spinal injuries [4-6]. The fracture morphology, "mechanical stability" and injury mechanism are considered in three divisions, which are referred to as the compression group, distraction group, and rotation group. Each category has subcategories from A1 to C3 level on the basis of severity of fractures. When one stops at A or B it means they met less severe thoracolumbar fractures or stable injury(ies) while going up to C signifying more severe thoracolumbar fractures or unstable injury(ies) but however this classification system does not cover all thoracolumbar fractures.

Spine Trauma Group introduced the Thoracolumbar Injury Classification and Severity Score (TLICS) in the year 2005 to fill out the lacunae of the previous classification system of thoracolumbar fractures. It helps in the decision-making about the treatment of fractures by combining both clinical features and imaging findings. Thus, TLICS scoring is done through three parameters; injury morphology; posterior ligamentous complex integrity; and neurologic status. Morphological patterns include wedge compression fracture (1 point), burst

Study	Frankel Grade of patients after surgery	
	Anterior approach	Posterior approach
Zhang et al. [12]	--	73% of patients showed improvements.
Danisa et al. [18]	38% of patients showed improvement	4.0±1.4 (mean change 0.5). Improvement in most cases.
Sasso et al. [20]	30 out of 33 patients at follow-up showed improvement in Frankel grade	3 did not show a change in Frankel grade. Other 10 showed an improvement of Frankel grade by at least 1 grade.
Hitchon et al. [21]	Improvement in most cases	An improvement in Frankel grade seen in all cases.
Lin et al. [22]	Increase by approximately 1.3 Frankel grade Average score of 4.2±0.8 (mean change of 0.5)	Increase by approximately 1.3 Frankel grade
Shin et al. [25]	improved from 3.5 ± 1.2 to 4.3 ± 0.9	Improved from 3.5 ± 0.7 to 4.5 ± 0.9

Table 2: The Frankel Grade of patients after surgery in selected studies.

Study	Postoperative complications	
	Anterior approach	Posterior approach
Danisa et al. [18]	No mortality. Complications in 4/16 patients	No mortality. Complications in 4/27 patients.
Wood et al. [19]	Complications seen in 3/20 patients	Complications seen in 17/18 patients.
Sasso et al. [20]	No complications seen	No complications seen
Hitchon et al. [21]	2 patients needed repeated surgery	Complications seen in 5/25 patients.
Lin et al. [22]	Postoperative complications seen in most patients.	Postoperative complications seen in less patients.
Jiang et al. [24]	Complications seen in 20% of the patients	Complications seen in 9% of the patients.
Shin et al. [25]	Postoperative complications reported in 3/22 patients.	No postoperative complications reported
Yao et al. [26]	Complications seen in 10% of patients	Complications seen in 47.5% of patients

Table 3: Postoperative complications after surgery in selected studies.

Study	Postoperative Kyphotic (Cobb) angle	
	Anterior approach	Posterior approach
Danisa et al. [18]	16.1° (±8.1°; range 5°–35°)	15.2° (±8.3°; range 0°–32°)
Wood et al. [19]	5° (range: -8 –25°)	4.5° (range: -10 –16°)
Sasso et al. [20]	3.5° (mean post-operative Cobb angle)	7.4° (range, 0–28°)
Hitchon et al. [21]	4.5±9.3°	9.8±9.4°
Lin et al. [22]	5.23±0.91°	5.13±1.01°
Wu et al. [23]	4.8±1.6	4.7±1.1
Jiang et al. [24]	42.35±4.66	31.19±4.15
Shin et al. [25]	11.9 ± 5.4	6.5 ± 6.2
Yao et al. [26]	2.5±0.3	8.9±1.6
Tan et al. [27]	7.6° (Range: 4.5–10.0°)	9.2° (Range: 4.6–12.5°)

Table 4: The postoperative kyphotic (Cobb) angle parameters in selected studies.

