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Comparison of Anterior Versus Posterior Approach in the Treatment of Thoracolumbar Fractures: A Systematic Review

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Despite extensive research on thoracolumbar fractures, controversy still exists about which approach is the most appropriate. Lack of evidence-based practice may result in patients being treated inappropriately. The objective of study was to perform a systematic review of the effectiveness of the anterior and posterior approaches in the treatment of thoracolumbar fractures. We conducted searches of PubMed and the Cochrane Library, searching for relevant trials up to August 2013 that compared anterior and posterior for the treatment of thoracolumbar fractures. The key words "anterior," "posterior," "thoracolumbar fracture," "CCT," and "RCT" were used. We assessed all included literature by using the Cochrane handbook (version 5.1). The results were expressed as the mean difference for continuous outcomes and risk difference for dichotomous outcomes, with a 95% confidence interval, using RevMan version 5.2. There were 3 randomized controlled trials and 11 clinical controlled trials included. The meta-analysis showed no significant difference between groups regarding Cobb angle, the Frankel scale, ASIA/JOA motor score, complications, and number of patients returning to work. Compared with the anterior approach, the posterior approach demonstrated superior canal decompression. In the burst fracture subgroup, operative times were significantly shorter and perioperative blood loss was less in the posterior approach

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group. The posterior approach is more effective for canal decompression, operative times, and perioperative blood loss. However, because of the lack of randomized controlled trials, and because of large sample size studies, heterogeneity was significant between reports. The optimal treatment for thoracolumbar fractures requires further study.

Key words: Anterior – Posterior – Thoracolumbar fracture – Systematic review

Approximately 90% of all spinal fractures occur at the thoracolumbar junction,[1–3] including burst fractures, osteoporotic thoracolumbar vertebral collapse, and chronic thoracolumbar fractures as the primary etiologies. The main treatment modality for thoracolumbar fractures is open reduction and internal fixation.[4] There are two main surgical approaches: anterior and posterior. However, the best approach remains controversial. We aimed to apply the methodology of systematic review and meta-analysis to thoracolumbar fractures in order to evaluate the effectiveness of the anterior versus posterior approach in their treatment.

Methods

Inclusion and exclusion criteria

Inclusion criteria were as follows: (1) patients with $T_{10}{\sim}L_2$ thoracolumbar fractures, with or without neurologic deficit, and a minimum age of 18 years; (2) anterior versus posterior approach was the mode of intervention; (3) more than 10 patients were studied, with a minimum follow-up period of 12 months; (4) article type included randomized controlled trials (RCTs) and clinical controlled trials (CCTs); and (5) evaluation included imaging, neurologic examination, and function index (at least 1 item).

Exclusion criteria were as follows: (1) severe open fracture; (2) cancer, infectious disease, hematologic system diseases, or other severe disease; (3) no need for surgical treatment; and (4) fractures higher than T_{10} or lower than L_2.[5,6]

Measurement index

Measurement indices used included: (1) Cobb angle (kyphosis) of the spinal column; (2) ASIA/JOA motor score; (3) average canal decompression; (4) Frankel scale for the recovery of neurologic function; (5) postoperative complications; (6) number of patients returning to work; (7) average blood loss (mL); and (8) average operative time (minutes).

Literature search

Searches of PubMed and the Cochrane Library databases for relevant trials up to August 2013 that compared anterior and posterior for the treatment of thoracolumbar fractures were performed for RCTs and CCTs using the key words "anterior," "posterior," and "thoracolumbar fracture." The literature search was done by two authors independently.

Assessment of risk of bias in included studies

We assessed risk of bias using the Cochrane Collaboration's tool for assessing risk of bias as described in section 8.5 of the *Cochrane Handbook for Systematic Reviews of Interventions*. The following domains were assessed as "low risk of bias," "unclear" (uncertain risk of bias), or "high risk of bias"[7]:

1. sequence generation;
2. allocation concealment;
3. blinding of participants and personnel;
4. blinding of outcomes assessment;
5. incomplete outcome data;
6. selective outcome reporting;
7. other bias.

We also categorized and reported the overall risk of bias of the included studies according to the following:

1. Low risk of bias (plausible bias unlikely to seriously alter the results) if all criteria were met;
2. Unclear risk of bias (plausible bias that raises some doubt about the results) if one or more criteria were assessed as unclear;
3. High risk of bias (plausible bias that seriously weakens confidence in the results) if one or more criteria were not met.

