EFFICACY AND SAFETY OF CONSERVATIVE TREATMENT IN PATIENTS WITH NEUROLOGICALLY INTACT THORACOLUMBAR BURST FRACTURES: A META-ANALYSIS

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Objective. To conduct a meta-analysis of studies focused on the conservative treatment of thoracolumbar burst fractures, and to determine the efficacy and safety of this method in the observed group of patients.

Material and Methods. The study was performed following PRISMA guidelines. Inclusion criteria for meta-analysis were as follows: availability of full-text version of the article in English or Russian; A3 or A4 type fractures according to the AOSpine classification, or burst fractures of types IIA, IIB or IIC according to the Denis classification, or a direct indication of the presence of a burst fracture without its classification; absence of neurological deficit; age over 18 years; detailed description of treatment outcomes or complications; and a follow-up for at least one year.

Results. The meta-analysis included 29 articles describing the results of treatment of 1107 patients. At the time of admission, the following radiographic parameters were calculated for patients: mean kyphotic angle, 13.6 (95 % CI, 10.8–16.5), degree of vertebral body compression, 39.9 % (95 % CI, 27.7–52.0), and the degree of compression of the spinal canal lumen, 41.7 % (95 % CI, 29.2–54.2). A follow-up examination revealed a significant increase in segmental kyphosis by 3%, in vertebral body compression by 3.7 %, and lysis of bone fragments with a decrease in the degree of spinal canal stenosis by 2 times. The incidence of neurological deficit and progression of thoracic and lumbar spine instability was 5.8 % (95 % CI, 4.1–8.1) and 6.5 % (95 % CI, 4.5–9.3), respectively. Recovery of work ability according to Denis scale was as follows: W1 and W2 – 74.7 % (95 % CI, 63.9–83.1); W3 – 14.1 % (95 % CI, 10.2–19.3); and W4 and W5 – 14.8 % (95 % CI, 8.8–23.9).

Conclusion. Conservative treatment of neurologically intact thoracolumbar burst fractures can be an effective and safe option if the angular deformity does not exceed 16 degrees and the anterior vertebral body compression rate is up to 52 %. With conservative therapy, a twofold reduction in spinal canal stenosis was observed due to the lysis of bone fragments. The pooled prevalence of radiculopathy or myelopathy with conservative therapy was 5.8 %. Orthopedic intervention due to the progression of instability of the damaged segment may be required in 6.5 % of patients. More than 90 % of patients returned to full-time work following conservative therapy. Comparative studies on the effectiveness of conservative therapy versus surgical treatment should be continued to form clear recommendations for the choice of treatment tactics for patients with uncomplicated fractures of the thoracic and lumbar spine.

Key Words: uncomplicated burst fractures, thoracic spine, lumbar spine, surgical treatment, conservative therapy.

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Conservative treatment for uncomplicated burst fractures of the thoracic and lumbar spine (types A3 and A4 according to AOSpine classification) is one of the most debatable issues in spinal surgery. Literature data in regard to this aspect are quite contradictory. Russian protocols for the management of the spine and spinal cord injuries either recommend surgical intervention [1] or provide no clear guidelines on conservative treatment [2]. In international guidelines, conservative treatment is considered as an option in cases of minor kyphosis and vertebral body compression [3, 4]. Despite the fact that randomized clinical trials demonstrating comparable clinical results of surgical and conservative treatment for thoracic and lumbar burst fractures were published more than 20 years ago [5, 6], conservative treatment has not become common practice. First of all, this may be due to the understandable concern of progressive dislocation of bone fragments with the subsequent development of neurological deficit. In literature sources, there are generally no systematic reviews on the safety and reliability of conservative treatment in patients with AOSpine A3 and A4 fractures of the thoracic and lumbar spine. Published meta-analyses compare surgical and conservative treatment techniques and provide no conception of complications and outcomes. The only systematic review of conservative treatment complications [7] was conducted with methodological inaccuracies that could have significant effect on the assessment of the rate of failure of the analyzed treatment technique for thoracic and lumbar burst fractures.

The objective is to conduct a meta-analysis of trials that refer to the conservative treatment for burst fractures of the thoracic and lumbar spine, as well as determination of the efficacy and safety of this treatment technique in the analyzed group of patients.

Material and Methods

Selection of articles

This systematic review was carried out in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [8]; the research was registered in the PROSPERO register (No. CRD42023476539).

The query used to search in the Pubmed database contained the following keywords: (Lumbar vertebrae [MeSH] OR Thoracic vertebrae [MeSH] OR spine [MeSH] OR Thoracolumbar [TIAB] OR thoraco-lumbar [TIAB] OR thoraco lumbar [TIAB] OR burst [Title]) AND (Injur* [TIAB] OR trauma* [TIAB] OR fractur* [TIAB] OR dislocation* [TIAB]) NOT animal [MeSH] NOT human [MeSH] NOT cadaver [MeSH] NOT cadaver* [Titl] NOT comment [PT] NOT letter [PT] NOT editorial [PT] NOT news [PT] NOT "newspaper article" [PT] NOT osteoporosis [MH] NOT osteoporotic fractures [MH] NOT osteoporo* [TITLE] NOT spinal neoplasms [MH] NOT tumor* [TITLE] NOT malignan* [TITLE].

