

Kyphotic deformity correction of different operative approaches in patients with thoracolumbar burst fractures: a meta-analysis

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Abstract: Background: As a common traumatic disease in spine surgery, thoracolumbar burst fractures (TLBF) often leads to complications such as back pain, kyphotic deformity and nerve damage, causing severe physical defects and economic burden on patients.

Objective: To explore kyphotic deformity correction of different operative approaches for TLBF.

Design of research: Systematic review and meta-analysis are utilized to compare the efficacy of different approaches for postoperative kyphotic deformity in TLBF patients.

Methods: English documents that discussed TLBF with different operative approaches were searched from various databases. The obtained documents were screened and evaluated.

Results: The comparison and analysis of preoperative Cobb angle, early-postoperative Cobb angle correction, and follow-up Cobb angle correction between the anterior and posterior approach groups showed no statistical significance [MD=0.97, 95% CI (-0.44, 2.38), P=0.18; MD=0.25, 95% CI (-0.04, 0.54), P=0.10; MD=-0.12, 95% CI (-0.44, 0.19), P=0.45].

Conclusion: While treating TLBF symptoms, both the anterior and posterior approaches were effective in correcting postoperative kyphosis deformity. Therefore, while determining a treatment method, the age and the tolerance to the surgery of each patient should be considered for the surgical treatment options. This study provides new ideas for clinical treatment of TLBF in the future.

1 Introduction

Thoracolumbar burst fractures (TLBF) is the most typical type of spinal fractures, which is often caused by excessive exercise or external force. Clinically, it has the typical manifestations of spinal fractures, including severe pains, inability to move the body, and positive conduction pains. In addition, the degree of disease is from incomplete paralysis to complete paralysis¹. Researchers have found that the non-surgical treatments are conservative therapeutic plans. On the contrary, about 20% of patients suffer from severe pains and increased nerve damages after surgeries, and 46% have aggravated kyphosis deformity. Surgical treatments significantly improve therapeutic efficacy; however, they are considered mainly for the correction and fixation of unstable fractures^{2,3}. Therefore, exploring the treatment of TLBF patients has become the focus of research.

TLBF is one of the most common thoracolumbar fractures, accounting for about 20% of spinal fractures and more than 50% of thoracolumbar fractures. Usually, it causes nerve damages and kyphosis deformity. Surgical decompression and bone grafting for internal fixation is the most commonly adopted treatment in recent years. With the increasing application of spinal biomechanical stability, controversies about the surgical

treatments are various. Currently, there are three major operative approaches, i.e., the anterior approach, the posterior approach, and the anterior-posterior joint approach^{4,5}. The anterior approach fixes the vertebral body with steel plates; therefore, excellent decompression and strong fusion to the fracture sites are obtained. However, the risk of surgery increases. The posterior approach is safer, which brings little damages to the lungs, internal organs, and blood vessels; meanwhile, it has lower technical requirements⁶⁻⁸.

In summary, to analyze the impacts of surgical treatments with different approaches on the postoperative kyphosis correction in TLBF patients, this study searched English documents associated with the therapeutic plans and efficacy of TLBF from various databases. The searched documents were screened and evaluated, hoping to provide new ideas for the surgical treatment and postoperative recovery of TLBF patients.

2 Method

2.1 Design of research

In this study, the meta-analysis method was applied to evaluate and analyze the documents that compared the therapeutic effects and safety of different approaches on

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postoperative kyphosis deformity correction of TLBF patients. Therefore, the design of this study was as follows. The first step was planning before the research and formulating the experimental objective of this study, as well as the inclusion and the exclusion criteria of the required documents. The second step was searching the English documents associated with the topic in full-text searching databases through a computer, and tracing the included documents and searching for other documents in the field through manual retrieval of conference materials. The third step was screening out the eligible documents. The fourth step was extracting and filing the data from the included documents. The fifth step was utilizing the Cochrane Reviewer's Handbook 5.3 for quality evaluation and statistical analysis of the included documents. The sixth step was analyzing the results and drawing conclusions. The study was exempt from the review of the Institutional Review Board at High Point University and subsequent university affiliations from all authors.