Data synthesis

We used Microsoft Excel to record and check all data, and we calculated the standard deviation by the following equation:

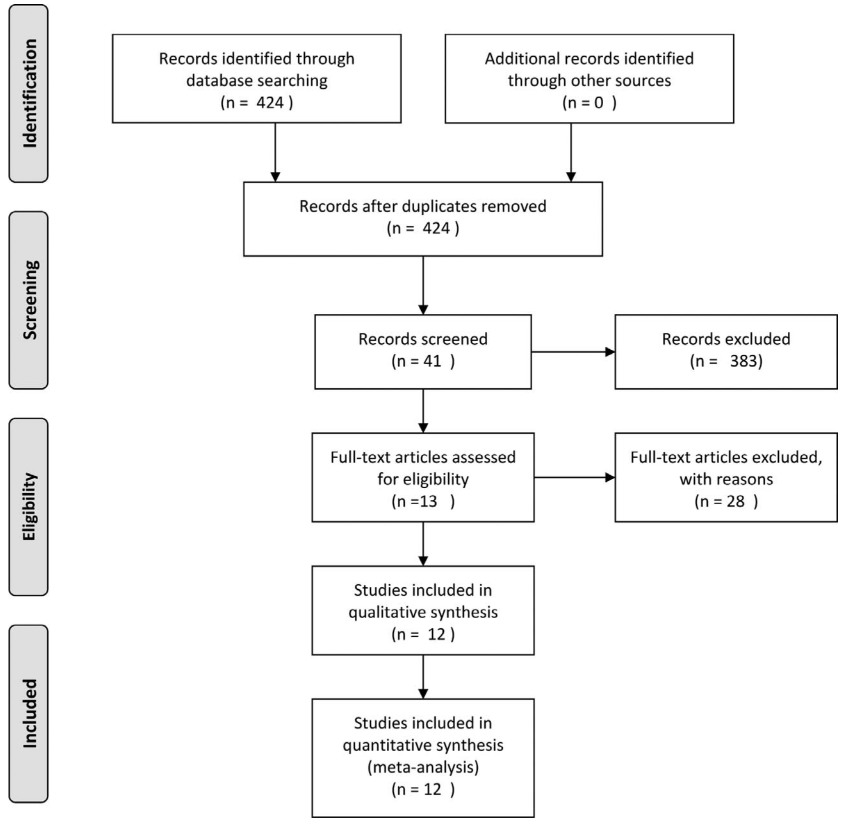

Fig. 1 Process of study review.

$$SD_{dif} = \sqrt{SD(B)^2 + SD(F)^2 - 2 \times 0.5 \times SD(B) \times SD(F)}$$

Data synthesis was carried out using RevMan software, version 5.2. The χ^2 test (statistical heterogeneity was considered significant at a P value greater than 0.1) and the I^2 statistic were used to assess statistical heterogeneity in each study.[8] Substantial heterogeneity was indicated when there was an I^2 value of 50% or higher. When heterogeneity existed, pooled data were meta-analyzed using a random-effects model. Otherwise, a fixed-effects model was used for analysis.[9] The risk difference (RD) and 95% confidence interval (CI) were calculated for dichotomous outcomes, whereas the mean difference (MD) and 95% CI were used for continuous outcomes.

Results

Results of literature search

The detailed selection process is shown in Fig. 1.

Methodologic quality assessment and characteristics

For the 12 included studies, 3 RCTs were graded B. The others were CCTs. Characteristics are shown in Table 1 and results of assessment in Table 2.

Results of meta-analysis

Analysis of the kyphosis in the short term

In 8 studies, the kyphosis change between preoperative and postoperative was compared in adult thoracolumbar fractures. Among 370 patients, there were 180 patients in the anterior group and 190 patients in the posterior group. Kyphosis in the short term was similar between groups [$P > 0.1$, WMD = –1.91 (–6.14, 2.33); heterogeneity: $\chi^2 = 6.04$, df = 7, $P < 0.00001$; $I^2 = 64.3\%$, random-effects model; Fig. 2]. The burst fractures subgroup also showed no difference between groups [$P > 0.1$, WMD = 0.51 (–0.85, 1.86); heterogeneity: $\chi^2 = 0.8$, df = 4, $P = 0.94$; $I^2 = 0\%$; Fig. 2].