Study	Length of stay/Return to work	
	Anterior approach	Posterior approach
Zhang et al. [12]	4±1.5 days	2.1±0.5 days
Danisa et al. [18]	4.9 days (± 3.1; range 1–12 days) stay	4.2 days (± 2.9; range 1–13 days) stay
Wood et al. [19]	55% return to work	44% return to work
Shin et al. [25]	40.8 ± 27.7 days hospital stay	14.9 ± 7.4 days hospital stay
Yao et al. [26]	9.5±1.3 days hospital stay	6.7±0.6 days hospital stays
Tan et al. [27]	80.8% (42 of 52 cases) return to work	84.0% (42 of 50 cases) return to work

Table 5: The postoperative Length of stay and return to work.

fracture (2 points), translation/rotation (3 points), and distraction (4 points). Posterior ligamentous complex injury status scored intact (0 points), suspected or indeterminate (2 points), or injured (3 points) as well. Neurologic involvement assigns 0 points for intact status, 2 points, for nerve root, or complete spinal cord injuries, and 3 points, for incomplete cord or cauda equina injuries. The high score, that is 3, on incomplete cord injury as compared to 2 on complete injury is due to the larger potential gain that surgery can result in. The TLICS provides a well-defined, inclusive structure for evaluating thoracolumbar injuries while balancing radiologic and clinical evaluations [7].

There are two main surgical techniques in the treatment of these fractures-the anterior approach and the posterior approach. The anterior approach involves anterior internal fixation after withdrawal of the fractured vertebra and decompression of the nerve [8-10]. Titanium plates are used to fix the vertebrae in order to obtain good decompression. However, the anterior approach poses a greater risk to the patient due to the intricacy of the anatomy and surgical procedure. Vascular injuries of the aorta, vena cava, or one of the segmental arteries can occur, which can be life-threatening or lead to hemorrhage or thrombosis. Neurological complications include injury to the sympathetic chain as well as damage to nerve roots or the spinal cord with resultant motor or sensory deficits. There can be injuries to the lungs, diaphragm, or abdominal organs, which can lead to complications such as pneumothorax or perforation. There is an increased possibility of acquiring retroperitoneal or mediastinal infections due to inherent wounds that bring the abdominal and thoracic structures closer. The surgical-accessory issues have an effect on length of surgery and patient outcomes. Complications may include postoperative pain, hernia, or instability at the access site. However, careful preoperative planning, accuracy of surgical technique, and departmental collaboration may decrease these risks [11]. Conversely, the posterior approach combines posterior direct or indirect decompression with or without laminectomy. Proponents of posterior surgery have documented excellent outcomes, including minimal patient morbidity, postoperative neurological improvement, spinal stability, and anatomical alignment. Additionally, posterior surgery has comparatively lower technical requirements [12].

Both the anterior and the posterior methods have their advantages and pitfalls. It is also important to note that the success of the surgery also depends on several variables like the level of damage which significantly entails the surgical approach, since more complicated or greater injuries, may need a combination of anterior-posterior surgical approaches, so that the better stability and decompression may be achieved. Patient age is another consideration; older people's bones tend to be of poorer quality, have associated comorbidities, or have lower capacity for healing. All this effect the surgical approach and recovery following surgery. The sagittal index, which corresponds to the alignment and curvature of the spine, is critical for restoring balance and ensuring long-term functional outcomes; failure to correct this malalignment appropriately can lead to complications like adjacent segment disease or persistent pain. The degree of neurological deficit will determine the immediacy and extent of the decompression that is required. Most of the time, incomplete deficits require aggressive intervention to achieve the greatest degree of recovery potential; stabilization in the face of a complete deficit may be warranted, even if little improvement is anticipated. All

Study	Estimated blood loss	
	Anterior	Posterior
Zhang et al. [12]	492±103 ml	317±162 ml
Danisa et al. [18]	1878 cc (±777 cc)	1103 cc (±793 cc)
Wood et al. [19]	784 mL (range: 250–1400 mL)	460 mL (range: 150–900 mL)
Lin et al. [22]	811.6±175.3 ml	720.0±179.9ml
Wu et al. [23]	255.1 ml ± 38.4 ml	143.3 ml±28.3 ml
Jiang et al. [24]	255.4±30.6 ml	152.3±25.5 ml
Shin et al. [25]	1566 ml	289 ml
Yao et al. [26]	416.9±45.9 ml	248.0±32.7 ml
Tan et al. [27]	970 ml (Range: 255–1878 ml)	558 ml (Range: 117–1103 ml)

Table 6: The estimated blood loss in selected studies.

these together determine surgical planning, approach selection, prognosis, and so on [13-15]. Currently, no consensus has been reached regarding whether the anterior or the posterior approach is better for surgical intervention to treat thoracolumbar fractures [16, 17]. Thus, the objective of this study is to systematically review relevant clinical trials to understand what surgical approach may be better in which context.

Review

Materials and methods

Literature search

Two databases: PubMed and Embase were searched for relevant studies up to 2024. The search terms were "anterior approach", "posterior approach" "thoracolumbar fracture," and "clinical trial" along with AND/OR operators.

