INJURIES TO THE THORACOLUMBAR JUNCTION: BIBLIOGRAPHIC ANALYSIS OF ENGLISH-LANGUAGE LITERATURE

S.V. Likhachev1, V.V. Zaretskov1,2, A.E. Shulga1, S.A. Gramma1, I.N. Shchanitsyn1, S.P. Bazhanov1, A.V. Zaretskov2, A.M. Donnik3

1Scientific Research Institute of Traumatology, Orthopedics and Neurosurgery of Saratov State Medical University n.a. V.I. Razumovsky, Saratov, Russia
2Saratov State Medical University n.a. V.I. Razumovsky, Saratov, Russia
3Saratov State University n.a. N.G. Chernyshevsky, Saratov, Russia

Objective. To analyze the 50 most cited articles related to the diagnosis, classification and surgical treatment of injuries of the thoracolumbar junction, which influenced the study of this problem.

Material and Methods. The Web of Science database was searched for keywords to detect articles related to thoracolumbar junction surgery. Articles were selected taking into account the title, abstract and the used methods, and then evaluated by the total number of citations to identify the fifty most cited. Characteristics of publications were analyzed.

Results. The United States of America, Thomas Jefferson University and A.R. Vaccaro were the most productive country, institution and author, respectively, dealing with the subject. The 2000s was the most active decade in terms of the number of publications. The greatest attention of scientists dealing with the problems of thoracolumbar injury was attracted by the article by McLain et al. analyzing the causes of the failures of short-segment transpedicular systems in the early postoperative period. The article by Laursen et al. presenting the results of using recombinant bone morphogenetic protein-7 in combination with metal fixation is at the top of the list in terms of average citation index. Most articles are well-designed randomized studies with the evidence level II.

Conclusion. Citation analysis allowed to identify the most relevant articles, the authors of which have made a significant contribution to the problem of surgery of the thoracolumbar junction. Study of the information field through the prism of the most cited articles allows seeing the mainstream and future development of diagnostics, classification and treatment of the injuries of this localization.

Key Words: spine, thoracolumbar junction, spondylosynthesis, bibliometric analysis, citation.


The classification of spinal injuries by localization is dominated by those of the thoracolumbar junction, which includes the T11–L2 vertebrae [1–5]. Injuries at the level of transition of the rigid thoracic section to the mobile lumbar one are usually accompanied by the formation of kyphotic spinal deformity and compression of the contents of the spinal canal [6, 7]. Surgical treatment of injuries of the thoracolumbar junction requires knowledge of the anatomy and biomechanics of this area, as well as understanding of the entire spectrum of modern methods of metal fixation [8, 9]. Citation analysis is a bibliometric tool [10, 11] that can be used to quantify the impact of an article on the study of the problem in modern reviews of the medical literature [12]. Considering the general availability of leading medical journals for a reader over the Internet, a literature review is gradually being transformed from a source of detailed information into a brief description of the main trends that define further independent search for the relevant information. At present, the use of a number of publications that is a multiple of fifty is optimal for reviews based on the principle of bibliometric analysis [13–15]. In this case, the primary search is carried out from 1900 to the year of writing the article, and the final list contains articles ranging from the most to the least cited work inclusive.

The objective of the study was to use the electronic Web of Science resource to select the 50 most cited articles related to the diagnosis, classification and surgical treatment of injuries of the thoracolumbar junction, which influenced the study of this problem.

Material and Methods

After the initial search, 50 articles were selected for inclusion in the final list by the following criteria: papers dedicated to the study of injury or spondylosynthesis of the thoracolumbar junction. Experimental studies on animals were excluded. Articles that discussed surgical aspects of treating injuries to other parts of the spinal column were considered only if the patients with a T12–L2 fracture represented the majority.
Relevant papers were selected from all journals and databases indexed in Web of Science at the time of this analytical study.

Results and Discussion

To create the final list of 50 articles, a two-step query was run on Web of Science platform. The first stage consisted of a thematic search for the term “thoracolumbar junction fracture”. This search yielded 2430 results, which were subsequently sorted by number of citations. Self-citations were excluded.

The search was limited to years 1900–2018. The initial list consisted of articles published in 1975–2017. The number of articles (Fig. 1) reached its peak in 2017 (205 articles in a year), and the year 2006 was the most productive in terms of the most cited articles (5).

Articles devoted to the problems of thoracolumbar junction surgery were most often published by Spine (373 articles, 15.3 % of 2430). It was followed by European Spine Journal (229 articles, 9.4 % of 2430) and Journal of Neurosurgery Spine (87 articles, 2.6 % of 2430) respectively (Fig. 2). Most of the articles in the list of the most cited ones were also published in Spine (19 articles, 380 %). The second most popular journal is Journal of Bone and Joint Surgery American Volume (6 articles, 12.0 %) and the third place is shared by European Spine Journal and Clinical Orthopaedics and Related Research (4 articles each, 8.0 %).

Most publications (828 articles, 34.0 % of 2430) were written by authors residing in the United States. Authors from Germany (332 articles, 13.7 %) and PRC (252 articles, 10.4 %) occupy the 2nd and 3rd places. The first ten countries by number of the published articles are shown in Fig. 3.