Criteria for the inclusion of articles in the meta-analysis were the following:

1) date of publication from January 01, 1984 to December 31, 2022;

2) full text of an article is available in English or Russian;

3) A3 or A4 fracture according to the AOSpine classification, or IIA, IIB or IIC burst fracture according to the Denis classification, or the presence of a burst fracture explicitly provided by the author with no classification;

4) absence of spinal cord injury or nerve root injury at the time of admission to the hospital;

5) patient age over 18;

6) description of treatment results or developed complications in the trial;

7) accumulation of long-term results no earlier than one year after the end of conservative treatment.

All articles that did not meet these criteria were excluded from our research. The algorithm for searching and selecting articles is provided in Fig. 1.

Data collection

Information obtained from each article was entered into a corresponding table cell. If there was no relevant information in the text of the article, the cell was marked as "not available" (N/a). Background information included sample size, mean age of patients, gender distribution, diagnosis, and mechanism of injury. Main data included the following information: treatment algorithm, duration of bed rest, duration of wearing a thoracolumbar brace for immobilization, complications of conservative treatment, the frequency of transition from conservative treatment to surgical intervention, radiological parameters on admission and during final examination, length of hospital stay, mean time to the final examination, severity of pain according to Denis Pain Scale (Table 1) and VAS, results of occupational adaptation according to the Denis Work Scale (Table 2), as well as quality of life at the time of final examination in accordance with any appropriate scale. Analysis of radiological parameters included kyphotic deformity (Cobb angle), the anterior vertebral body compression percentage (AVBCP) in comparison to intact segments, as well as the degree of spinal stenosis based on the mid-sagittal diameter [9].

Statistical analysis

Meta-analysis was performed using the Comprehensive Meta-Analysis software, version 2.2.064 (Biostat, Englewood, NJ, USA). Heterogeneity was estimated using the I^2 test. If I^2 value was < 50 %, heterogeneity was considered low; at I^2 in the range of 50–75 %, it was considered moderate; and at I^2 > 75 %, heterogeneity was considered high [10]. If there was no evidence of statistical heterogeneity between trials (Cochrane Q-test, p > 0,10), a fixed effects model was used. Otherwise, a random effects model was used (DerSimonian and Laird). Publication bias was considered at $p < 0.05$ in the Begg's test. If there was no publication bias, the result was presented as a forest plot. In case of publication bias, it was eliminated using the trim-and-fill method [11]; it was demonstrated as a funnel plot.

For comparing radiological parameters on admission and during final examination, a standardized mean difference (SMD) was used. The result was shown as a 95 % confidence interval (CI). The difference was considered statistically significant, if the whole interval was strictly > 0 or < 0.

Results

Selection of articles

A total of 1073 articles were found during the initial search in the Pubmed database. The paper abstracts remained after filtering for age and language were reviewed. As a result of the initial search, 123 papers were selected for full text review. 29 of these trials met the required criteria and were included in this research (Fig. 1). In total, treatment data obtained from 1107 patients were available. Gender distribution was reported in 24 articles (956 patients). There were 578 (60.4 %) male patients, and 378 (39.6 %) female patients. Median for mean age for all papers was 41 years. The mechanism of injury was reported in 19 trials (768 patients). Thoracic and lumbar spine injuries were mainly caused by falls from height (46.9 %) and road traffic accidents (38.4 %). General description of each trial is provided in Tables 3 and 4.

Meta-analysis of radiological parameters

The mean angle of kyphotic deformity on admission was 13.6° (95 % CI, 10.8–16.5; I^2 = 95.9 %; Q-test, p = 0.00; Begg's test, p = 0.073). By the time of the final examination, the increase in kyphotic deformity was statistically significant (SMD = -0,55 [95 % CI, -0.83, -0.27]; I^2 = 68.7%; Q-test, p = 0.000; Begg's test, p = 0.531) and was on mean 3.0° (95 % CI, 1.7–4.3; Fig. 2).

The cumulative AVBCP on admission was 39.9 % (95 % CI, 27.7–52.0;

I^2 = 98.8 %; Q test, p = 0.000; Begg's test, p = 0.573). Follow-up examination revealed an increase in AVBCP by mean 3,7 % since surgical treatment (95 % CI, 0.3–7.7; Fig. 3); it was statistically significant (SMD = -0.33 [95% CI, -0.56, -0.09]; I^2 = 37.9 %; Q-test, p = 0.185; Begg's test, p = 0.497).

Spinal canal lumen on admission was 41.7 % (95 % CI, 29.2–54.2; I^2 = 99.5 %; Q test, p = 0.000; Begg's test, p = 0.144). The final examination revealed a decrease in the total spinal canal lumen to 19.7 % (95 % CI, 16.4–23.1; I^2 = 88.8 %; Q-test, p = 0.000; Begg's test, p = 0.624); it was statistically significant (SMD = 1.89 [95 % CI, 1.62–2.17]; Fig. 4).

Meta-analysis of conservative treatment complications

General somatic complications in patients are described only in single papers. They included venous thrombosis of lower extremities, n = 2 (9.5%) [13]; thromboembolism of pulmonary artery branches, n = 2 (9.5 %) [13]; acute intestinal obstruction, n = 1 (4.8 %) [13]; urinary tract infection, n = 10 (8.3 %) [5, 16, 21, 24]; transient urination disorder, n = 10 (12.7 %) [16, 20]; and superficial pressure ulcer due to brace wearing, n = 4 (5.1 %) [5, 27]. There was small number of such descriptions; therefore, no statistical analysis of general somatic complications was performed.

