LONG-TERM RESULTS OF SURGICAL TREATMENT OF PATIENTS WITH NEUROLOGICALLY INTACT BURST FRACTURES OF THE THORACOLUMBAR JUNCTION

A.A. Grin, A.E. Talypov, A.Yu. Kordonskiy, V.A. Karanadze, I.S. Lvov, R.I. Abdrafiev
N.V. Sklifosovsky Scientific Research Institute of Emergency Medicine, Moscow, Russia

Objective. To analyze long-term radiological and clinical outcomes of treatment of neurologically intact burst fractures of the thoracolumbar junction and to determine the optimal method of surgical treatment.

Material and Methods. A single-center retrospective cohort study was conducted. Inclusion criteria were: AOSpine type A3 or A4 fracture at the T11–L2 level; absence of spinal cord and its nerve root injury; patient availability for a follow-up examination 12 months or later after surgery. Surgical treatment methods were divided into six groups depending on surgical approach (posterior, anterior, or combined) and whether decompression was performed. Standard radiological parameters were evaluated at admission, immediately after surgery, and at the final examination. Clinical outcomes were assessed using the Visual Analogue Scale (VAS) and the Oswestry Disability Index (ODI).

Results. A total of 57 patients (50.9% female, 49.1% male; mean age 41.1 ± 14.6 years) were included in the study. The median follow-up period was 57.6 months [28.9–110.4]. The study groups were homogeneous in terms of sex, age, and most radiological parameters. The dynamics of radiological parameters did not differ significantly between the groups, with the exception of spinal canal stenosis (SS), which was significantly lower ($p = 0.008$) in the groups without decompression upon admission. Among patients who underwent stabilization procedures, a separate subgroup of patients with stenosis of more than 30% ($n = 10$, Me 34.8% [32.6–48.8]) on admission was identified. This subgroup showed the greatest reduction in stenosis over time, with a median decrease of –28.9% [–31.3; –13.6]. The overall incidence of Grade Ia complications according to Landriel-Ibañez classification was 26.3%. Grades IIb and IIIa were detected in four patients (7.0%), predominantly from groups with decompression ($p = 0.025$). Bony fusion was detected in the majority of patients ($n = 50$, 87.7%), including stable pseudarthrosis in four patients (7.0%) and unstable pseudarthrosis in three cases (5.3%). There were no significant differences in radiological outcomes between the groups (χ^2 test, $p = 0.535$), however, decompression was found to be a significant risk factor for pseudarthrosis ($p = 0.039$). Pseudarthrosis developed significantly more often in cases involving bilateral facet joint resection ($p = 0.010$). When assessing the clinical results, the pain severity at the surgical site did not differ significantly between the groups ($p = 0.944$). The lowest ODI scores were observed in the group of transpedicular fixation without decompression.

Conclusion. Short-segment posterior pedicle screw fixation without laminectomy could be an effective treatment option for patients with neurologically intact burst fractures of the thoracolumbar junction with kyphotic deformity up to 21.5°, a decrease in the vertebral body anterior height down to 53.2%, and a vertebral body index over 0.53. In cases of spinal canal stenosis up to 49%, spontaneous bone fragment lysis with partial or complete canal remodeling can occur without decompressive surgery, provided rigid internal immobilization of the segment is achieved. Further prospective studies with a high level of evidence are necessary to determine the optimal surgical approach for treating neurologically intact thoracolumbar junction fractures.

Keywords: neurologically intact spinal fracture; burst fracture of the spine; thoracic fracture; lumbar fracture; pedicle screw fixation.

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The issue of surgical treatment of neurologically intact fractures of the thoracolumbar junction (TLJ) remains a relevant to this day. Despite extensive research, the selection of the optimal treatment option is a subject of debate. The most actual treatment protocol for neurologically intact spinal fractures in the Russian Federation was updated by the Association of Traumatologists and Orthopedists in 2023 [1]. The update reveals that certain fractures necessitate fusion and/or corporodesis, while others do not. The criteria for choosing a surgical technique are unclear in the guidelines, and even an experienced surgeon cannot always determine the treatment strategy. The Clinical Guideline for Neurologically Intact Spinal Cord Injury by the Russian Association of Neurosurgeons [2], on the other hand, provides rather clear guidelines for each type of fracture according to AO Spine, including specific treatment techniques; however, it was published in 2013 and, despite subsequent revisions, is now outdated. The recommendations of the Congress of Neurological Surgeons (CNS) also do not provide clear guidance on the choice of a specific surgical technique [3]. The most recent consensus of the World Federation of Neurosurgical Societies (WFNS) leans in favor of standard transpedicular fixation (TPF) [4]. At the same time, however, the question of the necessity of decompression in cases of

neurologically intact fractures remains open.