Analysis of the kyphosis in long-term effect

The studies (n = 467 patients; 236 in the anterior surgery group and 231 in the posterior surgery group) reported kyphosis as a long-term effect. There was no statistically significant difference in kyphosis in the long term between anterior and posterior approaches [$P > 0.1$, WMD = –1.25 (–4.65, 2.15); heterogeneity: $\chi^2 = 84.71$, df = 9, $P < 0.00001$; $I^2 = 89\%$, random-effects model; Fig. 3]. The burst fractures subgroup also showed no difference between groups [$P > 0.1$, WMD

Table 1 Basic characteristics of anterior versus posterior approaches for the treatment of thoracolumbar fractures

Source, y	Type	Study type	Group	Age, y	n	Sex		Level of fracture			Follow-up, mo
						Male	Female	T_{10}	T_{11}–L_2	L_3	
Esses *et al*,[3] 1990	Burst fracture	RCT	Anterior	34.8	18	13	5	1	36	3	20
			Posterior	34.2	22	12	10				
Danisa *et al*,[22] 1995	Unstable burst fracture	CCT	Anterior	35	16	11	5	0	16	0	27
			Posterior	38	27	19	8	0	27	0	
Stancić *et al*,[23] 2001	Unstable burst fracture	CCT	Anterior	36 (M)	13	7	6	0	13	0	>12
			Posterior	35 (M)	12	8	4	0	12	0	
Wood *et al*,[2] 2005	Burst fracture	RCT	Anterior	39	22	12	8	0	20	0	42.3
			Posterior	42	21	13	5	0	18	0	44.6
Hitchon *et al*,[24] 2006	Burst fracture	CCT	Anterior	42	38	26	12	0	63	0	33
			Posterior	42	25	19	6				
Sasso *et al*,[10] 2006	Unstable burst fracture	CCT	Anterior	37	40	29	11	0	39	2	31
			Posterior	34	13	10	3	0	12	1	
Uchida *et al*,[25] 2006	Osteoporotic vertebral collapse	CCT	Anterior	71.2	28	5	23	0	38	0	63.6
			Posterior	69.2	24	4	20	0	24	0	60
Shi *et al*,[26] 2008	With spinal cord injury	CCT	Anterior	40.6	18	10	8	0	18	0	—
			Posterior	41.8	16	8	8	0	16	0	—
Lin *et al*,[1] 2011	Burst fracture	RCT	Anterior	37.8	32	14	18	0	32	0	46.5
			Posterior	39.3	32	16	16	0	32	0	43.7
Chen *et al*,[12] 2012	Chronic fracture	CCT	Anterior	38.7	18	10	8	0	18	0	36.5
			Posterior	40.2	18	12	6	0	18	0	34.7
Wu *et al*,[11] 2012	Burst fracture	CCT	Anterior	44.7	14	—	—	0	14	0	24
			Posterior		28	—	—	0	28	0	
Sudo *et al*,[27] 2013	Osteoporotic vertebral collapse	CCT	Anterior	68.3	32	4	28	0	32	0	56.3
			Posterior	72.4	18	3	15	0	18	0	53.0

M, median; —, not mentioned in the study.

= 0.98 (–0.28, 2.24); heterogeneity: $\chi^2 = 1.79$, df = 5, $P = 0.88$; $I^2 = 0\%$; Fig. 3].

Analysis of ASIA/JOA motor score

All 236 patients (128 for the anterior approach and 108 for the posterior approach) were included, from which 2 studies used the ASIA motor score and 3 studies used the JOA motor score. There was no statistically significant difference both in the ASIA subgroup [$P > 0.1$, WMD = 0.00 (–4.32, 4.32); heterogeneity: $\chi^2 = 0$, df = 1, $P = 1$; $I^2 = 0\%$; Fig. 4] and in JOA subgroup [$P > 0.1$, WMD = –0.09 (–1.48, 1.29); heterogeneity: $\chi^2 = 13.84$, df = 2, $P = 0.001$; $I^2 = 86\%$; Fig. 4].