Changes in the neurological status from admission to the final examination were described in 28 articles (Table 4). During calculating the total incidence rate for neurological deficit, despite the absence of heterogeneity (I^2 = 0 %; Q-test, p = 0.574), publication bias was found (Begg's test, p < 0.001). To eliminate it and reach the symmetry of the funnel diagram, we had to add 14 papers with a small sample size and with no development of neurological complications (Fig. 5). As a result, the total incidence of neurological deficits was 58 % (95 % CI, 4.1–8.1).

In a number of patients, persistent pain syndrome during verticalization and its increase over time was observed that required the discontinuation of conservative treatment and surgical stabilization. This information was mentioned

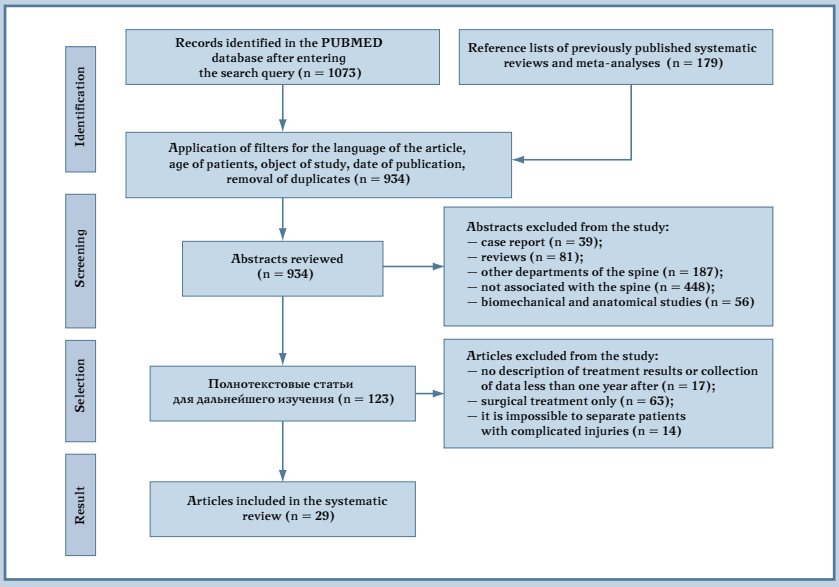


Fig. 1
Algorithm for searching and selecting articles – Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA)

Table 1
Pain severity scale according to Denis et al. [12]

Grade	Criteria
P1	No pain
P2	Minimal pain, no need for medication
P3	Moderate pain, occasional medi¬cation, no interruption of work or activities of daily life
P4	Moderate to severe pain, requires frequent use of pain medication, causes frequent absences from work or significantly facilitates the work performed
P5	Constant severe pain, chronic medication

Table 2
Occupational adaptation scale according to Denis et al. [12]

Grade	Criteria
W1	Physically demanding activity is possible
W2	Able to return to previous employment (sedentary) or return to physically demanding activity with slight modification
W3	Unable to return to previous employment, working full-time at a new job with easier working conditions
W4	Unable to return to previous employment, working at a new job with easier working conditions, working part-time or frequently missing work due to pain
W5	Unable to work

in 28 articles. The total rate of transition from conservative treatment to surgical intervention due to worsening back pain was 6.5 % (95 % CI, 4.5–9.3; Fig. 6).

Meta-analysis of long-term treatment outcomes

Most patients with uncomplicated fractures of the thoracic and lumbar spine in the long-term period of injury had no or minimal pain (Table 5). The VAS total score of pain severity was 2.5 (95 % CI, 2.1–3.0; I^2 = 97.8%; Q-test, p = 0.00; Begg's test, p = 0.295). Most patients returned to their previous full-time work (Table 5). Data obtained using the Oswestry and RMDQ questionnaires demonstrated slightly decreased quality of life of patients, however, due to the fact that these questionnaires are extremely rarely used in published papers, no statistical analysis for these scores was performed.

Discussion

At present time, in connection with the increased popularity of minimally invasive surgery, the focus on the conservative treatment for fractures of the thoracic and lumbar spine is decreasing. This is evidenced by the relatively small number of publications in international databases, the significant lack of such papers in Russian literature, as well as the almost complete lack of interest in this issue both at Russian and international conferences. It may be caused by the absence of systematic literature evidence that clearly demonstrates the high efficacy and safety of conservative treatment for such fractures of the thoracic and lumbar spine to surgeons.

We found only one meta-analysis [7] where the authors tried to figure out the incidence of complications that required surgical intervention. According to them, it was 9.2 % (95 % CI, 4.5–13.9). Unfortunately, this paper has a significant shortcoming: the authors did not include 17 more trials that are also important in the meta-analysis and have an effect on the final result. Moreover, despite the high heterogeneity of the articles included (I^2 = 83.82%), Tan et al. [7] have not estimated publication bias, that could also change the interpretation of the results obtained.