Systematic studies of neurologically intact spinal fractures indicate a growing tendency to avoid any decompression surgeries, even in cases of significant spinal stenosis (SS) grade, and to favor TPF over anterior procedures [5, 6]. At the same time, the Russian literature contains just few studies detailing the long-term treatment outcomes for neurologically intact fractures of TLJ. This is proved by the lack of Russian studies in the latest meta-analysis on the immediate and long-term outcomes of TPF use in uncomplicated injury [6].

The objective is to analyze long-term radiological and clinical outcomes of treatment of neurologically intact burst fractures of the thoracolumbar junction and to determine the optimal technique of surgical treatment.

Material and Methods

This study is a single-center retrospective cohort study and was conducted in accordance with the Declaration of Helsinki adopted by the World Medical Association. All patients gave their consent to participate in the study.

The material for the study included medical records and radiological data of patients who underwent surgery between 2009 and 2022. Inclusion criteria: 1) A3 or A4 fracture according to AO Spine [7] at the T11–L2 vertebrae; 2) no spinal cord and nerve root injury; 3) patient availability for follow-up examination 12 months or more after surgery. All patients who met these criteria were called to the in-patient department for a clinical examination and CT scan of the surgical site.

Surgical treatment techniques

Depending on the approach and whether spinal decompression was performed, all the surgeries were classified into 6 groups:

1) TPF without decompression;

2) TPF with laminectomy, resection of one or two facet joints, and anterior decompression through the posterior approach (decTPF);

3) an anterior spinal fusion without decompression;

4) an anterior spinal fusion with bone fragment removal from the spinal canal;

5) a combined spinal fusion without decompression;

6) a combined spinal fusion with decTPF.

Assessment of long-term treatment outcomes

When analyzing radiological results, the bisegmental Cobb angle (CobbA), the height of the anterior and posterior vertebral walls, and the spinal canal area at the level of the fracture and in the adjacent segments were measured.

After measurements, the following indicators were calculated:

1) $AVBH = \left(\frac{A_0}{(A_1 + A_2)/2}\right) \times 100\ \%$,

where AVBH is the relative height of the vertebral body along the anterior contour; A_0 is the height of the anterior edge of the fractured vertebral body (mm); A_1 and A_2 are the heights of the anterior edges of the adjacent and subjacent vertebral bodies (mm);

2) $VBI = \frac{A_0}{P_0}$,

where VBI is the vertebral body index, A_0 is the height of the vertebral body along the anterior contour (mm), and P_0 is the height of the vertebral body along the posterior contour (mm).

3) $SS = \left(1 - \frac{S_{SC_0}}{(S_{SC_1} + S_{SC_2})/2}\right) \times 100\ \%$,

where SS is the spinal canal stenosis degree (%), S_{SC0} is the spinal canal area at the fracture site (cm^2); S_{SC1} and S_{SC2} are the spinal canal areas at higher and lower levels (cm^2).

For all patients, $\Delta CobbA_{prsurg}$ and $\Delta CobbA_{final}$ were calculated representing the values of CobbA intraoperative correction and its progression from surgery to the final follow-up, respectively. ΔAVBH was calculated only for TPF and decTPF approaches, since other techniques involved discectomy or corpectomy, which could have affected this parameter. ΔSS was calculated as the overall progression from the moment of injury to the final examination, since some patients underwent follow-up radiography immediately after surgery, which prevented the calculation of the intermediate value of the spinal canal area.

Radiological results were divided into three groups [8, 9]:

1) fusion – multiple bone bridges between the graft and the vertebrae or ankylosis of a fixed segment in the area of the vertebral bodies or facet joints (Fig. 1);

2) stable pseudoarthrosis – no fusion in the operated segments without progression of kyphotic deformity, degree of vertebral compression, and clinical manifestations of instability; osteolysis around the screws of the fixation system is possible;

3) pseudoarthrosis with clinical and radiological signs of instability (no bone block with instability in the segment), with progression of kyphotic deformity and degree of vertebral body compression induced by instrumentation failure.