Fig. 4 shows the first ten institutions by the number of published articles from the full list. The most productive institutions are the Thomas Jefferson University (91 articles), the University of California (88 articles), and the Rothman Institute (67 articles).

At stage 2, the 50 most cited articles were selected for final inclusion in the list (see Table at the end of the article). Subjects of the articles included classification of injuries, transthoracic and retroperitoneal access to the thoracolumbar junction, transpedicular fixation, anterior spinal fusion, decompression intervention, biomechanical features of the injured and instrumented spine.

These 50 articles were published in 1983–2013.

The following information was extracted from each article in the final list: authors, title, year of publication, abstract, total number of citations, average number of citations (sum of the number of citations divided by the number of results found), type of research and level of evidence. The articles represented the following types of research: clinical or experimental. Study design: from randomized controlled trial to clinical cases.

The level of evidence (from I to V) was determined only for clinical studies:

I: evidence obtained from a meta-analysis of a large number of well-planned randomized studies and randomized studies with a low level of false positive and false negative errors;

II: evidence is based on the results of at least one well-designed randomized controlled trial and randomized trials with a high, relative to level I clinical studies, rate of false positive and false negative errors;

III: evidence is based on the results of well-planned non-randomized controlled studies with one group of patients, studies with a group of historical control;

IV: evidence obtained from non-randomized studies, indirect comparative studies, descriptive studies;

V: evidence is based on clinical cases and examples.

The most cited authors who published articles in this field of study are Vaccaro (78 articles, 3.21 % of 2430), Oner (53 articles, 2.181 %) and Kandziora (41 articles, 1.687 %). Vaccaro is also the most cited author among the authors of the 50 most cited articles (3 articles) and he is followed by McAfee, Dai, Kaneda, Knop and Oner (2 articles each). The remaining 44 authors published one article each.

The most discussed topic (13 publications in the final list) is the short-segment (bisegmental) transpedicular fixation [13, 16–27]. Seven papers [28–34] present the results of surgical treatment of patients with burst fractures of the thoracolumbar junction using decompression and fixation from the anterior approach, and five [35–39] deal with the classification of injuries of the thoracolumbar junction.

The most cited article on the analysis of results of surgical treatment of the thoracolumbar junction is the study by McLain et al. [22] discussing cases of short-segment transpedicular systems instability in injuries of T11–L2 vertebrae. The highest average number of citations (31.69) belong to the paper by Laursen et al. [40] devoted to the non-encouraging preliminary results of administration of recombinant bone morphogenetic protein-7 (BMP-7) into the body of the affected vertebra in combination with transpedicular fixation.

The article by a group of authors from the Syracuse Medical Center (USA), which is ranked 3rd in the total number of citations, demonstrates the superiority of CT in determining the method of spondylosynthesis based on the structure of the injury using the example of 100 patients with potentially unstable fractures and dislocation fractures of the thoracolumbar junction [36].

The study by Vaccaro et al. which was published in 2013, is ranked 18th and describes AOSpine thoracolumbar spine injury classification system developed by the authors based on data from 40 patients with a trauma to the thoracolumbar junction. Each spinal injury was assessed from the point of the fracture structure, the patient’s neurological status, the integrity of the capsule-ligament apparatus and the nature of the accompanying pathology. The classification system was approved by surgeons involved in the study, who confirmed its reliability, accuracy and good reproducibility [38].

The distribution of the 50 most cited articles by year of publication demonstrates several trends. There were 9 such articles published in 1983–1990, 19 in
1991–2000, 21 in 2001–2010, and only one published from 2001 to the present. Thus, the 2000s can be considered the most productive decade. There were no such articles published in 1986, 1989, 1991, 2008, 2011, 2012, as well as in the period from 2014 to the present. The drop observed in the 2010s can be attributed both to a short period of time since the publication which was insufficient to accumulate large number of citations and to overall stagnation in the study of this problem.

Thus, we can identify 13 articles, which deserve more detailed consideration in the context of bibliometric research.

The review of the most cited articles in each of the decades revealed the following. In the 1980s the most cited arti-
The article was the study by a group of authors of the Department of Orthopedics of the Syracuse Medical Center (USA), which reflects the technological leap in many branches of medicine associated with the invention X-ray computer tomography in 1970s. The key role of CT data in determining the choice of tactics for treatment of fractures of the thoracolumbar junction has been demonstrated [36]. In the last decade of the XX century, the article by McLain et al. [22], analyzing the failure of short-segment transpedicular systems in the early postoperative period attracted the most attention of scientists working in the field of thoracolumbar injuries. This article is also the most cited one in the top 50 list. In the 1990s, the total and relative increase in the number of surgical interventions with the use of immersion metal structures for spinal injuries led to many unsatisfactory results. A significant portion of the clinical studies and literature reviews of the time [4, 41–44] is devoted to search for and analysis of predictors of such complications.

By the 2000s, the need for a classification system allowing standardization of the algorithm for choosing treatment tactics for patients with spinal fractures became obvious. Previously existing classifications were no longer compatible with the increased capabilities of spinal surgery [45]. Vaccaro et al. [39] proposed the TLICS classification, which allows determining the type of damage and selecting the appropriate conservative or surgical treatment based on CT data on the fracture structure, MRI data on the dorsal ligamentous complex, as well as on the patient's neurological status [46, 47].

