

Thoracolumbar tuberculosis spondylitis: an analytical literature review of surgical reconstruction techniques

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Abstract

Introduction Tuberculous spondylitis is the most common extrapulmonary tuberculosis. The thoracolumbar lesion due to tuberculous spondylitis is one of the most difficult locations for surgical treatment. Analysis of the recent literature shows a limited amount of data on the results of various current surgical reconstruction techniques. **Purpose** To review the literature on surgical treatment of thoracolumbar tuberculous spondylitis published during the last five years and judge upon an optimal method. **Materials and methods** A systematic literature review was performed of the sources from eLibrary, PubMed, Cochrane Library databases. Inclusion criteria: etiologically verified tuberculous spondylitis of thoracolumbar location, follow-up ≥ 1 year, patients older than 18 years. Twenty-one studies that summarize 1,209 cases were selected. Patients were divided into three groups depending on the method of spinal reconstruction (group 1 – ventral approach, group 2 – combined approach, group 3 – dorsal approach). Surgical indicators, correction of kyphotic deformity and its dynamics in the long-term period, rates of complications and the length of hospital stay were analyzed. **Results and discussion** Blood loss and duration of the intervention were significantly lower in the reconstruction of the thoracolumbar spine from the dorsal approach (599.6 ± 195.1 ml and 196.3 ± 35.6 min). Correction of kyphotic deformity from posterior and combined approaches was higher than in the reconstruction from the ventral approach (64 and 69 %, respectively). At the same time, an inverse proportional dependence of the degree of correction loss in the long-term period was revealed, which was higher with anterior fusion ($7.3^\circ \pm 1.7^\circ$ according to Cobb). The duration of hospital stay was shorter in patients with reconstructions from the dorsal approach (13.7 ± 8.2 days). The rate of complications in group 3 was significantly lower ($p < 0.0001$), while the assessment of their structure indicates prevalence of neurological deficits in dorsal reconstructions, while in ventral and combined reconstructions, infectious complications, pneumothorax, and chronic pain syndrome in the area of autologous costal graft harvesting. **Conclusion** The optimal method of surgical treatment of thoracolumbar tuberculous spondylitis is a three-column reconstruction from the dorsal approach. The advantages of the method are a decrease in the rate of postoperative complications, a reduction in the duration of inpatient treatment, surgical blood loss and duration of surgical intervention.

Keywords: tuberculosis, spondylitis, kyphosis, vertebromy, thoracolumbar spine

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INTRODUCTION

Tuberculous spondylitis (TS) is the most common type of extrapulmonary tuberculosis. It reaches 50 % or more among osteoarticular lesions of granulomatous etiology [1-4]. According to the literature, lesions of the thoracic (40-50 %), lumbar (25-30 %) and cervical (10 %) regions prevail in the overall structure of tuberculous spondylitis [5-7]. Destruction of transitional (cervicothoracic (C7-T2), thoracolumbar (T12-L1) and lumbosacral (L5-S1) segments are rarely recorded (5-7 % of cases) in tuberculous spondylitis and are associated with the most severe clinical manifestations, among which polysegmental character, intense vertebrogenic pain syndrome due to instability, neurological disorders and early formation of rigid kyphotic deformities [8, 9].

It is shown that, along with the infection zone debridement, an important criterion for improving the quality of life of patients with destruction of the transitional junctions of the spine is the restoration

of sagittal balance parameters, including CSVA (cervical sagittal vertical axis), T1S (Th1 slope), NTA (neck tilt angle), TK (thoracic kyphosis), and LL (lumbar lordosis) [10]. The debridement of the infection focus, ensured segment stability and correction of kyphotic deformity are the key criteria for choosing a method for surgical reconstruction of the transitional region [11-14].

Despite a wide range of surgical methods for treating spondylitis of the thoracolumbar location, including isolated reconstruction of the anterior column of the spine from the thoraco-diaphragmatic approach, dorsal three-column vertebrotomy (Schwab type 4-6) and reconstruction from the combined approach, there are no systematized data on the results of these interventions in the domestic literature.

Purpose of the study was to define an optimal method of surgical treatment of tuberculosis spondylitis located in the thoracolumbar region.

MATERIALS AND METHODS

The literature review was carried out in accordance with the PRISMA recommendations [15]. Search depth: January 2017 throughout September 2022. The search was carried out with the keywords: “tuberculous spondylitis”, “spinal tuberculosis”, “surgical approach”, “sagittal balance”, “thoracolumbar”, “tuberculosis of the spine”, “thoracolumbar”, “tuberculous spondylitis”, “sagittal balance” in the domestic eLibrary database, in PubMed/MedLine, Cochrane Library.