Complications arising in the long-term period after injury were evaluated according to the scale developed by Ibañez et al. [10]. The VAS was used to evaluate back pain syndrome at the time of the follow-up examination. Quality of life was assessed using the Oswestry questionnaire.

Statistical analysis

All radiological indicators were calculated using Radiant DICOM Viewer, version 2024.1. Statistical data processing was performed using PC STATISTICA (version 10).

The normality of data distribution was verified using the Shapiro–Wilk test. Data with non-normal distribution were displayed as median values; interquartile range was shown in square brackets. For comparison of continuous data between the groups, the Mann–Whitney *U* test (M–W test) or Kruskal–Wallis test (K–W test) was used. For categorical and dichotomous variables, differences between the groups were evaluated using the chi-squared test (also the χ^2 test) or Fisher's exact two-tailed test (*F*-test). Statistical hypotheses were tested at a significance value of $p = 0.05$.

Results

General profile of patients

A total of 57 patients were included in the study; 29 (50.9%) were women and 28 (49.1%) were men. The mean age at

the time of surgery was 41.1 ± 14.6 years. The distribution of patients in the study groups was as follows: decTPF – 15 people; TPF – 11; anterior fusion with or without decompression – 9 and 11, respectively; combined fusion with or without decompression – 5 and 6, respectively. No significant differences in age and gender were found in these groups (K-W test; $p = 0.676$ and χ^2 test; $p = 0.876$, respectively).

It should be noted that up to 2016 including, anterior and combined surgeries with decompression were more commonly used in the surgical treatment of burst fractures of the TLJ. Since 2017, TPF has been predominantly used, as well as anterior and combined surgeries without decompression (χ^2 test; $p = 0.002$), while decTPF has been performed twice less frequently.

The follow-up period median for patients was 57.6 months [28.9–110.4].

Analysis of radiological indicators

The main radiological indicators and their changes are given in Tables 1 and 2. The higher CobbA value at admission in the TPF group was statistically insignificant (K–W test; $p = 0.248$). AVBH and VBI did not differ between the study groups; the only significant factor for choosing the type of surgery (with or without decompression) was spinal stenosis (M–W test; $p = 0.008$). Thus, the SS median for posterior decompression with resection of one or two facet joints was 37.0% [28.6–53.3%], while for all patients without decompression it was 24.4% [13.5–33.9%]. It should be noted that the SS in groups with resection of one or both facet joints did not differ significantly (M–W test; $p = 0.914$). The grade of SS after surgery decreased on mean from 13.6% to 22.5% (Fig. 2) in all observations without decompression, depending on the technique of surgery (K–W test; $p = 0.551$).

Among patients who underwent stabilization surgeries without decompression, a subgroup of patients with the SS upon admission of more than 30% ($n = 10$) should be highlighted. The median of this value in the subgroup was 34.8% [32.6–48.8%]. The overall progression of the SS in these patients was the highest, amounting to –28.9% [–31.3; –13.6%].

CobbA intraoperative correction was lowest in the groups of anterior and combined approaches without decompression, however it was not statistically significant (K–W test; $p = 0.519$). The increase in CobbA at the time of the final examination was the smallest in the TPF group and amounted to a median of 1.0°, while for the others it was significantly greater (K–W test; $p = 0.011$), the median ranging from 4.1° to 14.9° depending on the technique.

The overall progression of AVBH from admission to final examination for TPF and decTPF did not differ significantly (M–U test; 0.776). The medians of ΔAVBH were –2.1 and –3.3%, respectively.

Analysis of complications

The overall frequency of implant-associated complications (Table 3) that did not require repeated surgery (grade Ia according to Ibañez) was 26.3%. Despite this, in most cases (11 people; 19.3%), a bone block formed, and all complications were incidental findings on follow-up images. Meanwhile, only 5.3% of patients were diagnosed with stable pseudoarthrosis.