The second decade of the XXI century is the period of review and analysis of the colossal amount of data accumulated over previous years about spinal cord injury and methods of its treatment [3]. While continuing his work on the classification of thoracolumbar injuries, Vaccaro et al. [38] devoted special attention to availability of the developed instrument to the practical surgeons. The statistically similar results of determining the type of injury according to the AOSpine TL Injury Classification System in one group of patients by different independent experts allow recommending this classification for widespread use. This fact, apparently, defined the status of this publication as the most cited one in the 2010s.

The important role of evolution of algorithmic approach to choosing the type of spondylosynthesis depending on the nature of the injury should be noted. In our opinion, this factor, along with the development of minimally invasive techniques, is responsible for the significant reduction in the incidence of complications of surgical treatment of injuries of the thoracolumbar junction in the 2000s. Ranking based on the average number of citations puts one of the first articles describing the results of administration of BMP-7 in combination with metal fixation [40] at the top of the list. The second-ranked paper in the average number of citations is devoted to one of the controversial aspects in the choice of treat-
ment tactics for patients with thoraco-
larumbal junction injuries: comparing the
functional outcomes of uncomplicated
comminuted fractures after surgical and
conservative approach [48]. Remarkably,
the conclusions about similar results of
conservative and surgical treatment of
uncomplicated injuries [26, 49] coexist
in the final list of the articles with pub-
lications demonstrating the unequivocal
superiority of active surgical tactics [11,
13, 40, 44]. It should be noted, however,
that the number of the latter prevails.

The article that ranks 3rd in the aver-
age number of citations is an experiment-
al study on cadaveric material, confirm-
ing the unstable nature of burst frac-
tures of the thoracolumbar junction. It
has been established that the damaged
spine is the least resistant to rotational
loads. This biomechanical study [50] and
others like it [44] can be considered as a
step towards the development of a mod-
ern complex of indications for a stabiliz-
ing intervention.

Four literature reviews [1, 10, 39, 52]
include the final list occupy a special
place among the most cited articles.
Boerger et al. [10] published an analy-
ysis of data from 275 articles on the sur-
cical treatment of burst fractures of the
thoracolumbar localization, which allows
concluding that there is no correlation
between the completeness of decom-
pression and postoperative regression
of neurological deficit. Verlaan et al. [1]
analyzed the evolution of surgical tech-
niques for reconstruction of the thoraco-
lumbal junction in 1970–2001. A team of
authors headed by Vaccaro [39] conduct-
ed an analysis of the literature to deter-
mine predictors of instability of injuries
of the thoracolumbar localization in a
2005. The mechanism of injury (based on
the morphology of damage), the integrity
of the posterior ligamentous complex
and the neurological status are important
for determining the choice of spondylo-
synthesis technique. The Vaccaro’s clas-
sification is based on the findings of this
review. Dai et al. [52] search in PubMed
for articles devoted to treatment of inju-
ries of the thoracolumbar junction, sug-
gest the superiority of surgical techniques
over conservative one. Thus, the listed
literature reviews can be considered a
reflection of the key trends in spinal sur-
gery over the past two decades.

The most productive country, institu-
tion and author based on the analysis
of the 50 most cited articles are the USA,
the Thomas Jefferson University and Vac-
caro, respectively. However, as can be
seen from Fig. 3 and 4, the overall vision
of the problem has been developed by the
multinational and multi-institutional
academic community.

The distribution of articles included
in the final list by level of evidence is as
follows: level I, 5 papers, level II, 15, level
III and IV, 11 papers each; there are no
studies with level of evidence V (clini-
cal cases) among the articles with a high
number of citations. In addition to the
original articles, there are studies that are
not ranked in the level of evidence: one
discussion of the developed classification,
four literature reviews and three experi-
mental in vitro studies.

Limitations of the study. The authors
are aware of some of the limitations of
the study conducted by the means of
bibliometric analysis. Citation analysis is,
by definition, a biased assessment tool.
Citing does not always demonstrate the
direct influence of the literary source on
the research that refers to it. Often, the
authors provide a vast array of literature
references in the “Relevance of the study”
section, citing related articles or papers,
the content of which has not been ana-
lyzed thoroughly. Another important lim-
itation is the factor of self-citation, that is,
quoting one’s own works. Self-citations
artificially increase the total number of
citations of the article, which may cause
an incorrect assessment of the impact
of the publication in the relevant field.
After we removed self-citations the total
number of citations decreased, on aver-
age, by 9 per article. Another limitation
is associated with the date of publica-
tion; an earlier study has more chances to
accumulate citations than a more recent
one. The use of average number of cita-
tions allows circumventing this limitation.
The structure of the list of most cit-
ed articles reflects this phenomenon: the
article ranked 3rd was published in 1983,
whereas the 2013 paper, devoted to the
most relevant issue of the classification
of spinal injuries, ranks only 18th.

The average number of citations is
also not a perfect tool for assessing the
significance of the article. The more
time has passed since publication, the high-
er the denominator is in the equation for
calculating this value. This, in fact,
dilutes the total number of citations of
this article.