We included all published articles with the information on the results of conservative treatment in a certain sample of patients that met the inclusion criteria. Unlike the earlier research [7], we decided to divide the complications that required surgical treatment into two groups according to the mechanism of their development. Orthopedic complications were associated with impaired support ability of the vertebral body, manifested as increase in pain during verticalization up to significant one, and did not resolve for a long time, therefore, required surgical stabilization. The probability of developing orthopedic complications according to the data obtained during the meta-analysis was 6.5 %. Radiculopathy and myelopathy were included in the group of neurological complications. Unfortunately, due to insufficient description of the developed neurological deficit in three patients in one of the trials [38], we were unable to separately calculate the incidence of radiculopathy and myelopathy. Generally, the probability of developing compression of neural structures after eliminating publication bias was 5.8 %. It should be mentioned that in all cases of neurological deficit development, its regression associated with surgical treatment was observed.

Analysis of long-term results demonstrated excellent results of occupational adaptation in most patients. More than 90 % of patients had no pain or required occasional analgesics with no effect on everyday activities. Only 14.8 % of patients required part-time work or complete release from work what is comparable to the results of surgical treatment [40].

An important aspect of this research was the development of criteria for the selection of conservative treatment for patients with fractures of the thoracic and lumbar spine considering the cumulative radiological results obtained. Thus, according to the performed meta-analysis, conservative treatment can be effective and safe in patients with kyphotic deformity of a segment up to 16° and the grade of vertebral body compression up to 52 %. It should be mentioned that a significant increase in kyphosis and in the grade of vertebral body compression was observed during the final examination in all trials: on mean by 3.0° and 3.7 %, respectively. Nevertheless, similar changes can develop after surgical treatment [39], so we consider these changes as a normal course of spinal injury. Moreover, spontaneous lysis of bone fragments resulted in an at least 2-fold mean increase in the area of the spinal canal lumen; and this fact supports not performing spinal canal decompression in patients with uncomplicated fractures of the thoracic and lumbar spine.

Limitations of the study

A limitation of this meta-analysis is the lack of trials with a high level of evidence. A larger number of prospective trials with clear patient selection criteria and detailed descriptions at all treatment stages would help to obtain more accurate values, in particular, for the incidence of neurological deficits or orthopedic complications.

Another limitation is the combination of AOSpine A3 and A4 fractures and Denis type A, B and C fractures into one group. Dividing of burst fractures of the thoracic and lumbar spine into subtypes would allow performing a more precise analysis of the results of conservative treatment. Moreover, all published papers include no grouping of outcomes by the spine departments, and several trials concern only one of them. Separate evaluation of the thoracic and lumbar departments, as well as the thoracolumbar junction, in each article would allow obtaining more accurate data on radiological parameters and outcomes.

However, available trials are sufficient to develop a general presentation of the analyzed issue. The data obtained during the meta-analysis can provide surgeons with the opportunity to make an informed choice of the best treatment strategy, as well as provide clear values for informing the patient about possible adverse events during treatment and about the chances in relation to the occupational adaptation during the long-term period of injury.

Table 3
General features of patient groups at the time of hospital admission (according to literature data)