Complications of grades IIb and IIIa were identified in 4 (7.0%) patients, predominantly from the groups with spinal canal decompression (F-test; $p = 0.025$). The treatment outcomes for some of

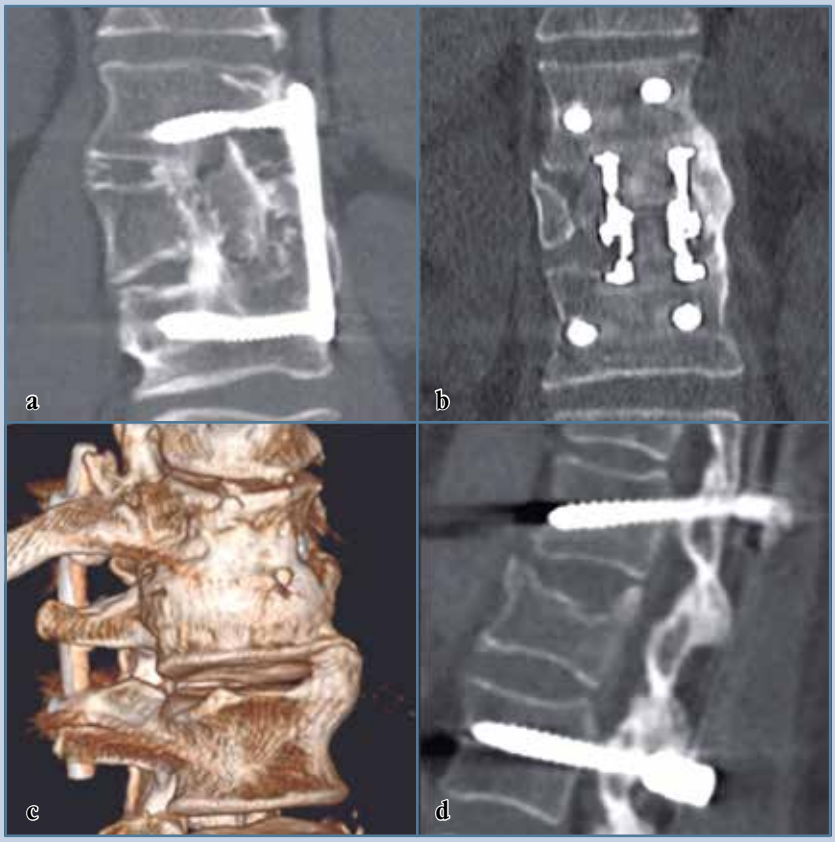

Fig. 1
Control CT images demonstrating fusion variants: **a** – interbody fusion with an allograft; **b** – interbody fusion with a graft filled with auto- and allobone; **c** – formed (T12–L1) and forming (L1–L2) interbody ankylosis in transpedicular fixation; **d** – fusion in the area of the facet joint

these patients were considered to be pseudoarthrosis with progression of kyphotic deformity, vertebral dislocation, and clinical deterioration, requiring repeated surgeries in the long-term follow-up period.

Long-term treatment outcomes

The CT scan data showed that in most cases (50 patients; 87.7%), fusion was verified in the operated segments (Table 4). The incidence of unstable pseudoarthrosis at the follow-up examination was 5.3% (3 patients). Generally, when comparing surgical techniques, there were no significant differences in radiological results (χ^2 test; $p = 0.535$). Nevertheless, decompression of the spinal canal was a relevant factor in the development of pseudoarthrosis (*F*-test; $p = 0.039$). Meanwhile, if decompression laminectomy during combined surgery or decTPF was performed, pseudoarthrosis developed more frequently after bilateral facet joint resection (χ^2 test; $p = 0.010$). Thus, preservation of facet joints on at least one side resulted in fusion in the operated segments in four patients after decTPF. There were six out of nine cases where fusion in TPF was achieved through joint ankylosis. Also, in one patient after a combined surgery, even though there was no consolidation in the area of the grafts, ankylosis in the facet joints provided a reason to consider the outcome as fusion.

The severity of pain in the surgical site did not differ significantly between the study groups when evaluating clinical outcomes (K–W test; $p = 0.944$). The lowest Oswestry scores were achieved in the group of patients with TPF without decompression. This difference was significant compared to anterior spine fusion with decompression (M–W test; $p = 0.031$), and there was a trend toward a higher value compared to dec-TPF (M–W test; $p = 0.08$). In comparison with other fixation techniques, this advantage was not statistically significant (K–W test; $p = 0.707$).