One must assume that only a com-
prehensive assessment of such indica-
tors as the total number of citations and
the average number of citations provides
an objective picture of the significance
of the published study for analyzing the
state of affairs in any subject field in gen-
eral and in surgery of the thoracolumbar
junction in particular.

Conclusion

We used Web of Science service to
identify 50 most cited articles devoted
to the study of traumatic injuries to
the thoracolumbar junction. Diagnosis,
classification and surgical treatment of
this pathology remain a subject of debate
even today. There is a notable shift in
the interests of scientists from particular
aspects of surgical tactics in 1980–
1990 to the problems of classifications,
algorithmic approaches and analysis
of accumulated information in 2000–
2010. The higher number of studies with
a level of evidence II–V compared to
level I studies confirms the advisability
of further work in this field.

The study did not have sponsorship. The authors
declare no conflict of interest.
<table>
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<tr>
<th>№</th>
<th>Authors</th>
<th>Year of publication, journal, issue, pages</th>
<th>Title of the article</th>
<th>Summary of the article</th>
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<th>Total number of citations</th>
<th>Average number of citations</th>
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<tbody>
<tr>
<td>1</td>
<td>McLain RF, Sparling E, Benson DR</td>
<td>J Bone Joint Surg Am. 1993;75:162–167</td>
<td>Early failure of short-segment pedicle instrumentation for thoracolumbar fractures. A preliminary report</td>
<td>The results of short-segment transpedicular fixation of burst fractures of the thoracolumbar localization are presented. Based on the analysis of 10 cases of metal fixation instability in 19 patients operated on using this technique, the author calls for caution in using this arrangement without ventral spinal fusion</td>
<td>Retrospective non-randomized clinical trial</td>
<td>IV</td>
<td>293</td>
<td>22.98</td>
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<td>3</td>
<td>McAfee PC, Yuan HA, Fredrickson BE, Lubicky JP</td>
<td>J Bone Joint Surg Am. 1983;65:461–473</td>
<td>The value of computed tomography in thoracolumbar fractures. An analysis of one hundred consecutive cases and a new classification</td>
<td>The example of 100 patients with potentially unstable fractures and fractures of the thoracolumbar localization (50 were operated on) was used to demonstrate the superiority of CT in determining the spondylosynthesis technique based on the structure of the injury.</td>
<td>Prospective non-randomized clinical trial</td>
<td>III</td>
<td>245</td>
<td>22.43</td>
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<td>5</td>
<td>Kaneda K, Taneichi H, Abumi K, Hashimoto T, Satoh S, Fujiya M</td>
<td>J Bone Joint Surg Am. 1997;79:69–83</td>
<td>Anterior decompression and stabilization with the Kaneda device for thoracolumbar burst fractures associated with neurological deficits</td>
<td>190 patients with complicated burst fractures of the thoracolumbar localization were operated on using anterior decompression, fusion and fixation with Kaneda device. Good radiographic and functional results were obtained.</td>
<td>Prospective non-randomized clinical trial</td>
<td>III</td>
<td>215</td>
<td>18.73</td>
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<td>6</td>
<td>Verlaan JJ, Diekerhof CH, Buskens E, van der Tweel I, Verbout AJ, Dhert WJA, Oner FC</td>
<td>2004;29:803–814</td>
<td>Surgical treatment of traumatic fractures of the thoracic and lumbar spine: a systematic review of the literature on techniques, complications, and outcome</td>
<td>A total of 132 articles from 1970–2001 were analyzed. The main surgical techniques used in patients with fractures of the thoracic and lumbar vertebrae have been identified and classified.</td>
<td>Literature review</td>
<td>—</td>
<td>195</td>
<td>14.55</td>
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<td>7</td>
<td>Denis F, Armstrong GW, Searle K, Matta L</td>
<td>1984; (189):142–149</td>
<td>Acute thoracolumbar burst fractures in the absence of neurologic deficit. A comparison between operative and non-operative treatment</td>
<td>Analysis of the long-term outcomes of treatment of 104 patients with unstable fractures of the thoracolumbar localization; 75% of the operated patients fully returned to their previous work, while 25% of those treated conservatively only returned on a part-time basis</td>
<td>Retrospective randomized clinical trial</td>
<td>II</td>
<td>190</td>
<td>25.07</td>
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<td>8</td>
<td>Parker JW, Lane JR, Karakovic EE, Gaines RW</td>
<td>2000;25:1157–1170</td>
<td>Successful short-segment instrumentation and fusion for thoracolumbar spine fractures: a consecutive 4 1/2-year series</td>
<td>46 patients with fractures of the thoracolumbar localization were operated on using short-segment fixation (transpedicular fixation or ventral stabilizing systems); algorithmic approach to determining indications for short-segment fixation, depending on the severity of the vertebral injury, from anterior or posterior access allowed for good treatment outcome</td>
<td>Retrospective non-randomized clinical trial</td>
<td>IV</td>
<td>180</td>
<td>17.39</td>
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<td>9</td>
<td>McAfee PC, Bohlman HH, Yum HA</td>
<td>1985;67:89–104</td>