2.2 Inclusion and exclusion criteria of documents

Inclusion criteria: Subjects had clear diagnostic criteria, i.e., the symptoms of TLBF were diagnosed; in addition, their medical history and clinical examinations were in line with the randomized controlled trial (RCT) or quasi-RCT; the inter-group baseline was similar and comparable. The subjects were grouped according to the different operative approaches, i.e., they were divided into an anterior approach surgery group and a posterior approach surgery group. Before performing TLBF surgery, the patients should undergo spinal X-ray and computed tomography (CT) examinations. The measurement index should include one or more of the following: -preoperative Cobb angle, early-postoperative Cobb angle correction, and follow-up Cobb angle correction. While screening the documents, if the document was published by the same research laboratory or hospital and the results overlapped, the one with more patients would be selected as the research object, which would increase the quality of this study.

Exclusion criteria: The preoperative imaging data of the participants in the documents showed ossification or osteogenesis of the anterior longitudinal ligament of the injured vertebra, and the participants suffered from superficial large vessel wall calcification. Participants were excluded from spinal dorsal kyphosis or fracture nonunion due to other reasons. Participants had apparent contraindications surgery and were intolerable of the surgery. Participants with significant coronary imbalance. Documents that were conference abstracts or documents in other languages were excluded.

2.3 Searching strategies

A computer was used to retrieve major English databases, such as Medline, Cochrane Library, PubMed, and EMBase. The efficacy of the anterior approach and the posterior approach on the treatment of postoperative

kyphosis deformity of TLBF patients was compared. The search time-span was from the establishment of the database to October 2019. In major English databases, the search keywords included thoracolumbar burst fracture, treatment, anterior approach, posterior approach, kyphosis deformity, correction, randomized controlled trials, and quasi-RCT. The selected keywords should be searched as topic words and free words in free combinations, thereby forming different search methods. Meanwhile, the titles, abstracts, and full-texts of the searched documents that were determined as correlative were browsed to determine whether to include the documents.

2.4 Document screening and data extraction

The retrieved documents were included and excluded according to the inclusion and exclusion criteria set in advance, thereby completing the screening of the retrieved documents and the extraction of data. Once the included documents were finalized, the following information was extracted for each included document: the basic information (first author, year of publication, age, number of patients in each group, baseline situation), trial design, study period, surgical method, outcome index detection (preoperative Cobb angle, early-postoperative Cobb angle correction, and follow-up Cobb angle correction), and follow-up time. Finally, the extraction of the data in the included documents was completed.

2.5 Quality evaluation of documents

The Cochrane risk assessment tool was used in this study to evaluate the quality of the included documents. The quality evaluation indicators included random sequence schemes, the presence or absence of a double-blind method, loss to follow-up, hidden assignments, completeness of data results, the presence or absence of selectively reported research results, and the presence or absence of bias or other sources of bias. The indicators were evaluated according to the comprehensive results. If they were all satisfied, the document was rated as A, indicating the least possibility of bias. If ≥ 1 indicator was unclear, it indicated that the risk of bias in the document was moderate, which was rated as B. If ≥ 1 indicator was incorrect, it indicated that the risk of bias in the document was high, which was rated as C.

2.6 Statistic analysis

In this study, the Cochrane RevMan 5.3 software was used for meta-analysis. The continuous variables appearing in the documents were analyzed by using the mean difference and 95% confidence interval (CI). The

Odds Ratio (OR) was used for the analysis of the binary variables, and the 95% CI was used as the evaluation interval to represent the size of the effect amount. The χ^2 test was used to verify the heterogeneity of the clinical researches in the included documents. If ($P > 0.05$, $I^2 < 50\%$), a fixed effect model (Fixed) was used for meta-analysis. If ($P < 0.05$, $I^2 > 50\%$), the statistical heterogeneity between the results was considered to be greater. Furthermore, while analyzing the heterogeneity, a random effect model (Random) was used for meta-analysis. Afterward, the inverted funnel chart was used to evaluate whether the publication was biased.

3 Results

3.1 Analysis of document screening

Searches of documents were performed on the selected English databases according to the criteria formulated in advance. A total of 527 documents associated with TLBF and different operative approaches were initially retrieved. After reading the document titles, abstracts, repetition, case reports, and reviews, documents that failed to meet the inclusion criteria were excluded. The preliminary screening kept 25 documents. Eventually, after carefully reading the full text of each document, a total of 10 RCT documents that met the inclusion criteria were included. The specific document screening results were shown in Figure 1.