Analysis of canal decompression

Only 2 studies recorded canal decompression at 2-year follow-up. Canal decompression was signifi-

Table 2 Methodologic quality of anterior versus posterior for treatment of thoracolumbar fractures

Source, y	Random	Blind	Allocation concealment	Baseline	Loss to follow-up	Grade
Esses *et al*,[3] 1990	L	NC	NC	L	2	B
Danisa *et al*,[22] 1995	H	NC	NC	L	0	—
Stancić *et al*,[23] 2001	H	NC	NC	L	6	—
Wood *et al*,[2] 2005	L	NC	NC	L	5	B
Hitchon *et al*,[24] 2006	H	NC	NC	NC	23	—
Sasso *et al*,[10] 2006	H	NC	NC	L	3	—
Uchida *et al*,[25] 2006	H	NC	NC	L	0	—
Shi *et al*,[26] 2008	H	NC	NC	L	0	—
Lin *et al*,[1] 2011	L	NC	NC	L	0	B
Wu *et al*,[11] 2012	H	NC	NC	NC	0	—
Chen *et al*,[12] 2012	H	NC	NC	L	0	—
Sudo *et al*,[27] 2013	H	NC	NC	L	0	—

H, high risk; L, low risk; NC, not clear; —, not applicable.

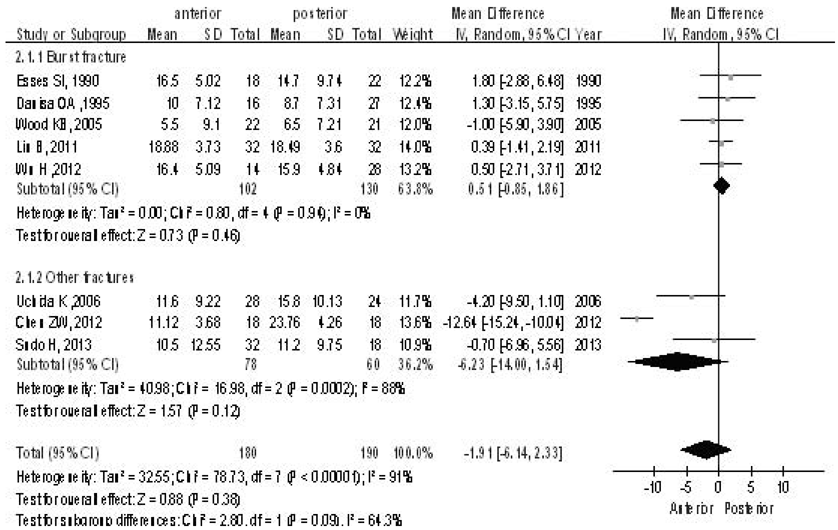

Fig. 2 Kyphosis in the short term between anterior and posterior approaches in the treatment of thoracolumbar fractures.

cantly better in the posterior group compared with the anterior group [$P < 0.1$, WMD = 16.29 (–2.33, 34.90); heterogeneity: $\chi^2 = 11.81$, df = 2, $P = 0.0006$; $I^2 = 92\%$; Fig. 5].

Analysis of the Frankel scale for the recovery of neurologic function

There were 6 studies (n = 297 patients; 160 for the anterior group and 137 for the posterior group) comparing the Frankel scale, preoperatively and at the 2-year follow-up point, showing no difference between groups [$P > 0.1$, RR = 1.09 (0.88, 1.34); heterogeneity: $\chi^2 = 18.04$, df = 5, $P = 0.003$; $I^2 = 72\%$; Fig. 6].

Analysis of complications after surgery

In 8 studies, 364 patients were included, in which 201 patients underwent the anterior approach and 163 underwent the posterior approach. No difference was seen between groups [$P > 0.1$, RR = 0.86 (0.37, 2.05); heterogeneity: $\chi^2 = 17.87$, df = 7, $P = 0.01$; $I^2 = 61\%$; Fig. 7] and in the burst fractures subgroup [$P > 0.1$, RR = 0.61 (0.23, 1.62); heterogeneity: $\chi^2 = 11.22$, df = 5, $P = 0.05$; $I^2 = 55\%$; Fig. 7].