<td>Anterior decompression of traumatic thoracolumbar fractures with incomplete neurological deficit using a retroperitoneal approach</td>
<td>Analysis of the results of decompression and stabilization performed from the retroperitoneal approach in 70 patients with complicated T11-L2 vertebral fractures. Good clinical and radiological outcomes allow the authors to recommend performing decompression and stabilization operations for injuries of the thoracolumbar localization using extrapleural retroperitoneal access described by the authors</td>
<td>Retrospective non-randomized clinical trial</td>
<td>III</td>
<td>168</td>
<td>28.60</td>
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<td>10</td>
<td>Kaneda K, Abumi K, Fujiya M</td>
<td>1984;9:788–795</td>
<td>Burst fractures with neurologic deficits of the thoracolumbar-lumbar spine. Results of anterior decompression and stabilization with anterior instrumentation</td>
<td>A total of 27 patients with burst complicated fractures of the thoracolumbar localization; decompression, correction and fixation from the anterior access is performed; 15 patients operated on using Kaneda device showed the best functional results</td>
<td>Prospective randomized clinical trial</td>
<td>II</td>
<td>161</td>
<td>28.23</td>
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<td>12</td>
<td>Shen WJ, Liu TJ, Shen YS</td>
<td>Spine. 2001;26:1038–1045</td>
<td>Nonoperative treatment versus posterior fixation for thoracolumbar junction burst fractures without neurologic deficit</td>
<td>80 patients with uncomplicated burst fractures of the T11–L2 vertebrae: 47 received conservative treatment, 33 underwent short-segment transpedicular fixation. Surgical treatment allows to correct post-traumatic deformity and provide an early antalgic effect. Long-term outcomes are comparable</td>
<td>Prospective randomized clinical trial</td>
<td>II</td>
<td>130</td>
<td>17.15</td>
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<td>13</td>
<td>Bradford DS, McBride GG</td>
<td>Clin Orthop Relat Res. 1987;218:201–216</td>
<td>Surgical management of thoracolumbar spine fractures with incomplete neurologic deficits</td>
<td>Long-term outcomes of surgical treatment of 59 patients with complicated fractures of the thoracolumbar localization. Anterior decompression of the contents of the spinal canal (20 patients) provides better regression of the neurological deficit than posterior decompression (39 patients)</td>
<td>Retrospective randomized clinical trial</td>
<td>II</td>
<td>126</td>
<td>23.43</td>
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<td>15</td>
<td>Farcy JP, Weidenbaum M, Glassman SD</td>
<td>Spine. 1990;15:958–965</td>
<td>Sagittal index in management of thoracolumbar burst fractures</td>
<td>Analysis of the results of surgical treatment of 62 patients with kyphotic deformity due to burst fractures of T12–L2 vertebrae. In the course of preoperative planning, the sagittal index used to simulate the rods of dorsal combination system (laminar hooks — transpedicular screws) was determined based on X-ray data. The technique allowed to achieve encouraging radiological and clinical results.</td>
<td>Prospective non-randomized clinical trial</td>
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<td>119</td>
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<td>16</td>
<td>Siebenga J, Leekrink VJM, Segers MJM, Elzinga MJ, Bakker FC, Haarman HJ, Rommens PM, ten Duis HJ, Patka P</td>
<td>Spine. 2006;31:2881–2890</td>
<td>Treatment of traumatic thoracolumbar spine fractures: a multicenter prospective randomized study of operative versus nonsurgical treatment</td>
<td>34 patients with type A fractures of T11–L2 according to AO: 18 were operated on, 16 received conservative treatment. Analysis of radiological and functional outcomes allows recommending ventral spondylodesis in case of A3 fractures according to AO classification.</td>
<td>Multicenter prospective randomized trial</td>
<td>I</td>
<td>119</td>
<td>9.72</td>
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<td>17</td>
<td>Vaccaro AR, Oner C, Kepler CK, Dvornik M, Schmale K, Belbahri C, Reinhold M, Aarabi B, Kandziora F, Chapman J, Shanmuganathan R, Fehlings M, Vaille L</td>
<td>Spine. 2013;38:2028–2037</td>
<td>AOSpine Thoracolumbar Spine Injury Classification System Fracture Description, Neurological Status, and Key Modifiers</td>
<td>AOSpine Thoracolumbar injury classification system was developed. Data from 40 patients with thoracolumbar trauma were analyzed in the framework of this classification by a group of specialists. The system was highly approved, and its reliability and accuracy were confirmed.</td>
<td>The study of the reliability of the classification system based on retrospective data</td>
<td>II</td>
<td>109</td>
<td>2.37</td>
</tr>
<tr>
<td>18</td>
<td>Hashimoto T, Kaneda K, Abumi K</td>
<td>Spine. 1988;13:1268–1272</td>
<td>Relationship between traumatic spinal canal stenosis and neurologic deficits in thoracolumbar burst fractures</td>
<td>The relationship between the severity of deficit of the spinal canal lumen in damage to T11–L2 vertebrae and the risk of neurological deficit was identified</td>
<td>Retrospective non-randomized clinical trial</td>
<td>III</td>
<td>109</td>
<td>19.28</td>
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<td>19</td>
<td>Cho DY, Lee WY, Sheu PC</td>
<td>Neurosurgery. 2005;55:1554–1561</td>
<td>Treatment of thoracolumbar burst fractures with polymethyl methacrylate vertebroplasty and short-segment pedicle screw fixation</td>