Inclusion criteria:

- Confirmed etiological verification of tuberculosis spondylitis with bacteriological, molecular genetics and histological methods ;
- Thoracolumbar location of the destruction;
- Catamnesis followed for one year or more;
- Age over 18 years.

The primary search found 43 publications, including 17 cohort studies, 22 clinical series and case studies, 2 meta-analyses and 2 systematic reviews. At the second stage, publications without an available full text version, duplicate works, as well as those works that did not fully meet the inclusion criteria were excluded. The final analysis included 14 publications on the results of surgical treatment of 1,209 patients. The selection scheme is shown in Figure 1.

Characteristics of the works included in the review are presented in Tables 1-3.

The following study groups were formed according to the method of reconstruction of the thoracolumbar region: group 1 – anterior-only approach ($n_1 = 178$ cases), group 2 – combined approach ($n_2 = 315$ cases), group 3 – dorsal approach ($n_3 = 716$ cases).

Criteria for the effectiveness of the methods of surgical reconstruction were volume of surgical blood loss (ml), duration of the intervention (min), the amount of correction of kyphotic deformity and correction loss in the long-term period (in degrees according to Cobb), the length of hospital stay (days) and the rate of postoperative complications.

Statistical processing was carried out using the Statistical Package for the Social Sciences (SPSS), version 22.0 (SPSS Inc., Chicago, IL, USA). To assess the presence of statistically significant differences between the analyzed parameters in the groups, the nonparametric Kruskal-Wallis H-test was used. The impact of the “surgical reconstruction option” parameter on the analyzed performance criteria was assessed using one-way analysis of variance (ANOVA). Statistical differences were considered significant at two-tailed $p < 0.05$. The results are presented as $M \pm m$.

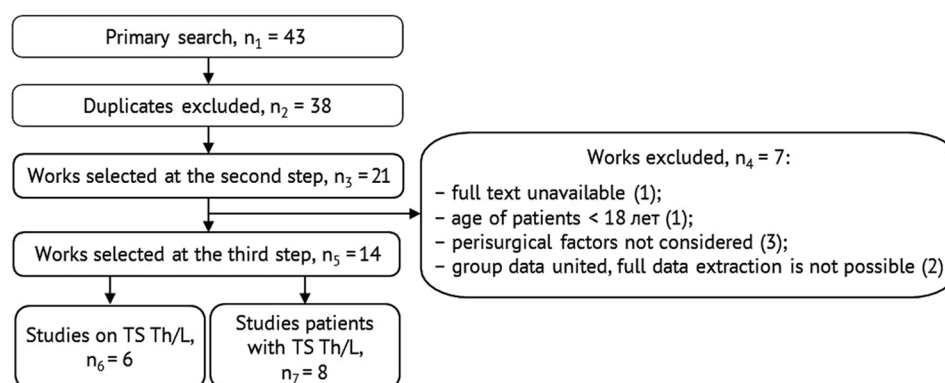


Fig. 1 Methodology of literature selection

Table 1

Anterior approach

Author	Year	Number of patients	Blood loss (ml)	Kyphosis before surgery (° Cobb)	Kyphosis after surgery (° Cobb)	Loss of correction (° Cobb)	Inpatient stay (days)	Duration of operation (min)
Tang Y. et al. [6]	2019	22	895.2±395.1	20.2±7.6	10.1±4.9	5.5±3.1	27.0±5.9	324.7±44.2
Zeng Y. et al. [14]	2019	45	744.0± 193.8	22.7±7.9	11.2±5.4	5.5±3.7	–	330.2±45.4
Wang L. et al. [16]	2017	57	798.7 ± 72.5	27.3 ± 8.1	14 ± 1.7	2.3 ± 1.6	–	256.6 ± 55.1
Omran K. et al. [17]	2017	22	700 ± 250	49 ± 5.2	20 ± 3.2	6 ± 1.1	6.3 ± 2.3	190 ± 40
Zhang H. et al. [18]	2017	32	649.0 ± 120.0	22.9±3.2	9.5±1.0	2.5	14 ± 2.4	270.7 ± 32.0