Comparison of a short and extended TPF without decompression

We divided the group of TPF without decompression into two subgroups depending on the length of the fixation system: a short TPF (4-screw system with fixation of two vertebrae adjacent to broken one) and an extended TPF (fixation of three or more spinal motion segments). Radiological indicators of fractures upon admission to the hospital in these groups (CobbA, AVBH, VBI, and SS) did not differ significantly (M-W test; $p = 0.556$, 0.413, 0.412, and 0.903, respectively). $\Delta CobbA_{prsurg}$, $\Delta CobbA_{final}$, $\Delta AVBH_{prsurg}$, $\Delta AVBH_{final}$, and ΔSS also did not differ significantly in these two subgroups (M–W test; $p = 0.136$, 0.868, 0.371, 0.175, and 0.903, respectively). The frequency of implant-associated complications that did not require repeated surgery (grade Ia according to Ibañez) was the same for both subgroups (χ^2 test; $p = 0.658$). Clinical outcomes according to VAS and Oswestry also did not differ significantly (M–W test; $p = 0.905$ and 0.769, respectively).

Discussion

The choice of surgical treatment for neurologically intact fractures of TLJ remains a matter of debate. A large number of studies, as well as regular meta-analyses and systematic reviews, indicate that there is no consensus on such aspects as the choice of optimal approach and the need for spinal canal decompression in cases of significant grade of spinal stenosis [6]. The sample of patients included in

Table 1

Radiological parameters (median and interquartile range) of patients in the study groups after decompression and stabilization surgeries

Parameters	Type of procedure after decompression (Dec+)			*p*
	transpedicular fixation	anterior fusion	combined fusion	
CobbA upon admission, degrees	11.1 [6.6–7.9]	6.5 [4.6–12.8]	8.8 [5.0–20.3]	0.518
$\Delta CobbA_{prsurg}$	–6.4 [–21.3–1.4]	–3.0 [–9.5; –1.1]	–6.8 [–8.6; –3.6]	0.894
$\Delta CobbA_{final}$	+8.4 [3.7–17.2]	+4.1 [1.1–5.7]	+14.9 [11.2–17.3]	0.128
AVBH upon admission, %	66.8 [58.8–75.7]	69.8 [60.8–84.5]	69.0 [63.0–85.6]	0.699
$\Delta AVBH_{prsurg}$	+17.0 [2.6–21.2]	–	–	–
$\Delta AVBH_{final}$	–22.1 [–29.1; –5.5]	–	–	–
VBI upon admission	0.76 [0.57–0.78]	0.78 [0.69–0.91]	0.79 [0.69–0.96]	0.575
SS upon admission, %	36.7 [28.6–53.3]	32.2 [22.6–42.0]	41.5 [33.3–43.1]	0.597

Table 2
Radiological parameters (median and interquartile range) of patients in the study groups after stabilization surgeries

Parameters	Type of procedure without decompression (Dec–)			*p*
	transpedicular fixation	anterior fusion	combined fusion	
CobbA upon admission, degrees	16.0 [10.3–21.5]	14.3 [12.0–18.2]	12.4 [11.8–14.0]	0.738
$\Delta CobbA_{prsurg}$	–8.0 [–13.3; –3.6]	–1.0 [–8.5–1.7]	–0.9 [–4.8; –0.7]	0.180
$\Delta CobbA_{final}$	+1.0 [–0.15–4.0]	+7.0 [6.3–12.6]	+4.1 [1.4–5.3]	0.015
AVBH upon admission, %	64.3 [53.2–77.4]	66.7 [58.2–70.8]	73.2 [61.9–74.0]	0.881
$\Delta AVBH_{prsurg}$	–0.8 [–8.2–12.4]	–	–	–
$\Delta AVBH_{final}$	+1.4 [–9.3–7.2]	–	–	–
VBI upon admission	0.66 [0.53–0.75]	0.67 [0.64–0.71]	0.72 [0.62–0.85]	0.692
SS upon admission, %	22.2 [17.4–28.4]	18.7 [7.9–32.6]	33.7 [31.3–49.0]	0.086
ΔSS	-17.4 [–22.2; –10.1]	-13.6 [–28.9; –7.9]	–22.5 [–31.3; –21.0]	0.416

the article is conditionally divided into two time groups: up to 2016 including, patients were treated in strict accordance with the guidelines of the Association of Neurosurgeons of the Russian Federation, and therefore, in cases of burst fractures, preference was given to anterior or combined fusion [2, 11]. Spinal canal decompression was usually performed in patients suffering from spinal stenosis exceeding 20%. Since 2017, the hospital has started to use percutaneous TPF techniques more widely, which has led to a significant decrease in the number of decompression procedures. This provided the basis for forming comparison groups for the six main surgical options currently available for treating TLJ fractures.