<td>Analysis of the results of surgical treatment of 70 patients with burst fractures of the thoracolumbar localization: 50 of them underwent short-segment transpedicular fixation, in 20 patients it was supplemented with polymethyl methacrylate vertebroplasty. The combined method allows to achieve a better antalgic effect and reduces the risk of metal structure instability.</td>
<td>Prospective randomized clinical trial</td>
<td>II</td>
<td>108</td>
<td>14.72</td>
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<td>2003;55:228–235</td>
<td>Prospective validation of computed tomographic screening of the thoracolumbar spine in trauma</td>
<td>The advantage of CT scan over X-rays in the diagnosis of injuries of the thoracolumbar junction, including in case of combined trauma is demonstrated</td>
<td>Prospective non-randomized clinical trial</td>
<td>III</td>
<td>107</td>
<td>14.30</td>
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<td>22</td>
<td>Wang ST, Ma HL, Liu CL, Yu WK, Chang MC, Chen TH</td>
<td>2006;31:2646–2652</td>
<td>Is fusion necessary for surgically treated burst fractures of the thoracolumbar and lumbar spine?: a prospective, randomized study</td>
<td>58 patients with burst fractures of the thoracolumbar localization were operated on using transpedicular fixation: 30 of them underwent a posterior spinal fusion with autograft, 28, had no spinal fusion. No advantage of combining transpedicular fixation with posterior spinal fusion before transpedicular fixation has been identified.</td>
<td>Prospective randomized clinical trial</td>
<td>II</td>
<td>105</td>
<td>9.71</td>
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<td>Mermelstein LE, McLain RF, Yerby SA</td>
<td>1998;23:664–670</td>
<td>Reinforcement of thoracolumbar burst fractures with calcium phosphate cement. A biomechanical study</td>
<td>Short-segment transpedicular fixation with additional stabilization of the anterior column of the damaged vertebra with calcium phosphate cement demonstrates greater stability compared to standard transpedicular fixation</td>
<td>Experimental – biomechanical research</td>
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<td>1992;5:335–343</td>
<td>Unstable thoracolumbar and lumbar burst fractures treated with the AO fixateur interne</td>
<td>25 patients with unstable T10–L2 vertebral fractures were operated on using transpedicular fixation. Good outcomes have been achieved in terms of post-traumatic kyphosis correction and spinal canal remodeling</td>
<td>Prospective non-randomized clinical trial</td>
<td>III</td>
<td>99</td>
<td>34.80</td>
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<td>Been HD, Bouma GJ</td>
<td>Acta Neurochir (Wien). 1999;141:349–357</td>
<td>Comparison of two types of surgery for thoraco-lumbar burst fractures: combined anterior and posterior stabilisation vs. posterior instrumentation only</td>
<td>Analysis of the results of surgical treatment of 46 patients with complicated trauma of the thoraco-lumbar junction. The regression of neurological deficit in 27 patients operated on using decompression-stabilizing operations from the anterior approach did not differ from the results obtained for transpedicular spondylosynthesis and decompression obtained through ligamentotaxis</td>
<td>Retrospective randomized clinical trial</td>
<td>II</td>
<td>97</td>
<td>20.96</td>
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<td>27</td>
<td>Danisa OA, Shaffrey CI, Jane JA, Whitehill R, Wang GJ, Szabo TA, Hansen CA, Shaffrey ME, Chan DP</td>
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<td>Surgical approaches for the correction of unstable thoraco-lumbar burst fractures: a retrospective analysis of treatment outcomes</td>
<td>Based on the analysis of the results of surgical treatment of 49 patients with unstable and burst fractures of the vertebrae of the thoraco-lumbar junction operated on from the ventral (16), dorsal (27) and combined approaches. There was no significant difference in the long-term results of surgical treatment, spondylosynthesis from the posterior access was performed faster and with lower blood loss</td>
<td>Retrospective randomized clinical trial</td>
<td>II</td>
<td>97</td>
<td>26.60</td>
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<td>Lee HM, Kim HS, Kim DJ, Suk KS, Park JO, Kim NH</td>
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<td>Reliability of magnetic resonance imaging in detecting posterior ligament complex injury in thoraco-lumbar spinal fractures</td>
<td>The integrity of the posterior ligamentous complex in case of an injury to the thoracolumbar junction is best determined by T2-weighted images MRI with fat suppression</td>
<td>Prospective non-randomized clinical trial</td>
<td>III</td>
<td>92</td>
<td>14.04</td>
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<td>J Neurosurg. 1997;86:48–55</td>
<td>Selection criteria and outcome of operative approaches for thoracolumbar burst fractures with and without neurological deficit</td>
<td>An example of satisfactory functional outcomes of surgical treatment of 25 patients with burst fractures of the thoracolumbar localization is used to demonstrate an algorithmic approach to the choice of spondylosynthesis tactics depending on the number of damaged columns, spinal canal hemien deficit, segmental kyphosis, degree of compression, neurological status</td>
<td>Non-randomized prospective clinical trial</td>
<td>III</td>
<td>88</td>
<td>27.79</td>
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<td>Kyphoplasty: report of eighty-two thoracolumbar osteoporotic vertebral fractures</td>