Table 2

Posterior approach								
Author	Year	Number of patients	Blood loss (ml)	Kyphosis before surgery (° Cobb)	Kyphosis after surgery (° Cobb)	Loss of correction (° Cobb)	Inpatient stay (days)	Duration of operation (min)
Tang Y. et al. [6]	2019	31	805.9±769.6	23.2±9.7	9.8±5.4	2.2±2.7	27.7±9.2	257.4±4.0
Gao et al. [11]	2021	26	588.9±263.8	29.36±13.29	3.6±5.4	2.1	–	199.7±47.5
Zeng Y. et al. [14]	2019	80	349.8±289.4	20.8±8.3	8.7±3.8	1.6±1.9	–	227.9±58.5
Wang L. et al. [16]	2017	62	625.0±127.3	28.4±9.2	6.8±1.1	1.9±1.4	–	170.6±31.0
Omran K. et al. [17]	2017	23	700±250	49±5.2	20±3.2	2±4.1	6.3±2.3	190±40
Zhang H. et al. [18]	2017	63	409.5±107.9	28.5±6.5	7.4±0.8	0.8	13±3.2	207.9±30.9
Garg B. et al. [19]	2022	60	–	19.9	10.3	2.4	15	260±30
Zhou Y. et al. [20]	2018	34	760.7±146.2	26.1±6.0	9.9±3.7	1.4±1.1	23.3±4.5	160.4±20.6
Kuwakornsavat S. et al. [21]	2019	22	656.8±484.1	23.5±13.5	9.5±9.2	3.5±3.8	–	158.9±41.7
Wang B. et al. [22]	2020	32	710.9	33.6±9.3	10.6±2.6	0.8±0.9	–	172.7
Wu W. et al. [23]	2021	34	731.8±585.8	16.0±15.4	8.1±7.4	2.9	–	224.4±71.1
Kire N. et al. [24]	2021	100	155±33.3	22.33±5.6	5.14±1.32	2.67	–	154.9±17.2
Singh S. et al. [25]	2017	47	701±312	68.2±26.9	29.6±20.3	1.3	–	197.2±30.5
Ma S. et al. [26]	2022	102	–	29.9±8.6	11.8±3.6	1.8±1.8	9.3±2.2	162.0±38.4

Table 3

Combined approach								
Author	Year	Number of patients	Blood loss (ml)	Kyphosis before surgery (° Cobb)	Kyphosis after surgery (° Cobb)	Loss of correction (° Cobb)	Inpatient stay (days)	Duration of operation (min)
Tang Y. et al. [6]	2019	79	1187.3±504.6	18.7±7.3	9.11±3.6	1.8±1.8	31.3±11.7	422.6±70.2
Zeng Y. et al. [14]	2019	23	1134.6±328.2	18.1±6.8	8.4±4.2	1.7±2.2	–	408.0±54.3
Wang L. et al. [16]	2017	65	1167.9±200.7	29.3±9.1	7.0±1.1	1.6±1.1	–	388.2±45.7
Zhang H. et al. [18]	2017	42	840.0±168.7	23.9±7.6	7.4±1.0	1.1	19±2.1	349.7±38.9
Zhou Y. et al. [20]	2018	30	1023.8±197.9	23.7±3.7	9.6±3.3	1.0±0.9	26.5±3.5	231.5±27.4
Ma S. et al. [26]	2022	76	–	30.3±7.7	10.8±3.9	2.2±2.3	12.4±3.3	243.6±53.7

RESULTS

Comparative analysis of intra-operative parameters (volume of blood loss and duration of surgical intervention) in the study groups shows the possibility of reducing these parameters in reconstruction from the dorsal approach ($p < 0.0001$). At the same time, reconstruction from a combined approach is associated with a more than a twofold increase in these indicators (Table 4).

The value of kyphotic deformity correction was comparable in dorsal-only and combined approaches, averaging 64 and 69 % of the initial value ($p > 0.05$). In most studies, reconstruction from an anterior approach was performed in patients with a smaller initial deformity, and the amount of kyphosis correction did not exceed 30 % after the intervention. A bigger loss of correction in the postoperative period was noted in group 1 ($p < 0.0001$).

Table 4

Summary of surgical results in groups

Group/parameter	Group 1 (n ₁ = 178)	Group 2 (n ₂ = 315)	Group 3 (n ₃ = 716)
Blood loss * (ml)	757.3 ± 94.7	1070.7 ± 143.6	599.6 ± 195.1
Duration of operation * (min)	274.43 ± 57.2	340.6 ± 83.5	196.3 ± 35.6

* – significant intergroup differences in the studied parameters are marked

Table 5

Summary of kyphosis correction

Group/parameter	Group 1 (n ₁ = 178)	Group 2 (n ₂ = 315)	Group 3 (n ₃ = 716)
Preoperative kyphosis (° Cobb)	24.0 ± 5.1	28.4 ± 11.7	29.9 ± 13.5
Postoperative kyphosis (° Cobb)	14.9 ± 4.3	8.7 ± 1.4	10.8 ± 6.6
Loss of correction* (° Cobb)	7.3 ± 1.7	1.5 ± 0.4	1.9 ± 0.7

* – significant intergroup differences in the studied parameters are marked

The dynamics of sagittal balance parameters after reconstruction of the thoracolumbar spine in tuberculous spondylitis was investigated only in two publications included in the review [19, 28]. The authors testify to the presence of a correlation between the restoration of the parameters and the improvement in the quality of life of patients, assessed by profile questionnaires (ODI, SRS-22).