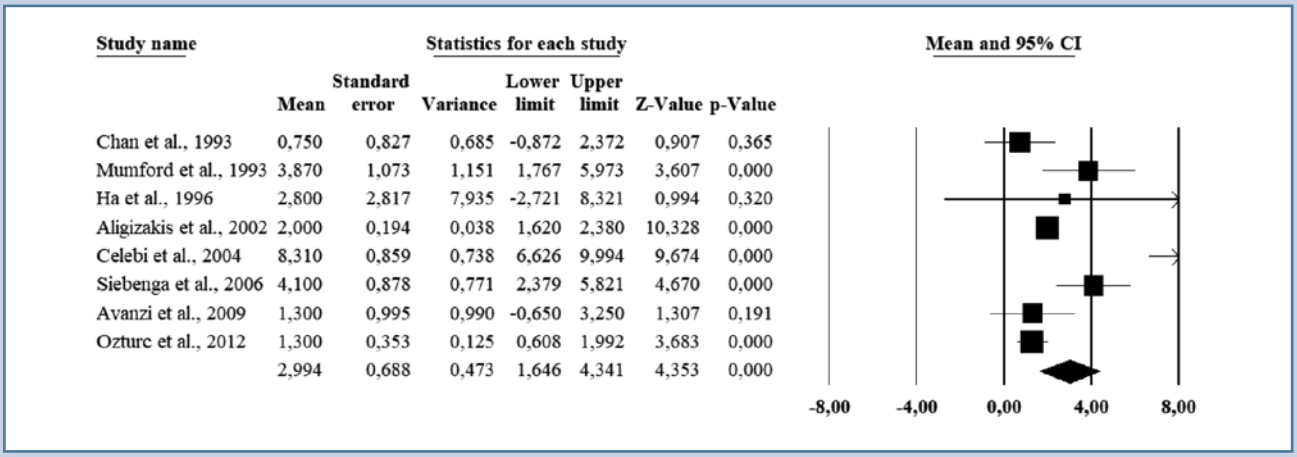
Study	Patients, n	Duration of bed rest, days	Duration of immobilization, weeks	Angle of kyphotic deformity, degrees	Degree of vertebral body compression, %	Reduction of the spinal canal lumen, %	Conservative treatment complications, n (%)	Transition to surgical treatment, n (%)
Denis et al. [12]	39	N/a	N/a	–	–	–	Paraparesis – 2 (5.1), radiculopathy – 4 (10.2)	4 (10.2)
Reid et al. [13]	21	N/a	24.0 (8–30)	–	41.00 ± 15.00	–	–	–
Cantor et al. [14]	18	N/a	N/a	19.00	64.00	26.00	–	–-
Chan et al. [15]	20	N/a	12.6 (6–20)	8.40 ± 9.50	77.80 ± 12.40	40.10 ± 21.10	–	–
Mumford et al. [16]	41	31.3 days	11.9 (2–24)	16.20 ± 10.03	38.47 ± 16.51	37.28 ± 13.10	Radiculopathy – 1 (2.4)	1 (2.4)
Hartman et al. [17]	20	4–6 weeks	12.0	–	–	–	–	–
Chow et al. [18]	26	Up to 7 days	12.0–24.0	5.30	30.20	–	Increased back pain – 2 (7.7)	2 (7.7)
Ha et al. [19]	6	1–3 months	5.0	–	–	60.80 ± 10.20	–	–
Shen and Shen [20]	38	N/a	N/a	–	–	–	Increased back pain – 2 (5.3)	2 (5.3)
Shen et al. [6]	47	0	12.0	–	–	34.00 ± 21.00	–	–
Aligizakis et al. [21]	60	Up to 7 days	24.0	6.00 ± 4.00	35.00 ± 27.80	32.00 ± 6.50	–	–
Wood et al. [5]	23	N/a	8.0–12.0	11.30	–	34.00	–	–
Alanay et al. [22]	15	1 day	12.0	16.50	69.00	–	–	–
Celebi et al. [23]	26	2 days	16.0–24.0	19.90 ± 5.36	–	35.45 ± 10.30	Increased back pain – 3 (11.5)	3 (11.5)
Agus et al. [24]	16	5 days	24.0	14.80	72.13	45.90 ± 20.00	–	–
Al-Khalifa et al. [25]	60	Up to 7 days	12.0	–	–	–	Increased back pain – 5 (8.3)	5 (8.3)
Butler et al. [26]	15	N/a	12.0	–	69.00	16.00	–	–
Tezer et al. [27]	16	3–4 weeks	32.0	–	–	–	–	–
Siebenga et al. [28]	15	5 days	12.0	15.70 ± 6.40	–	–	Conus medullaris syndrome – 1 (6.7)	–
Post et al. [29]	25	6 weeks	36.0	–	–	–	–	–
Stadhouder et al. [30]	25	3–5 days	12.0	11.80 ± 8.40	–	–	Increased back pain – 1 (4.0)	1 (4.0)
Avanzi et al. [31]	36	N/a	N/a	12.20 ± 9.97	–	–	–	–
Ozturc et al. [32]	26	2 days	12.0	16.80 ± 5.60	19.40 ± 6.30	–	–	–
Bailey et al., no TLSO [33]	49	N/a	–	14.20 ± 5.50	–	–	Increased back pain – 2 (4.1)	2 (4.1)
Bailey et al., TLSO [33]	47	Up to 7 days	12.0	15.10 ± 7.80	–	–	Increased back pain – 4 (8.5)	4 (8.5)
Shen et al. [34]	129	3–5 days	12.0	–	–	–	Increased back pain – 25 (19.4)	25 (19.4)
Azhari et al. [35]	113	N/a	N/a	–	–	67.40 ± 10.80	Increased back pain – 14 (12.4)	14 (12.4)
Hitchon et al. [36]	50	0	8.0–12.0	–	–	–	Increased back pain – 3 (6.0)	3 (6.0)
Pehlivanoglu et al. [37]	24	7 days	12.0	–	–	–	–	–
Alimohammadi et al. [38]	67	2 days	12.0	13.10 ± 4.13	28.30 ± 5.01	23.28 ± 4.71	Increased back pain – 13 (19.4), development of neurological deficit, unspecified – 3 (4.5)	16 (23.9)

N/a – not available.

Table 4
General features of groups of patients with uncomplicated fractures of the thoracic and lumbar spine at the final examination (according to the literature)