<td>52 patients with compression fractures of the thoracolumbar localization and osteoporosis were operated on using balloon kyphoplasty. Good results in terms of correction of the vertebral body, pronounced antalgic effect were achieved</td>
<td>Retrospective non-randomized clinical trial</td>
<td>IV</td>
<td>86</td>
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<td>Pedicle screw instrumentation for thoracolumbar burst fractures and fracture-dislocations</td>
<td>Good results were obtained using transpedicular fixation in treatment of 38 patients with burst fractures of the thoracolumbar junction.</td>
<td>Non-randomized prospective study</td>
<td>IV</td>
<td>85</td>
<td>19.71</td>
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<td>Functional outcome of thoracolumbar burst fractures without neurological deficit</td>
<td>24 patients with fractures of the thoracolumbar junction were observed for two years after injury. Functional capabilities were not related to the magnitude of the residual kyphosis and depended on the pain intensity. No significant difference in functional status depending on treatment tactics has been identified.</td>
<td>Retrospective randomized clinical trial</td>
<td>II</td>
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<td>Shono Y, McAfee PC, Cunningham BW</td>
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<td>Experimental study of thoracolumbar burst fractures. A radiographic and biomechanical analysis of anterior and posterior instrumentation systems</td>
<td>The superiority of decompression and stabilization operations using Kaneda anterior screw instrumentation system over the posterior instrumentation has been established</td>
<td>Experimental - biomechanical research</td>
<td>–</td>
<td>85</td>
<td>22.7</td>
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<td>Does canal clearance affect neurological outcome after thoracolumbar burst fracture?</td>
<td>Based on the analysis of 275 articles on the surgical treatment of burst fractures of the thoracolumbar localization, the authors conclude that there is no correlation between the completeness of decompression and postoperative regression of the neurological deficit</td>
<td>Literature review</td>
<td>–</td>
<td>84</td>
<td>16.18</td>
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<td>Ferguson RL, Allen BL Jr</td>
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<td>A mechanistic classification of thoracolumbar spine fractures</td>
<td>A classification of fractures of the thoracic and lumbar vertebrae depending on the mechanism of injury is presented.</td>
<td>Clinical cases corresponding to the proposed classification are presented</td>
<td>IV</td>
<td>84</td>
<td>25.20</td>
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<td>Transpedicular instrumentation and short-segment fusion of thoracolumbar fractures: a prospective study using a single instrumentation system</td>
<td>Eleven patients with burst fractures of the thoracolumbar junction were operated on using short-segment transpedicular fixation with posterior spinal fusion with autograft. The instability of metal structures in several patients testifies to the inadequacy of the intervention volume, however, the patients with stable constructions demonstrate good functional outcomes.</td>
<td>Non-randomized retrospective clinical study</td>
<td>IV</td>
<td>82</td>
<td>30.39</td>
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<td>The corpectomy, fusion and fixation of the extramedullary Z-plate made it possible to achieve good radiological and functional results in 35 patients with burst fractures of the thoracolumbar spine</td>
<td>Non-randomized prospective clinical trial</td>
<td>IV</td>
<td>82</td>
<td>11.75</td>
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<td>Eur Spine J. 2002;11:235–245</td>
<td>Classification of thoracic and lumbar spine fractures: problems of reproducibility</td>
<td>Comparison of AO and Denis classifications using CT and MRI of 52 patients. The authors propose to increase reproducibility of the AO classification by using MRI</td>
<td>Retrospective non-randomized study</td>
<td>III</td>
<td>82</td>
<td>16.09</td>
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<td>Short segment fixation of thoracolumbar burst fractures without fusion</td>
<td>28 patients with burst fractures of the thoracolumbar localization were operated on using short-segment transpedicular fixation. Performing posterior spinal fusion with autograft did not affect the long-term outcome of the intervention.</td>
<td>Retrospective randomized clinical trial</td>
<td>II</td>
<td>82</td>
<td>21.56</td>
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<td>A review of the management of thoracolumbar burst fractures</td>
<td>By analyzing the results of the search for sources devoted to the treatment of injuries of the thoracolumbar junction in PubMed the authors concluded that surgical techniques are superior to conservative treatment</td>
<td>Literature review</td>
<td>—</td>
<td>81</td>
<td>9.30</td>
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<td>Posterior short-segment fixation with or without fusion for thoracolumbar burst fractures. A five to seven-year prospective randomized study</td>
<td>73 patients with burst fractures of the thoracolumbar junction: 36 were operated on using short-segment transpedicular fixation. 37 using transpedicular segmentation with posterolateral spinal fusion. No advantages of the combined technique were identified</td>