Selection criteria

Only the trials with the following characteristics were included in the study: (i) Patients exhibited T10-L2 fractures. (ii) anterior or posterior approach for surgery was used. (iii) standard indicators to assess the efficacy of the approach were used. (iv) only articles with full text available were considered for the study.

Data extraction

Information regarding the study design, patient demographics, inclusion and exclusion criteria, interventions, outcomes, follow-up duration, and rate of lost to follow-up duration for each treatment group was extracted.

Results

Selection of studies

The protocol for the selection of studies is shown in Fig. 1. On a thorough literature survey of two databases: PubMed and Embase, we found a total of 1215 studies that could potentially be included in this study. After screening the titles and the abstracts, 1130 studies were removed.

A total of 85 articles were selected for further assessment. After screening, 74 studies were further removed. These were studies that were either reviews, had less relevance to this study, had an illegible experimental design, or the entire articles could not be accessed. Finally, 11 studies were selected for review. In all these studies, the patients showed T10-L2 fractures and underwent either posterior or anterior approach for surgery.

Characteristics of the selected studies:

The detailed characteristics of the 11 selected studies is summarized in Table 1.

These studies contained two randomized controlled trials (RCTs) and eight retrospective cohort studies (RCSs), which included 287 patients treated with the anterior approach and 361 patients treated with the posterior approach. One article details a series of 19 cases where the patients underwent a posterior approach for the treatment of TBFs and then underwent revision surgery in which either anterior (2 cases) or posterior (17 cases) approaches was taken. The fractures in patients included fractures in T10, T11, T12, L1, and L2. People of all age groups ranging from 17 to 69 were included in the study. Both the genders were also well represented in the study. All 11 articles were published from 1995 to 2022 [18-27].

Description of the surgical approach

Most of the studies that were included had some description of the surgical approach that was taken. Some studies also described the rationale for the selection of either the anterior or the posterior approach. In two studies, for example, the approach was decided by randomization (RCT). Moreover, there are several other critical factors and criteria that influence this decision such as pathology location and extent, correction of deformities, stability requirements, minimizing trauma and morbidity, patient-specific consideration, surgical access and visualization, recovery, and rehabilitation. Patients were placed in the right lateral decubitus position (left side up) for the anterior approach surgeries. Additionally, subtotal corpectomies were carried out, and the degrees of decompression were reported in certain investigations. The majority of surgeries for the posterior approach were done while the patient was prone. Either a laminectomy or

transpedicular/facetal decompression was used to accomplish direct decompression.

Neurological outcomes

Few articles had details of the neurological conditions of the patients before and after the operation. Most studies reported the neurological damage status through the Frankel grade. The details of the neurological outcomes are shown in Table 2. It was noted that in most studies, there was an improvement in the Frankel grade of patients who underwent surgery using both the anterior and the posterior approach. There was only one case in where the patient had neurological deterioration after the posterior approach. It was also noted in most cases there was not a significant difference in the improvement of neurological conditions between the two approaches.

Postoperative complications

Several cases of postoperative complications were reported in both patients who had surgery with anterior decompression and with posterior decompression. Typically, patients experienced abdominal distension, back pain, constipation, hemopneumothorax, and wound infections. Some cases of loosening of a screw were also reported. The details of postoperative complications are shown in Table 3.

Wood et al. and Yao et al. have reported significantly more incidences of complications (more blood loss, more operative time, etc.) seen in patients those who underwent surgery using the anterior approach. Whereas some studies like Lin et al. and Jiang et al. reported much less postoperative complications in patients that underwent posterior decompression. In some studies complications such as nerve function sensation score, the height of the vertebral body, and the recovery of Cobb angle were less in the posterior approach . It is, therefore, still unclear as to which method leads to lesser incidences of postoperative complications [19,22,24,25].

Cobb angle recovery

Cobb angle, is a standard technique to quantify spinal curvature.

It was observed that in most studies, the postoperative kyphotic angle was within the same range for surgeries done using the anterior and posterior approach. Both the anterior and the posterior approach surgeries had a wide range of Cobb angles, as shown in Table 4. Overall, both methods were comparable in terms of restoration of the Cobb angle.