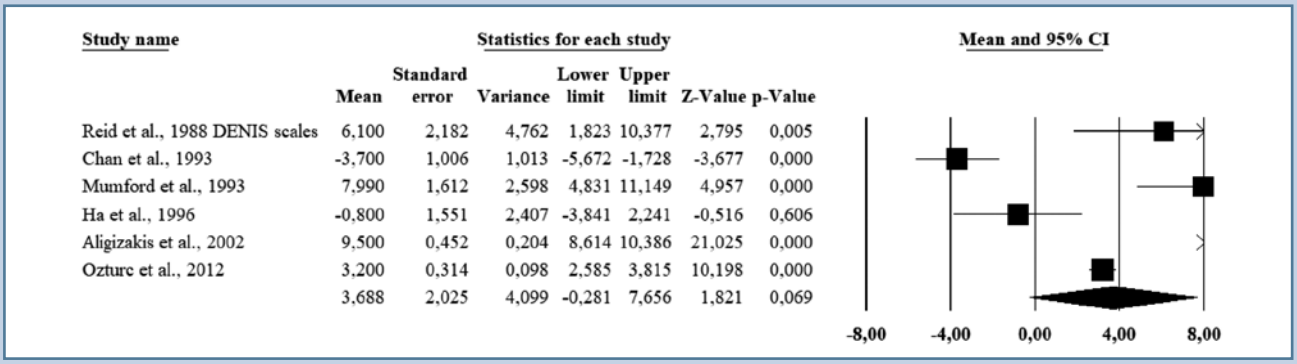
Study	Patients, n	Angle of kyphotic deformity, degrees		Mean degree of vertebral body compression, %		Mean reduction of the spinal canal lumen, %		Pain severity according to Denis					Occupational adaptation grade according to Denis					Mean values of other scales for quality of life assessment
		fin.	ch.	fin.	ch.	fin.	ch.	P1	P2	P3	P4	P5	W1	W2	W3	W4	W5	
Denis et al. [12]	35	–	–	–	–	–	–	5	13	9	4	0	4	15	3	5	4	–
Reid et al. [13]	21	–	–	–	6.10 ± 10.00	–	–	8	3	10	0	0	9	8	0	3	1	–
Cantor et al. [14]	18	20.00	–	64.00	–	–	–	9	6	2	1	0	14	3	0	0	1	–
Chan et al. [15]	20	9.20 ± 10.60	0.75 ± 3.70	74.20 ± 13.20	-3.70 ± 4.50	–	–	5	14	1	0	0	–	–	–	–	–	–
Mumford et al. [16]	40	20.10 ± 10.50	3.90 ± 6.90	46.50 ± 15.30	8.00 ± 10.30	14.50 ± 10.90	-22.80 ± 14.50	–	–	–	–	–	–	–	–	–	–	VAS 2.4 ± 1.3
Hartman et al. [17]	20	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Chow et al. [18]	24	7.50	–	40.90	10.70	–	–	11	8	3	1	1	12	6	3	2	1	–
Ha et al. [19]	6	–	–	–	–	26.70 ± 8.10	-34.20 ± 4.90	–	–	–	–	–	–	–	–	–	–	–
Shen and Shen [20]	36	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Shen et al. [6]	47	–	–	–	–	15.00	–	–	–	–	–	–	–	–	–	–	–	VAS 1.5 ± 1.3
Aligizakis et al. [21]	60	8.00 ± 3.50	2.00 ± 1.50	44.50 ± 29.50	9.50 ± 3.50	22.00 ± 5.00	-10.00 ± 2.50	30	20	4	1	5	28	22	5	0	5	–
Wood et al. [5]	23	13.80	–	–	–	–	-19.00	–	–	–	–	–	–	–	–	–	–	VAS 1.9 ± 2.6; OSW 10.7 ± 15.3; RMDQ 0.7
Alanay et al. [22]	15	17.00	0.50	68.00	-1.00	–	–	1	10	3	1	0	–	–	–	–	–	–
Celebi et al. [23]	23	28.2 ± 5.6	8.30 ± 4.40	–	–	17.34 ± 4.00	-18.10	5	11	7	0	0	9	8	4	2	0	–
Agus et al. [24]	16	17.10	2.40	62.13	-10.00	20.80 ± 9.00	-24.80 ± 15.00	12	4	–	–	–	12	4	–	–	–	–
Al-Khalifa et al. [25]	55	–	–	–	–	–	–											–
Butler et al. [26]	15	14.40	–	–	–	–	–	2	4	3	5	1	1	5	2	4	3	–
Tezer et al. [27]	16	–	–	–	–	–	–	5	4	7	–	–	–	–	–	–	–	–
Siebenga et al. [28]	15	19.80 ± 5.70	4.10 ± 3.40	–	–	–	–	–	–	–	–	–	–	–	–	–	–	RMDQ 8.9 ± 7.3
Post et al. [29]	25	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	RMDQ 3.1 ± 3.7
Stadhouder et al. [30]	24	11.80 ± 9.50	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Avanzi et al. [31]	36	13.40 ± 10.70	1.30 ± 6.00	–	–	–	–	5	15	8	6	2	12	10	8	1	5	VAS 4.1 ± 2.9
Ozturc et al. [32]	26	18.20 ± 5.60	1.30 ± 1.80	22.70 ± 6.00	3.20 ± 1.60	–	–	13	9	4	–	–	4	15	6	1	–	–
Bailey et al., no TLSO [33]	47	21.00 ± 9.00	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	VAS 3.4 ± 0.3; RMDQ 9.8 ± 0.6
Bailey et al., TLSO [33]	43	22.00 ± 5.00	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	VAS 2.7 ± 0.2; RMDQ 8.7 ± 0.7
Shen et al. [34]	104	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Azhari et al. [35]	99	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	OSW 12.4 ± 11.1
Hitchon et al. [36]	47	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	VAS 1.9 ± 1.9; OSW 25.0 ± 23.0
Pehlivanoglu et al. [37]	24	11.70	4.03	17.90	–	–	–	–	–	–	–	–	–	–	–	–	–	VAS 2.3; OSW 12.1
Alimohammadi et al. [38]	51	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–

ch. — changes of the value over time compared to the value upon admission; fin. — value at the time of the final examination; VAS — Visual Analog Scale; OSW — Oswestry Quality of Life Scale; RMDQ — Roland-Morris Disability Questionnaire.