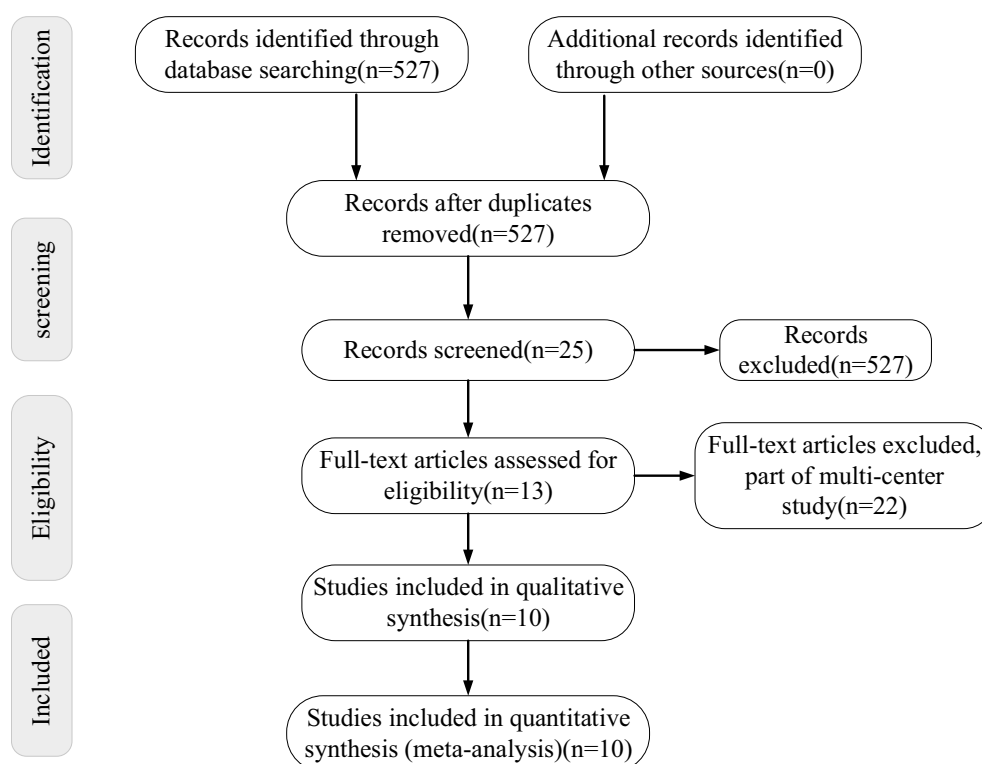


Figure. 1 The screening process of searched documents

3.2 Quality evaluation of included documents

A total of 10 included documents (No. 9-18) were submitted to quality evaluation. The obtained results were shown in Table 1. As shown in Table 1, the included documents all adopted random sequence schemes; in addition, none of the distribution schemes were explicitly explained, and the distribution schemes were hidden. In terms of the blind approach, it was

difficult to achieve double-blindness since different schemes were adopted for both groups. However, it had no effects on the results of the documents. In terms of loss to follow-up and withdrawal, neither was clearly described but did not affect the results. Final quality evaluation of the documents found no other bias sources in the 10 included documents. In terms of the quality, 3 documents were rated as A, indicating less bias, while 7 documents were rated as B, indicating moderate bias.

Table. 1 Quality evaluation of included documents

Included documents	Year of publication	Grouping	Random sequence schemes	Number of patients	Description of loss to follow-up	Other bias sources	Quality
Esses ⁹	1990	Anterior/posterior group	Yes	18/22	No	None	B
Danisa ¹⁰	1995	Anterior/posterior	Yes	16/27	No	None	B

Author	Year	group	Yes	No	None	Group
Wood ¹¹	2005	Anterior/posterior group	Yes	20/18	No	None B
Hitchon ¹²	2006	Anterior group/group	Yes	38/25	No	None A
Sasso ¹³	2006	Anterior/posterior group	Yes	40/13	No	None B
Lin ¹⁴	2012	Anterior/posterior group	Yes	32/32	No	None B
Wu ¹⁵	2014	Anterior/posterior group	Yes	14/28	No	None A
Sudo ¹⁶	2013	Anterior/posterior group	Yes	32/18	No	None B
Han ¹⁷	2013	Anterior/posterior group	Yes	24/38	No	None A
Wang ¹⁸	2015	Anterior/posterior group	Yes	22/23	No	None B

3.3 Detection indicator and efficacy evaluation

This study analyzed the correction effects of different surgical approaches on postoperative kyphosis deformity in TLBF patients. As shown in Figure 2, the comparative analysis of preoperative Cobb angles of patients in both

groups, 10 documents evaluated the preoperative Cobb angles. The documents showed ($P < 0.05$, $I^2 > 50\%$). Random analysis showed no statistical significance between both groups [MD=0.97, 95% CI (-0.44, 2.38), $P = 0.18$].