The shortest length of hospital stay was in the second group (13.7 ± 8.2 days), while the use of ventral approach, both alone (15.7 ± 10.4) and in the variant of combined reconstruction (22.2 ± 8.2), significantly increases the duration of inpatient treatment ($p < 0.0001$).

Analysis of the timing of postoperative complications was carried out according to Prinz V. and Valkoczy P. [29]; the nature of complications was assessed according to Dindo et al. [30]:

- reconstruction from the dorsal approach decreases the rate of complications to 11.8 % ($p < 0.0001$);
- neurological disorders requiring conservative therapy (Grade 2) or revision interventions (Grade 3b) prevail;
- ventral (18.2 %) and combined approaches (41.2 %) are more associated with the development of superficial SSI, pneumothorax and chronic pain in the area of autograft harvesting.

The structure of complications in groups is shown in Table 6.

Table 6

Structure of complications

Approach/complications	Time of complication manifestation Prinz V. and Valkoczy P. (2020) [29]	Character of complications Dindo D. et al (2004) [30]
Ventral (18.2 %, n ₁ = 43)	Early * (34.2 %)	Grade 1 – 18.7 %
	Delayed ** (45.4 %)	Grade 2 – 25.5 %
	Late *** 20.4 %	Grade 3b. – 55.8 %
Combined (41.2 %, n ₂ = 130)	Early (41.9 %)	Grade 1 – 20.8 %
	Delayed (45.1 %)	Grade 2 – 63 %
	Late 13 %	Grade 3b – 16.2 %
Dorsal (11.8 %, n ₃ = 100)	Early (77.6 %)	Grade 1 – 52 %
	Delayed (18.2 %)	Grade 2 – 27 %
	Late (4.2 %)	Grade 3a – 7 %
		Grade 3b – 20 %

Complications: * – up to 4 weeks post-surgery; ** – from 6 weeks to 12 months; *** – from 12 months and more post-surgery

DISCUSSION

For a long time, ventral reconstruction of the anterior spinal column with autologous bone from the thoracodiaphragmatic approach was considered to be the "gold standard" for the treatment of thoracolumbar tuberculosis spondylitis [16, 20, 31]. Such operations provided adequate visualization of the affected segment, as well as the revision of the m. psoas and retroperitoneal space in the presence of voluminous granulomatous

soft tissue components (abscesses and granulomas) [23, 24]. However, this technique is associated with the need for coagulation of segmental vessels, which in conditions of tuberculous inflammation is associated with technical difficulties and risks of bleeding. Lack of fixation of the posterior support column, limited possibilities for correcting the sagittal profile, a high percentage of significant loss of deformity correction in

the long-term period, and formation of pseudarthrosis are considered by us as the main disadvantages of this technique [34, 35].

The use of a combined approach both in the 360° (ventral-dorsal approach) and in the 540° (ventral-dorsal-ventral approach) surgery options provides thorough debridement of destructed tissues, circular decompression of intracanal neural structures, and correction of the sagittal profile of the spine [27, 36]. As there is no need for traction of the dura mater for the installation of an interbody implant, the risks of neurological disorders are reduced; however, the traumatism of the intervention due to a significant increase in blood loss and duration of the operation does not allow it to be considered optimal for patients with a high comorbidity index [37].

The trend of the last decade is the use of a posterior-only approach for simultaneous

debridement, spinal fusion, and fixation of the spine in conditions of the thoracolumbar TS [25, 38, 39]. From the point of view of intraoperative factors, intraoperative blood loss is significantly lower in the posterior approach than in the combined anteroposterior approach; better results are also achieved with kyphosis correction than with the anterior approach [22, 23]. Despite the positive aspects of this technique, the main limiting criterion should be mentioned – high incidence of neurological complications, which in our opinion is associated with the need for significant traction of the dural sac to visualize the anterior column and radiculotomy of one or more spinal roots for the installation of an interbody implant. The use of neurophysiological intraoperative monitoring, both according to our clinical data and reported data of other authors, can reduce such complications, the rate of which is still high and, according to the literature, reaches 10-12 % [40, 41].

CONCLUSION

A systematic review of the literature allows us to conclude the following: the optimal method of surgical treatment of tuberculous spondylitis of the thoracolumbar location is a three-column

reconstruction from the dorsal approach. This method reduces complications, the time of inpatient treatment, the volume of surgical blood loss and the duration of the surgical intervention.

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