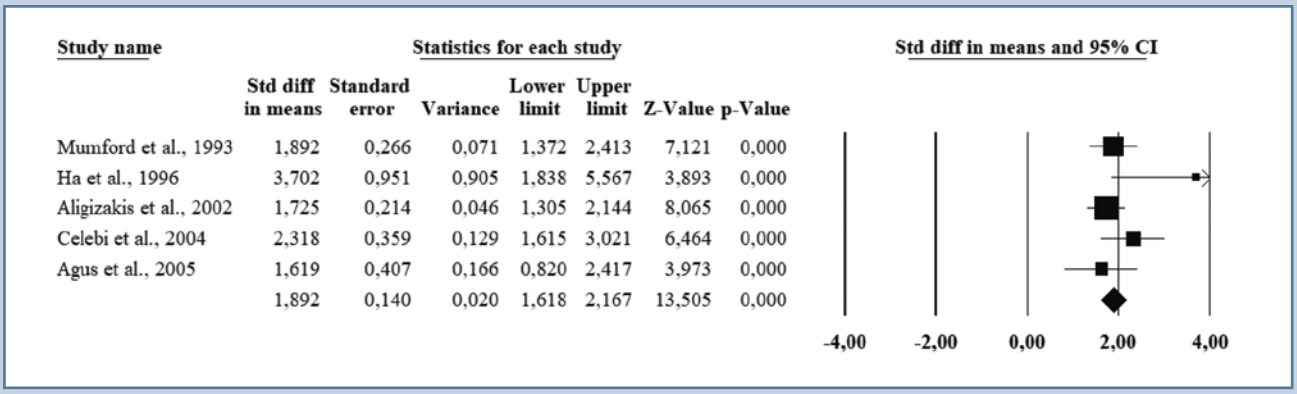
Study name	Mean	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Chan et al., 1993	0,750	0,827	0,685	-0,872	2,372	0,907	0,365
Mumford et al., 1993	3,870	1,073	1,151	1,767	5,973	3,607	0,000
Ha et al., 1996	2,800	2,817	7,935	-2,721	8,321	0,994	0,320
Aligizakis et al., 2002	2,000	0,194	0,038	1,620	2,380	10,328	0,000
Celebi et al., 2004	8,310	0,859	0,738	6,626	9,994	9,674	0,000
Siebenga et al., 2006	4,100	0,878	0,771	2,379	5,821	4,670	0,000
Avanzi et al., 2009	1,300	0,995	0,990	-0,650	3,250	1,307	0,191
Ozturc et al., 2012	1,300	0,353	0,125	0,608	1,992	3,683	0,000
	2,994	0,688	0,473	1,646	4,341	4,353	0,000

Fig. 2
Overall value of kyphotic deformity increase in patients with burst fractures of the thoracic and lumbar spine: I^2 = 89.5 %; Q-test, p = 0.000; Begg's test, p = 0.322



Study name	Mean	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Reid et al., 1988 DENIS scales	6,100	2,182	4,762	1,823	10,377	2,795	0,005
Chan et al., 1993	-3,700	1,006	1,013	-5,672	-1,728	-3,677	0,000
Mumford et al., 1993	7,990	1,612	2,598	4,831	11,149	4,957	0,000
Ha et al., 1996	-0,800	1,551	2,407	-3,841	2,241	-0,516	0,606
Aligizakis et al., 2002	9,500	0,452	0,204	8,614	10,386	21,025	0,000
Ozturc et al., 2012	3,200	0,314	0,098	2,585	3,815	10,198	0,000
	3,688	2,025	4,099	-0,281	7,656	1,821	0,069

Fig. 3
Overall value of the increase in the compression degree of the anterior parts of the vertebral body in patients with burst fractures of the thoracic and lumbar spine: I^2 = 97.8 %; Q-test, p = 0.000; Begg's test, p = 0.573



Study name	Std diff in means	Standard error	Variance	Lower limit	Upper limit	Z-Value	p-Value
Mumford et al., 1993	1,892	0,266	0,071	1,372	2,413	7,121	0,000
Ha et al., 1996	3,702	0,951	0,905	1,838	5,567	3,893	0,000
Aligizakis et al., 2002	1,725	0,214	0,046	1,305	2,144	8,065	0,000
Celebi et al., 2004	2,318	0,359	0,129	1,615	3,021	6,464	0,000
Agus et al., 2005	1,619	0,407	0,166	0,820	2,417	3,973	0,000
	1,892	0,140	0,020	1,618	2,167	13,505	0,000

Fig. 4
Standardized difference in means for the value of compression degree of the spinal canal at the time of admission and during the follow-up examination: I^2 = 34.4 %; Q-test, p = 0.192; Begg's test, p = 0.142