Length of stay, return to work, and operational cost

All studies did not have data available on the length of hospital stay and the patients return to work (if applicable). It may be noted that the typical length of stay in the hospital was a little longer for people who underwent surgery using the anterior approach (right lateral decubitus position) compared to the people who underwent surgery using the posterior approach. The approximate length of stay in the hospital for each study is tabulated in Table 5. This difference in the length of stay is also reflected in the total operational cost. As expected, the surgeries done using the anterior approach were more expensive for the patients although it must be noted that only a few studies have reported the operational costs for the procedure.

Estimated blood loss

We also compared the estimated blood loss in each of these studies. It was observed that the blood loss in surgeries done with the anterior approach was significantly more (ranging from 255 to 1878 ml) compared to surgeries done using the posterior approach (ranging from 152 to 1103 ml). The estimated blood loss from select studies is shown in Table 6.

Discussion

Thoracolumbar burst fractures (TBFs) can be treated surgically using anterior, posterior, or combined anterior-posterior techniques. While there have been reported advantages and pitfalls of each of these surgical methods, there has not been a consensus that has been able to determine whether the anterior approach or the posterior approach is a better method for surgical intervention when treating thoracolumbar fractures.

In the present review, we have summarized articles that consisted of two RCTs and eight RCSs, with an aggregate sample size of 287 patients treated anteriorly and 361 patients treated posteriorly. One study was a case series of 19 patients treated by posterior approach because of TBF who later underwent revision surgery, either by an anterior approach (2 cases) or a posterior approach (17 cases). The fractures involved thoracic and lumbar vertebrae, specifically levels T10, T11, T12, L1, and L2. The studies included both males and females within a large age range (17–69 years), with all 11 articles being published between 1995 and 2022.

These studies showed that both anterior and posterior approached have been taken for surgeries and compared the two approaches based on different parameters such as neurological outcomes, postoperative complications blood loss and, operational cost, etc. After conducting this systematic analysis, we can come to the conclusion that as far as recovery of neurological damage was concerned, there was only one case, as reported by Hitchon et al. where deterioration in the Frankel grade was observed in the patient who underwent posterior

surgery [21]. Apart from this, there was a significant improvement in the Frankel grades in all patients regardless of the surgical approach taken. When considering patient safety, it is generally believed that the posterior approach is a safer approach to take when we took into consideration the postoperative complications seen in patients in the selected studies, we conclude that both the anterior as well as the posterior approaches had postoperative complications to a similar degree. On the contrary, Wang et al., reported that the posterior approach, as compared with other approaches, have decreased bleeding, shorter operation time, and a considerable improvement in the Cobb angle, thus confirming the findings of Tan et al. [27-36]. In fact, as far as the study is concerned, more posterior approach group post-operative complications occurred than with the anterior. It could be that more complex anatomy and more trauma from surgery done by the anterior approach could result in a higher incidence of postoperative complications. It must be noted that patients that underwent surgeries using the anterior decompression had much more blood loss compared to patients that underwent posterior decompression. These patients also had a longer hospital stay and higher operational costs.

According to Bolesta et al., anterior surgery (right lateral decubitus position) is the best way to surgically resolve TBFs with nerve injury, but with rigid posterior ligaments. As stated by Anghel et al., there is no hard and fast rule for selecting between anterior and posterior approaches, but through the anterior method correction, the angular deformities stability is achievable. Although anterior surgery raises pressure on the spinal cord in satisfactory fusion, it requires a transthoracic or abdominal approach, and so is highly technical and rarely used generally. Materials on the posterior approach, however, include traditional avenues that a common TLBF treatment has adopted as this would entail simpler anatomy, shorter surgery time, less trauma, and less bleeding. Their ability to allow early decompression and reduce the effects of secondary injury to nerves has made them popular among surgeons [37-41]. Therefore, this study leads us to the conclusion that, while the patient's overall recovery (as measured by neurological outcomes and vertebral column realignment) appears to be similar for both groups, the posterior decompression approach is a better surgical option for treating thoracolumbar fractures due to certain factors like increased blood loss and higher operating costs associated with the anterior approach.

Conclusions

Therefore, this study leads us to the conclusion that, while the patient's overall recovery (as measured by neurological outcomes and vertebral column realignment) appears to be similar for both groups, the posterior decompression approach is a better surgical option for treating thoracolumbar fractures due to certain factors like increased blood loss and higher operating costs associated with the anterior approach.

Clinical Message

Though the neurological outcome of both approaches is equal in thoracolumbar fracture management, the other factors like surgical cost and blood loss are higher in the anterior approach.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given the consent for his/ her images and other clinical information to be reported in the journal. The patient understands that his/ her names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

Conflict of interest: Nil **Source of support:** None

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