It should be noted that no significant differences in CobbA, AVBH, and VBI were found between the study groups upon admission to the hospital; the only relevant difference was in SS, which was significantly higher in patients undergoing decompression surgery. Meanwhile, 10 patients in the group without decompression had SS exceeding 30%, with three of them having it above 49%. At the same time, no cases of neurological deficit progression were recorded, and control images detected lysis of fragments restoring the spinal canal lumen to values of Me greater than 28% (Fig. 2). These findings, along with the results of meta-analyses [5], suggest that in the lack of neurological deficit and SS with bone fragments less than 49%, anterior or posterior decompression may be optional in some patients. Furthermore, immobilization using standard TPF without anterior corpectomy may be sufficient for significant lysis of bone fragments in the long-term posttraumatic period.

Another significant aspect of our study is the clear demonstration of the need to preserve the posterior support column during orthopedic surgeries in patients with neurologically intact TLJ fractures. We did not find any studies in the literature specifically determining the role of spontaneous fusion in the area of facet joints in the interpretation of radiological results in spinal injury. Meanwhile, this fusion may be biomechanically comparable to the anterior bone block [12]. Therefore, in our study, complications resulting in repeated surgery in the long-term period developed significantly more often in patients after decompression laminectomy. The development of various forms of pseudoarthrosis also correlated with bilateral resection of the facet joints. On the one hand, resection of the facet joints significantly simplified procedures and allowed for better correction of kyphosis. On the other hand, in 11 (19.3%) of 57 patients, fusion in the facet joint area was crucial to the treatment outcome. Their more frequent ankylosis is noted in cases of TPF since most surgeries were open, and during the skeletonization of the posterior structures, injury to the joint capsule occurred, which could have aggravated the progression of degenerative changes in the facet joint. Simultaneously, more frequent interbody ankylosis was detected in the group of decTPF, which we associate with anterior decompression through the posterior approach. One patient in the combined approach group did not show consolidation in the graft area, but ankylosis in the facet joints also prevented the development of pseudoarthrosis. All this indicates the importance of preserving facet joints on at least one side