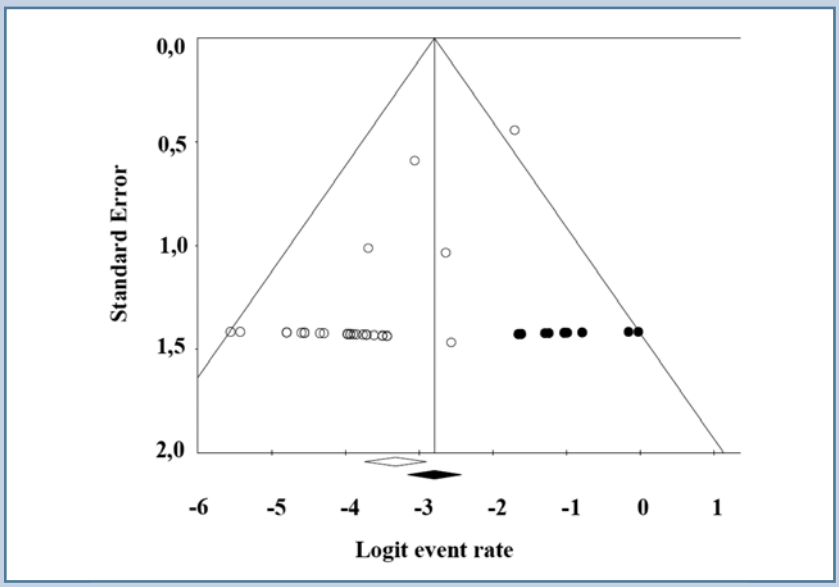


Fig. 5
Funnel plot showing publication bias in calculating the incidence rate of neurological deficits: white markers – published studies; black markers – added using the trim-and-fill method of a series of follow-up

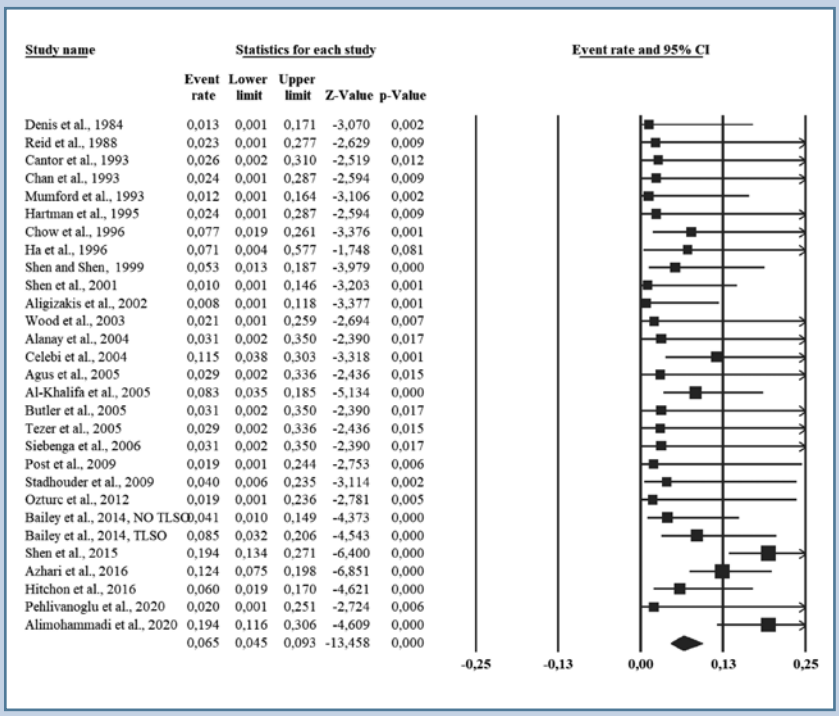


Fig. 6
Overall incidence of pain syndrome requiring surgical intervention: I^2 = 42.3 %; Q-test, p = 0.009; Begg's test, p = 0.961

Conclusion

Conservative treatment in patients with fractures of the thoracic and lumbar spine with no neurological deficit can be an effective and safe in cases of angular deformity up to 16° and the grade of vertebral body compression in its anterior part up to 52 %. In connection to the conservative treatment, a 2-fold decrease in total spinal canal stenosis was registered due to the lysis of bone fragments. The total incidence of radiculopathy or myelopathy associated with the conservative treatment was 5.8 %. Patients may require orthopedic intervention due to the progression of instability of the injured segment in 6.5 % of cases. More than 90.0 % of patients returned to full-time work after conservative treatment, in their previous position or in less demanding conditions. Comparative trials of the efficacy of conservative treatment and surgical intervention should be continued to develop clear guidelines on the treatment strategy in patients with uncomplicated fractures of the thoracic and lumbar spine.

Table 5

Results of a meta-analysis of the pain severity and occupational adaptation according to Denis in the long-term period of injury

Grade by Denis	Indicator (95% CI)	Heterogeneity		Begg's test
		I^2, %	Q-test, p	
Severity of pain				
P1 and P2	71.0 % (60.1–79.4)	63.3	0.001	0.091
P3	20.2 % (13.6–28.9)	57.5	0.005	0.118
P4 and P5	9.7 % (5.5–16.6)	47.0	0.032	0.103
Results of occupational adaptation				
W1 and W2	74.7 % (63.9–83.1)	62.3	0.005	0.090
W3	14.1 % (10.2–19.3)	16.5	0.291	0.104
W4 and W5	14.8 % (8.8–23.9)	57.6	0.012	0.061

The study had no sponsors. The authors declare that they have no conflict of interest.
The study was approved by the local ethics committees of the institutions. All authors contributed significantly to the research and preparation of the article, read and approved the final version before publication.

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