Analysis of patients returning to work

There were 4 studies (n = 140 patients; 68 for the anterior approach and 72 for the posterior approach). The study showed no difference between

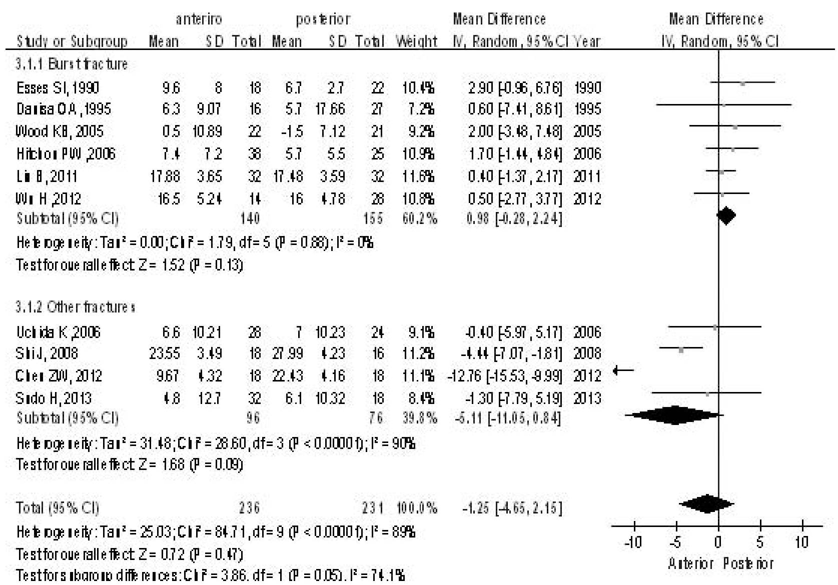

Fig. 3 Kyphosis as a long-term effect between anterior and posterior approaches in the treatment of thoracolumbar fractures.

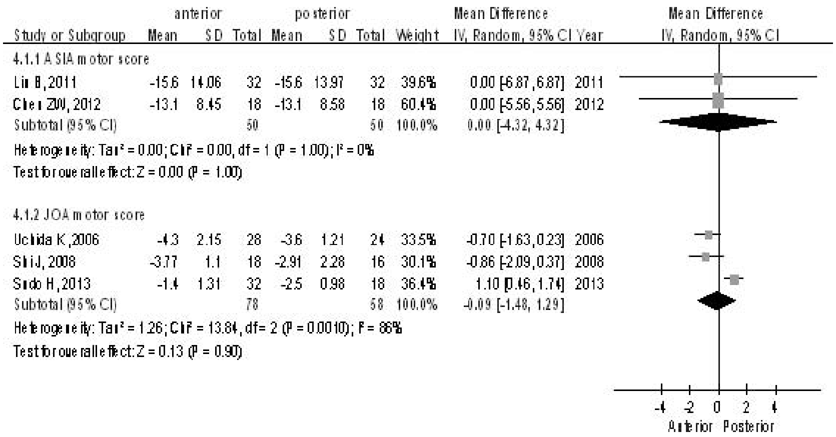

Fig. 4 The ASIA/JOA motor score between anterior and posterior approaches in the treatment of thoracolumbar fractures.

groups [$P > 0.1$, RR = 1.05 (0.86, 1.27); heterogeneity: $\chi^2 = 1.10$, df = 3, $P = 0.78$; $I^2 = 0\%$; Fig. 8].

Analysis of average blood loss (milliliters)

Of the 337 patients from 8 studies, 165 patients underwent the anterior approach and 172 the posterior approach. The posterior group had less intraoperative blood loss than the anterior group in total [$P < 0.1$, WMD = 252.72 (102.40, 403.04); heterogeneity: $\chi^2 = 126.55$, df = 7, $P < 0.00001$; $I^2 = 94\%$; Fig. 9] and in the burst fractures subgroup [$P < 0.1$, WMD = 335.17 (118.37, 551.96); heterogeneity: $\chi^2 = 110.38$, df = 4, $P < 0.00001$; $I^2 = 96\%$; Fig. 9].

Analysis of average length of operative time (minutes)

There were 9 studies (n = 400 patients; 203 for the anterior approach and 197 for the posterior approach). The posterior group had shorter operative time than the anterior group in total [$P < 0.1$, WMD = 42.72 (12.82, 72.63); heterogeneity: $\chi^2 = 155.81$, df = 8, $P < 0.00001$; $I^2 = 95\%$; Fig. 10] and in the burst fractures subgroup [$P < 0.1$, WMD = 63.10 (24.20, 102.00); heterogeneity: $\chi^2 = 120.34$, df = 5, $P < 0.00001$; $I^2 = 96\%$; Fig. 10].