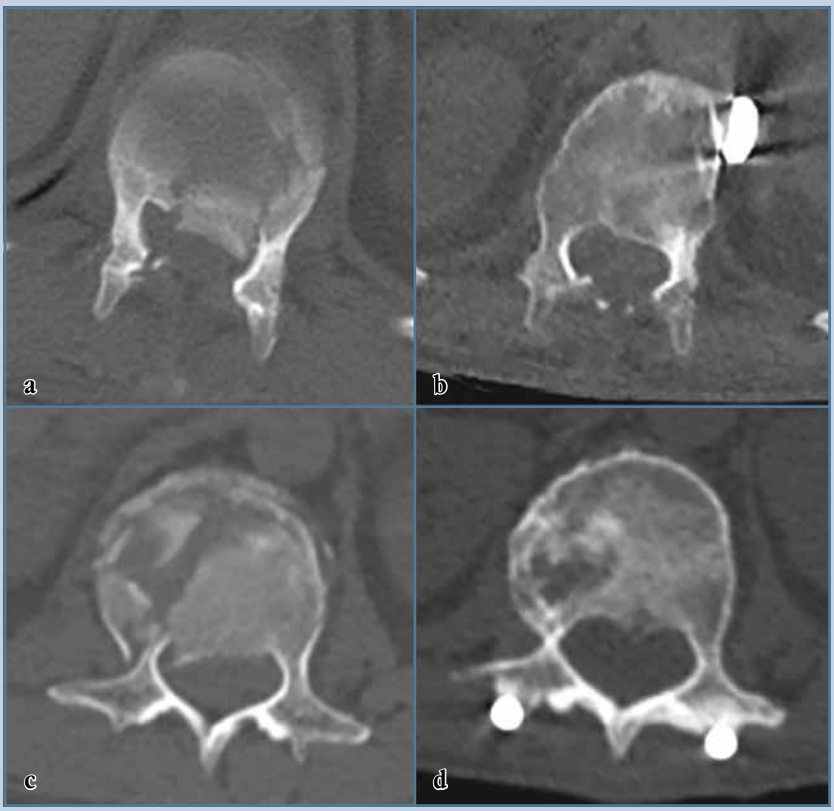

Fig. 2
CT data demonstrating lysis of bone fragments after anterior fusion without spinal canal decompression **(a, b)** and transpedicular fixation **(c, d)**: **a** – T12 fracture, type A3; **b** – control images 10 years after surgery, ΔSS = 34%, a fragment of the metal plate is visualized in the area of the left edge of the vertebral body; **c** – L1 fracture, type A3; **d** – CT data 1.5 years after surgery, ΔSS = 21%

when performing decompression laminectomy. In any case, further study of the issue of degenerative changes in facet joints after various surgical techniques for treating TLJ is required to determine their role in the formation of bone block in the operated segment.

Regarding clinical outcomes in the long-term period after injury, the severity of pain syndrome did not differ significantly between the groups. The best quality of life indicator in the late period after injury was observed in the TPF group.

Therefore, the treatment groups under study did not differ significantly regarding demographic and most radiological parameters. Analysis of long-term treatment outcomes showed that the standard TPF technique without laminectomy in patients, even with significant spinal canal compression, can manifest clinical and radiological outcomes similar to those of combined and anterior surgeries. Considering the fact that we did not find any significant differences in all parameters between the extended and short TPF subgroups, as well as the data from available systematic reviews and meta-analyses [5], the use of extended fixation instrumentation may be unnecessary in some patients with neurologically intact TLJ fractures.

Study limitations

The main limitations of the study are its retrospective nature and relatively small patient samples. Nevertheless, their sizes are sufficient for statistical analysis. The available data provide an opportunity to demonstrate the main tendencies concerning the techniques under study, as well as to emphasize the necessity for surgeons to limit invasive and destructive surgeries in a number of patients with neurologically intact fractures of TLJ.

A prospective randomized study with large patient groups would provide clear guidelines with a high level of evidence.

Conclusion

1. A short TPF without laminectomy may be an effective technique for treating patients with neurologically intact burst fractures of TLJ with kyphotic deformity up to 21.5°, reduction of vertebral body height along the anterior contour up to 53.2%, and VBI greater than 0.53.

2. In case of the spinal stenosis by up to 49% and rigid internal immobilization of the segment, spontaneous lysis of bone fragments with partial or complete restoration of its lumen is expected without decompression surgery.

3. Preservation of facet joints can be important for bone block formation in the operated segment, including in anterior and combined procedures.

4. Bilateral facet joint resection provides better correction of kyphotic deformity and decompression; nevertheless, it is associated with a higher incidence of complications and pseudoarthrosis in the operated segment.

5. Further prospective studies with a high level of evidence should be performed in the future to determine the optimal surgical option for patients with neurologically intact fractures of TLJ.

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

Table 3

Implant-associated complications identified in the long-term posttraumatic period, *n*

Complications	Transpedicular fixation		Anterior fusion		Combined fusion		Total
	Dec+	Dec–	Dec+	Dec-	Dec+	Dec–	
Grade Ia according to Ibañez							
Increase in kyphosis + osteolysis	1	–	–	–	–	–	1
Increase in kyphosis + screw breakage	–	–	–	–	1	–	1
Increase in kyphosis + end plate fracture by prosthesis	–	–	–	–	1	–	1
Increase in kyphosis + implant migration	–	–	–	1	–	–	1
End plate fracture caused by implant	–	–	1	2	–	–	3
End plate fracture caused by implant + screw migration	–	–	1	–	–	–	1
Osteolysis around a screw	2	1	–	1	–	–	4
Screw breakage	–	1	–	–	–	–	1
Allobone lysis	–		–	–	–	1	1
Implant migration	–	–	1	–	–	–	1
Total	3	2	3	4	2	1	15
Grades IIb and IIIa according to Ibañez							
Implants suppuration	1	–	–	–	1	–	2
Screw breakage + increase in kyphosis	1	–	–	–	–	–	1
Implant migration + increase in kyphosis	1	–	–	–	–	–	1
Total	3	–	–	–	1	–	4

Dec+ — anterior and/or posterior decompression; Dec– — without decompression.