<td>Prospective randomized study</td>
<td>I</td>
<td>81</td>
<td>4.68</td>
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<td>Pilot study of the administration of recombinant bone morphogenetic protein-7 to the vertebral body in combination with transpedicular fixation. No promising results were not obtained in 5 patients with thoracolumbar fractures</td>
<td>Non-randomized prospective clinical trial</td>
<td>IV</td>
<td>81</td>
<td>41.67</td>
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<td>Intervertebral disc degeneration can predispose to anterior vertebral fractures in the thoracolumbar spine</td>
<td>An experimental study based on the determination of effort required to destroy 41 vertebral motor segments of corpses aged 62–94 years. Degenerative changes in the segment reduced the force that causes a vertebral compression fracture.</td>
<td>Non-randomized experimental cadaver study</td>
<td>III</td>
<td>80</td>
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<td>Thoracolumbar burst fracture. A biomechanical investigation of its multidirectional flexibility</td>
<td>Based on the experiment using cadaveric material, the unstable nature of the burst fractures of the thoracolumbar junction was confirmed. The damaged spine is least resistant to rotational loads</td>
<td>Experimental - biomechanical research</td>
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<td>Reinhold M, Knoop C, Beisse R, Audige L, Kandzia F, Pizanis A, Pramal R, Gereck E, Schultheiss M, Weckbach A, Buhren V, Blauth M</td>
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<td>Analysis of epidemiology of spinal injuries, outcomes of surgical treatment of 733 patients: 47% of the injuries are located in the thoracolumbar junction. The best functional results were achieved for dorsal interventions, the best correction for combined (ventral-dorsal) ones, the use of container vertebral prostheses resulted in a smaller loss of correction than the use of autograft. The long-term neurological outcome did not depend on the type of intervention</td>
<td>Multicenter study</td>
<td>I</td>
<td>77</td>
<td>3.71</td>
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<td>Minimally invasive transmuscular pedicle screw fixation of the thoracic and lumbar spine</td>
<td>104 patients were operated on using transcutaneous transpedicular systems. 87% of screws are installed correctly. Authors recommend transcutaneous transpedicular fixation for widespread use.</td>
<td>Non-randomized prospective clinical trial</td>
<td>IV</td>
<td>70</td>
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<td>53 patients with unstable fractures of the thoracolumbar localization. In 40 cases, anterior spondylosynthesis was performed with resection of the vertebral body, fusion and fixation with a plate. In 13 cases, short-segment transpedicular fixation was performed. Anterior spondylosynthesis demonstrates lower loss of correction in the postoperative period.</td>
<td>Retrospective randomized clinical trial</td>
<td>II</td>
<td>67</td>
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S.V. Likhachev, MD, PhD, senior researcher of the Department of Innovation Projects in Neurosurgery and Vertebrology, Scientific Research Institute of Traumatology, Orthopedics and Neurosurgery of Saratov State Medical University n.a. V.I. Razumovsky, Chernyshevskogo str., 148, Saratov, 410002, Russia, likba4@mail.ru;
Vladimir Vladimirovich Zaretskov, DMSc, leading researcher of the Department of Innovation Projects in Neurosurgery and Vertebrology, Scientific Research Institute of Traumatology, Orthopedics and Neurosurgery of Saratov State Medical University n.a. V.I. Razumovsky, Chernyshevskogo str., 148, Saratov, 410002, Russia, vzhzaretskov@mail.ru;
Alexey Evgenyevich Shulga, MD, PhD, senior researcher of the Department of Innovation Projects in Neurosurgery and Vertebrology, Scientific Research Institute of Traumatology, Orthopedics and Neurosurgery of Saratov State Medical University n.a. V.I. Razumovsky, Chernyshevskogo str., 148, Saratov, 410002, Russia, doc.shulga@yandex.ru;
Svetlana Anfasovna Gramma, head of Bibliographic Information and Document Support Department, Scientific Research Institute of Traumatology, Orthopedics and Neurosurgery of Saratov State Medical University n.a. V.I. Razumovsky, Chernyshevskogo str., 148, Saratov, 410002, Russia, svetagramma@mail.ru;
Ivan Nikolaevich Shchanitsyn, MD, PhD, junior researcher of the Department of Innovation Projects in Neurosurgery and Vertebrology, Scientific Research Institute of Traumatology, Orthopedics and Neurosurgery of Saratov State Medical University n.a. V.I. Razumovsky, Chernyshevskogo str., 148, Saratov, 410002, Russia, dr.green@list.ru;
Sergey Petrovich Bazhanov, MD, PhD, senior researcher of the Department of Innovation Projects in Neurosurgery and Vertebrology, Scientific Research Institute of Traumatology, Orthopedics and Neurosurgery of Saratov State Medical University n.a. V.I. Razumovsky, Chernyshevskogo str., 148, Saratov, 410002, Russia, baj.s@mail.ru;
Aleksandr Vladimirovich Zaretskov, MD, PhD, Associate Professor of Traumatology and Orthopedics Department, Saratov State Medical University n.a. V.I. Razumovsky, Chernyshevskogo str., 148, Saratov, 410002, Russia, sgmutravma@mail.ru;
Anna Mikhailovna Donnik, programmer of the Division of High-Performance Computing Systems, Education and Research Institute of Nanostructures and Biosystems, Saratov State University n.a. N.G. Chernyshevsky, Astrakhanskaya str., 83, Saratov, 410012, Russia, mathandon@mail.ru.