Discussion

The question of how thoracolumbar fractures should be approached and stabilized (anteriorly or posteriorly) has remained a controversial subject.[1,10–12] Although there are several reports of thoracolumbar fractures, most studies are based on only one surgical method or on internal fixation.[13,14] There is a paucity of evidence-based literature on the subject.[5,15]

Kyphosis (Cobb angle)

The middle column of the spine is the key determinant of spinal stability, and its involvement will be a sufficient criterion for instability.[16] Titanium mesh cages filled with autologous bone graft have been used to reconstruct defects created by decompressive corpectomy for thoracolumbar burst fractures, allowing for restoration of height and correction of kyphosis.[17–20] The first prospective randomized study[2] of not only radiographic and perioperative clinical aspects, but also patient-reported functional outcomes of anterior and posterior surgery, found no significant difference between the two groups when evaluating fracture kyphosis on admission, at discharge, or at final follow-up. Similarly, Esses *et al*[3] performed an RCT in 1990, in which no significant difference was found when comparing anterior and posterior approaches. The above two studies support our study, in which no significant difference of the short- and long-term effects of kyphosis (Cobb angle) was found in the treatment of thoracolumbar fractures. The anterior

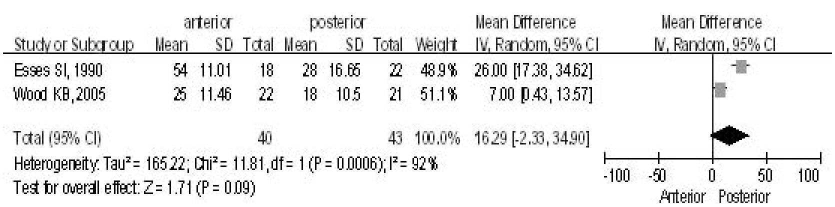

Fig. 5 Canal decompression at 2-year follow-up between the anterior and posterior approaches in the treatment of thoracolumbar fractures.

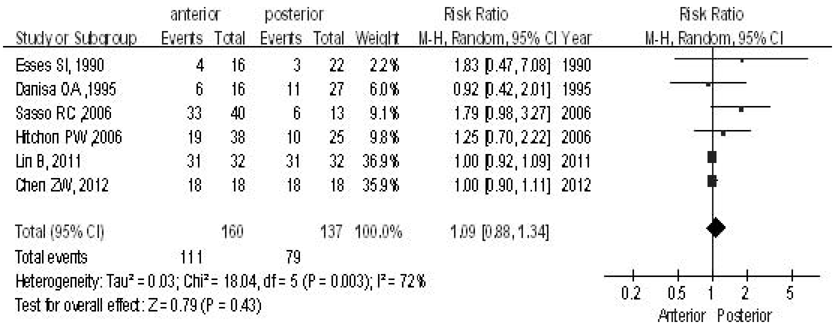

Fig. 6 The Frankel scale for the recovery of neurologic function between the anterior and posterior approaches in the treatment of thoracolumbar fractures.

approach can provide excellent exposure for reconstruction with titanium mesh cages filled with autologous bone graft in the case of fracture with loss of support of the anterior and middle columns. Meanwhile, Lin *et al*[1] suggest that titanium mesh cages filled with autologous bone graft can be inserted into the decompressive space in the posterior approach. Laminectomy may destabilize the spine with progression of deformity, but posterior pedicle screw segmental instrumentation could allow for more rigid fixation by the fixation of 3 columns.

Postoperative complications

Postoperative complications include implant loosening, translocation, and screw breakage; reoperation after internal fixation and bone grafting failure; pulmonary complications; urinary system infection; and pseudoarthrosis. Our study showed no significant difference in postoperative complications between the anterior and posterior approaches, or in the burst fractures subgroup. Wood *et al*[2] reported 17 complications in 18 individuals treated with posterior surgery, whereas of the 20 patients treated with the anterior approach, there were only 3 complications but no infections, with no instrumentation-related problems. Complications included late removal of painful posterior instrumentation, instrumentation breaks, and failure of posterior instrumentation. However, Lin *et al*[1] reported fewer complications of hemopneumothorax, abdominal distension, and constipation in the posterior group, because the posterior approach avoids violating the pulmonary, visceral, and vascular structures, and is less technically demanding.