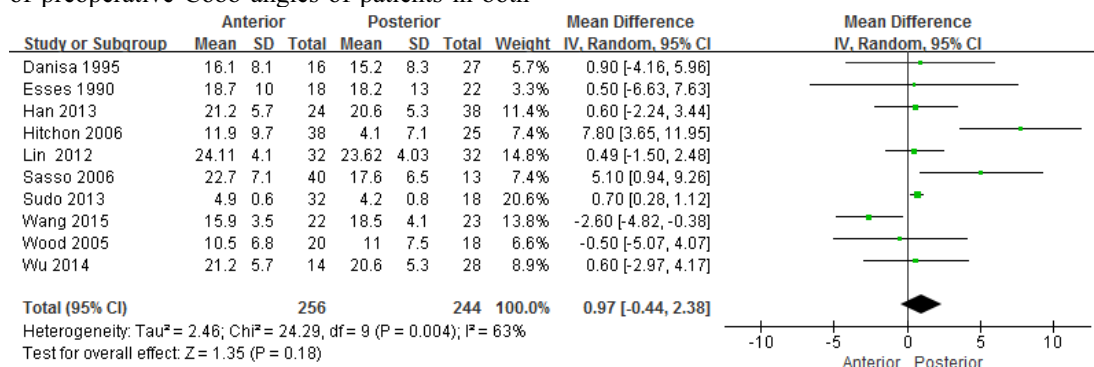


Figure. 2 The meta-analysis forest graph of comparison of preoperative Cobb angles between TLBF patients of the anterior approach group and the posterior group

As shown in Figure 3, the comparative analysis of postoperative Cobb angle correction of patients in both groups, 10 documents evaluated the postoperative Cobb angle correction. The documents showed ($P > 0.05$,

$I^2 < 50\%$). Fixed analysis of results in Figure 3 showed no statistical significance of postoperative Cobb angle correction between both groups [MD=0.25, 95% CI (-0.04, 0.54), $P = 0.10$].

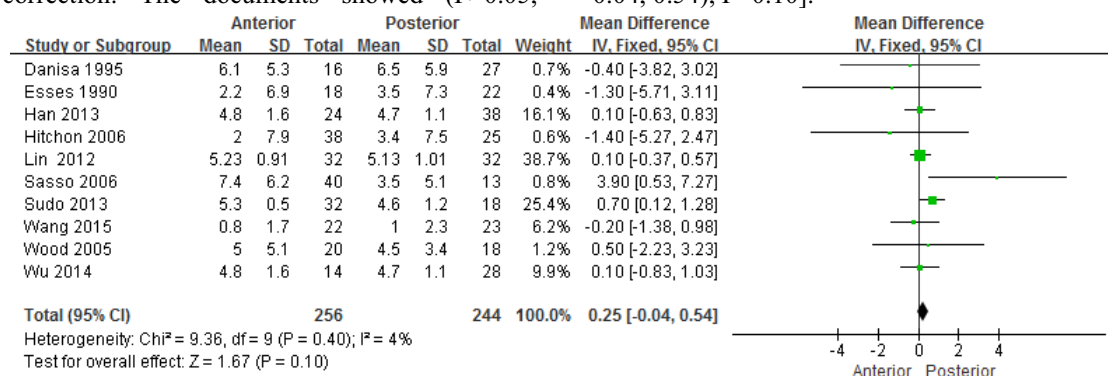


Figure. 3 The meta-analysis forest graph of comparison of postoperative Cobb angle correction between TLBF patients of the anterior approach group and the posterior group

As shown in Figure 4, the comparative analysis of follow-up Cobb angle correction of patients in both groups, 10 documents evaluated the follow-up Cobb angle correction. The documents showed ($P > 0.05$,

$I^2 < 50\%$). Fixed analysis showed no statistical significance of follow-up Cobb angle correction between both groups [MD=-0.12, 95% CI (-0.44, 0.19), $P = 0.45$].