Table 4

Long-term treatment outcomes of patients in the study groups

Indicators	Transpedicular fixation		Anterior fusion		Combined fusion		Total
	Dec+ (*n* = 15)	Dec– (*n* = 11)	Dec+ (*n* = 9)	Dec– (*n* = 11)	Dec+ (*n* = 5)	Dec– (*n* = 6)	(*n* = 57)
Radiological outcomes, n (%)							
Fusion	12 (80)	11 (100)	8 (88.9)	10 (90.9)	3 (60.0)	6 (100)	50 (87.7)
– in implants area	–	–	6	9	2	5	22
– interbody ankylosis	8	3	2	1	1	-	15
– in joints area only	4	6	–	–	–	1	11
– of fracture only with instrumentation removal	–	2	–	–	–	–	2
Stable pseudoarthrosis	2 (13.3)	–	–	1 (9.1)	1 (20)	–	4 (7.0)
Pseudoarthrosis with signs of instability	1 (6.7)	–	1 (11.1)	–	1 (20)	–	3 (5.3)
Clinical outcomes, Me [Q1–Q3]							
VAS	3 [1–3]	3 [1–4]	2 [1–3]	2 [1–3]	2 [1–4]	2 [1–2]	–
Oswestry	6 [4–11]	3 [1–5]	11 [6–13]	5 [2–15]	4.5 [2–8]	5 [4–8]	–

Dec+ — anterior and/or posterior decompression; Dec– — without decompression.

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Address correspondence to:
Abdrafiev Rinat Irfanovich
N.V. Sklifosovsky Research Institute for Emergency Medicine,
3 Bolshaya Sukharevskaya sq.,
Moscow, 129090, Russia,
rinat-abdrafiev@mail.ru

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Andrey Anatolyevich Grin, DMSc, Corresponding Member of the Russian Academy of Sciences, Chief Freelance Specialist on Neurosurgery of the Moscow Healthcare Department; Head of the Scientific Department of Emergency Neurosurgery, N.V. Sklifosovsky Research Institute for Emergency Medicine, 3 Bolshaya Sukharevskaya sq., Moscow, 129090, Russia, eLibrary SPIN: 2194-2598, ORCID: 0000-0003-3515-8329, aagreen@yandex.ru;
Alexandr Ernestovich Talypov, DMSc, leading lesearcher, Department of Neurosurgery, N.V. Sklifosovsky Research Institute of Emergency Medicine, 3 Bolshaya Sukharevskaya sq., Moscow, 129090, Russia; Professor of the Department of Fundamental Neurosurgery, N.I. Pirogov Russian National Research Medical University, 1 Ostrovitianova str., Moscow, 117513, Russia, eLibrary SPIN: 3415-8260, ORCID: 0000-0002-6789-8164, dr.talypova@mail.ru;
Anton Yuryevich Kordonskiy, MD, PhD, neurosurgeon, researcher of the Department of Emergency Neurosurgery, N.V. Sklifosovsky Research Institute of Emergency Medicine, 3 Bolshaya Sukharevskaya sq., Moscow, 129090, Russia, eLibrary SPIN: 1263-2284, ORCID: 0000-0001-5344-3970, akord.neuro@mail.ru;
Vasily Amiranovich Karanadze, MD, PhD, neurosurgeon, Head of the Neurosurgical Department for the treatment of patients with vascular diseases of the brain, N.V. Sklifosovsky Research Institute of Emergency Medicine, 3 Bolshaya Sukharevskaya sq., Moscow, 129090, Russia, eLibrary SPIN: 8101-3583, ORCID: 0000-0003-0180-9154, karanadzev@mail.ru;
Ivan Sergeyevich Lvov, MD, PhD, neurosurgeon, N.V. Sklifosovsky Research Institute of Emergency Medicine, 3 Bolshaya Sukharevskaya sq., Moscow, 129090, Russia, eLibrary SPIN: 1252-3377, ORCID: 0000-0003-1718-0792, speleolog@mail.ru;
Rinat Irfanovich Abdrafiev, neurosurgeon, Neurosurgical Department for the treatment of patients with vascular diseases of the brain, N.V. Sklifosovsky Research Institute of Emergency Emergency Medicine, 3 Bolshaya Sukharevskaya sq., Moscow, 129090, Russia, ORCID: 0000-0003-3328-8349, rinat-abdrafiev@mail.ru.