Canal decompression and the Frankel scale

The midsagittal diameter of the spinal canal at the level of the injury was measured on computed tomography and is to be used as an index to describe canal decompression. Our study included 2 RCTs in

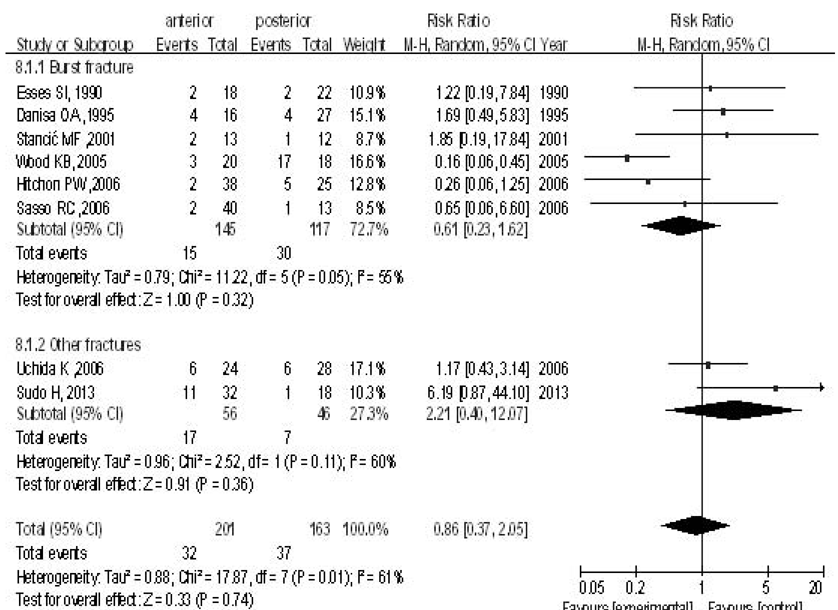

Fig. 7 Complications after surgery between the anterior and posterior approaches in the treatment of thoracolumbar fractures.

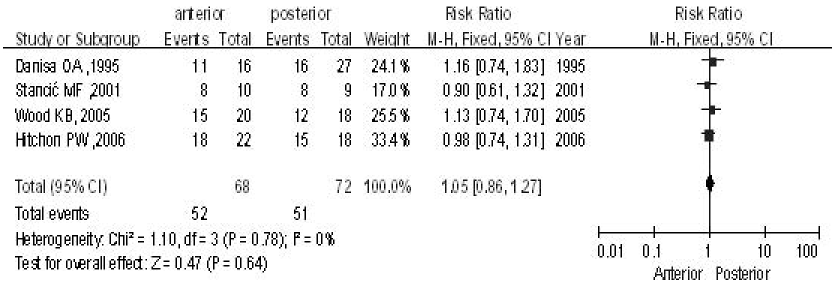

Fig. 8 Patients return to work between the anterior approach and the posterior approach in the treatment of thoracolumbar fractures.

the random-effect model, showing that the posterior approach has a better canal decompression effect. Meanwhile, Ayberk *et al*[21] reported the posterior approach to be the better choice in the short term and in follow-up, with the following advantages: (1) the posterior approach is simpler, with less trauma, blood loss, cost, and better recovery of neurologic function; (2) anterior decompression could be completed through the inside of the pedicle; and (3) through internal fixation, the posterior longitudinal ligament pulls the bone block of the anterior canal back, achieving decompression indirectly. Some authors[1,21] consider that the neurologic deficit is always caused by impact and compression to the ventral surface of the spinal cord in most patients with thoracolumbar fractures, and that the anterior approach can provide optimal direct exposure for visualization of the ventral aspect of the dura during decompression. Because of the lack of studies on this subject, reliability of this result is low.

Blood loss (milliliters) and operative time (minutes)

Our study found no significant difference between groups regarding blood loss and operative times. However, in the burst fractures subgroup, the posterior group recorded less blood loss and operative time than the anterior surgical group. Tian *et al*[5] achieved the same result in a systematic review of anterior versus posterior surgical treatment of thoracolumbar fractures, claiming that the anterior approach had more injuries and blood loss secondary to bleeding of the venous plexus on the cancellous bone surface and dural sac during decompression. After decompression, bone block, and internal fixation, bleeding was controlled. Operative time is related to the surgeon's experience. As a traditional surgical approach, the posterior approach is more familiar to surgeons in general.