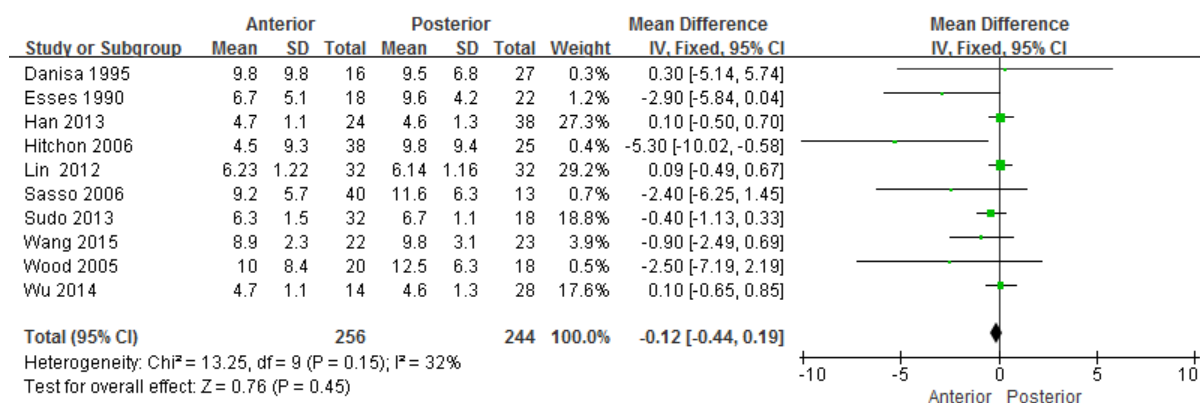


Figure. 4 The meta-analysis forest graph of comparison of follow-up Cobb angle correction between TLBF patients of the anterior approach group and the posterior group

4 Discussion

Usually, TLBF is due to high-energy violence, such as fall injuries from high altitudes and car accident injuries. This causes more destruction to the spine, resulting in fractures invading the spinal canal, compressing the spine, inducing spinal canal stenosis, and eventually causing the symptoms of neurological compression. Treatments for TLBF patients often decompress the spinal cord and nerve roots of the patients and restore the spinal stability and physiological curvature¹⁹. At present, the treatment methods of TLBF are mostly anterior approach and the posterior approach. Controversies still exist in the efficacy analysis. The purpose of the anterior approach is to relieve the compression of the spinal cord and nerves, thereby restoring the normal anatomy of the spine and healing the injured spine. The purpose of the posterior approach is to reduce and fix the spine by stretching and distraction traction. The operation is simple, and the intraoperative blood loss and injuries are less^{20,21}.

Scholars have investigated the efficacy of TLBF. Some of them used the anterolateral approach for vertebral body resection, single-segment fusion, and fixation by expandable vertebral body or cage with bone graft and screws. Eventually, they found that the anterolateral approach was a feasible, effective, and safe approach for treating unstable TLBF, while the anterior approach was successful in correcting angular deformities⁵. Also, scholars analyzed the clinical efficacy of the Limited Long-Segment Pedicle Instrumentation (LLSPI) by the posterior approach in several patients with thoracolumbar fractures. The results elaborated that LLSPI was satisfactory in treating thoracolumbar fractures; especially for maintaining the height of the fractured vertebral body, LLSPI had significant impacts on reducing the loss of sagittal kyphotic Cobb angle (SKA) and the device failure rate²². This study analyzed the correction effects of different surgical approaches on postoperative kurtosis deformity of TLBF patients. Eventually, 10 documents were included. All the included documents had involved the variations of Cobb angle. Some of the included documents also compared

the postoperative Frankel grade and complications; however, these were not the focuses of this study. Only the variations of Cobb angle were discussed in this study. The efficacy of different surgical approaches on postoperative kurtosis deformity of TLBF patients was compared and analyzed. The preoperative Cobb angle of patients in the anterior approach group and the posterior approach group showed no statistical significance. Further comparison of postoperative Cobb angle correction and follow-up Cobb angle correction between patients in both groups also showed no statistical significance.

In summary, this study found that while treating TLBF symptoms, both the anterior and posterior approaches were effective in correcting postoperative kyphosis deformity. Therefore, while determining a treatment method, the age and the tolerance to the surgery of each patient should be considered for the surgical treatment options. Deficiencies also existed while analyzing the correction effects of different surgical approaches on postoperative kyphosis deformity of TLBF patients. For example, although the included documents were correlative, their sample sizes were small, and the obtained results had clinical heterogeneity. Definitely, it must be acknowledged that the treatments for TLBF symptoms have different effects on different patients; thus, the influencing factors of surgical treatments have increased in the clinical analyses. Therefore, in the subsequent study, to guide the selection of TLBF surgical approaches, the RCT experiments with better quality should be included, thereby obtaining more rigorous theoretical basis.

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