Other aspects

In 2 studies, hospital stay and operative cost were reported, considering that the posterior approach was preferred. Danisa *et al*[22] reported the anterior, posterior, and anterior-posterior combined approaches. Meanwhile, Wu *et al*[11] reported the anterior, posterior, and paraspinal approaches. There were few studies involving the anterior-

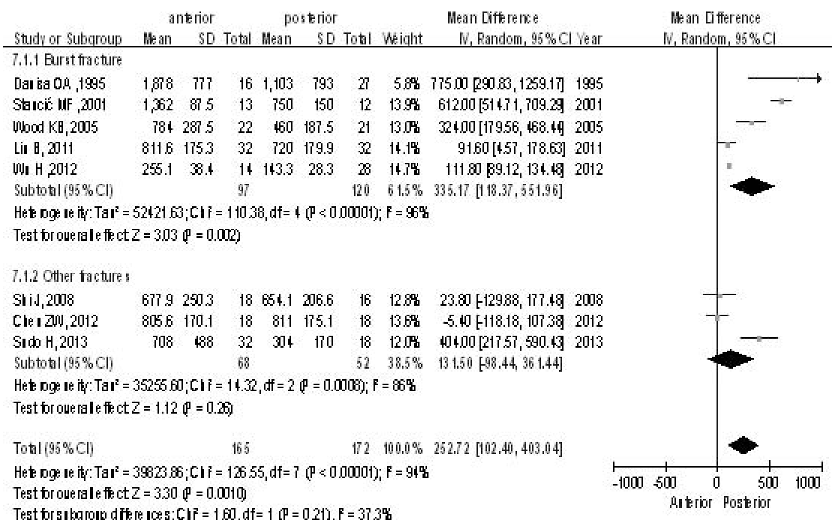

Fig. 9 Average intraoperative blood loss (milliliters) between the anterior and posterior approaches in the treatment of thoracolumbar fractures.

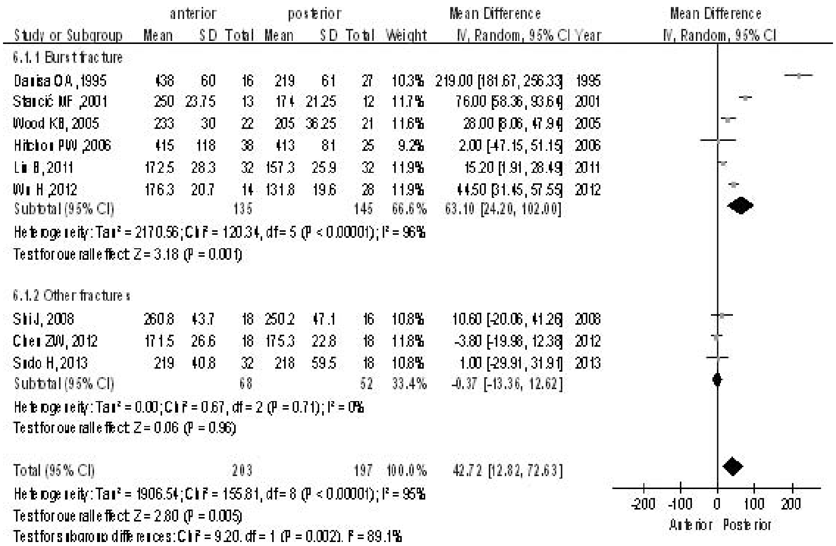

Fig. 10 Length of operative time (minutes) between the anterior and posterior approaches in the treatment of thoracolumbar fractures.

posterior combined approach and paraspinal approach, which require further study.

In summary, literature involving the anterior and posterior approaches had a large degree of heterogeneity, lack of RCTs, difficulty in blinding, small sample sizes, long follow-up periods, and large numbers of patients lost to follow-up, among other things. There was a significant difference in canal decompression, intraoperative blood loss, and operative times. Large–sample size, multicenter RCTs are necessary.

Acknowledgments

Qicong Zhu and Fengchao Shi contributed equally to the present study.

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