# EXPERIENCE IN SURGICAL TREATMENT OF PATIENTS WITH TRAUMATIC SPINAL INJURIES ASSOCIATED WITH ANKYLOSING SPONDYLITIS

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**Objective.** To analyze characteristics, diagnostic features and results of surgical treatment of patients with traumatic spinal injuries associated with ankylosing spondylitis.

**Material and Methods.** A retrospective analysis of the results of surgical treatment of 32 patients (25 men and 7 women) operated on in 2019–2022 was performed. Results were followed-up during 12 months in all patients. Patient characteristics, diagnostic features, clinical outcomes, and the range of postoperative complications were reviewed.

**Results.** The number of damaged levels in the cervical, thoracic and lumbar spine was 39. Low-energy injury (fall from a height and from a sitting position) was observed in 20 patients (62.5 %), and high-energy injury (fall from a height of more than 1 m and a road traffic accident) – in 12 patients (37.5 %). Type B3 fractures according to the AOSpine classification were present in 23 patients (71.8 %), and type C translational fractures – in 9 (28.2 %). CT of the spine and verification of the diagnosis were performed within 24 hours after the injury in 24 patients (75 %). The remaining 8 (25 %) patients underwent primary diagnosis later – in 19.8 ± 24.4 days (range 5–46 days). All patients underwent posterior fixation with or without decompression. The time of surgical intervention depended on the presence of neurological symptoms. Twenty one (65.6 %) patients with complicated injury underwent surgical intervention within 8 hours after admission to the hospital. In the remaining 11 (34.4 %) neurologically uncomplicated patients, operations were performed within 3.2 ± 1.4 days. In-hospital mortality was 6.25 % (n = 2), and 1-year mortality was 28 % (n = 9). There were no neurological symptoms before or after surgery in 11 patients (36.7 %). In the group of patients with initial neurological complications (n = 21), 3 (14.3 %) patients had complete regression of neurological symptoms (from AIS D to AIS E), 4 (19 %) - incomplete regression of symptoms (from AIS C to AIS D), and 14 (66.7 %) patients did not show significant positive dynamics. Pulmonary embolism (PE) and pneumonia were observed in 5 (15.6 %) and 6 (18.75 %) patients, respectively. In the postoperative period, the deep vein thrombosis of the lower extremities was most frequent (n = 9; 28.1%), and in 5 cases it was complicated by PE.

**Conclusion.** The basis for diagnosing fractures in patients with ankylosing spondylitis is clinical data (increased pain after a fall and/or the appearance of neurological deficit) and radiological data (CT scan of the whole spine). Fractures in ankylosing spondylitis are characterized by absolute instability with a high risk of developing secondary neurological deficits in the case of conservative treatment or delayed surgical intervention. The essence of the surgery is the use of extended fixation with 8 screws in the cervical spine and more than 10 screws in the thoracic and lumbar spine. The most common complications of the early postoperative period include liquorrhea, surgical wound suppuration, pulmonary embolism, pneumonia, and loosening of transpedicular screws.

**Key Words:** traumatic spinal injuries, ankylosing spondylitis, neurological deficit, complications.

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Ankylosing spondylitis (Bekhterev's disease) is a chronic autoimmune inflammatory disease belonging to the spondyloarthritis group of diseases that affects the sacroiliac joints and/or spine [1]. According to 36 trials analyzed by Dean et al. [2], the mean prevalence of ankylosing spondylitis was 23.8 per 10 thousand in Europe, 16.7 in Asia, 31.9 in the North America, 10.2 in Latin America, and 7.4 in Africa. In 2010 in the Russian Federation, the overall incidence of ankylosing spondylitis in the adult population was 34.4 per 100 thousand [3].

The prevalence of spinal fractures in patients with ankylosing spondylitis in Europe and the North America is 10 % and 17 %, respectively, and the incidence of spinal cord injury is 19.0 % and 21.1 % [4]. A higher risk of fractures in patients with ankylosing spondylitis is explained by the associated decrease in bone mineral density (BMD) when even low-energy trauma can result in a spinal injury. According to Bessant and Keat [5], the incidence of osteoporosis in patients with ankylosing spondylitis ranges from 18.7 % to 62.0 %.

Delayed diagnostics of spinal injuries in patients with ankylosing spondylitis is rather common. Patients with a delayed or late diagnosis usually have progressive pain, increasing symptoms of neurological deficits, as well as increasing spinal deformity [6, 7].

Diagnostics and treatment strategy for traumatic spinal injuries in patients with ankylosing spondylitis currently differ depending on the medical organization reasoned by the lack of generally approved algorithms. Russian research papers with the results of treatment for ankylosing spondylitis are generally represented as case reports [8–11].

The objective is to analyze the epidemiological parameters, diagnostic criteria, specific features and results of surgical treatment, as well as the incidence and structure of postoperative complications in patients with traumatic spinal injuries associated with ankylosing spondylitis.

## Material and Methods

This research is an observational, descriptive, retrospective analysis of case series (n = 32).

The object included patients with isolated or combined traumatic spinal injuries associated with ankylosing spondylitis.

The subject being analyzed includes the specific aspects of diagnosis, surgical treatment, and outcomes of spinal injuries in patients with ankylosing spondylitis.

The following methods were used during the research:

1) neurological and physical examinations – to objectively assess a patient's condition;

2) ASIA/ISNCSCI Scale – to assess the neurological status before surgery and during discharge of patients from the hospital;

3) ASIA Impairment Scale (AIS) – to assess the extent of spinal cord injury;

4) VAS – to assess the intensity of pain before surgery and during discharge of patients from the hospital;

5) AOSpine classification – to systematize fractures based on CT data using specific modifiers for ankylosing spondylitis: M2 – for fractures of the thoracic and lumbar spine, M3 – for fractures of the subaxial cervical spine [12].

The obtained clinical results were processed using IBM SPSS software. Statistical significance of the results obtained was determined using Wilcoxon signed-rank test; the significance of difference in sampling populations was assessed using nonparametric tests; $p < 0.05$ value of statistical significance was taken as the lower confidence limit.

## Results

*Patient characterization*

A retrospective analysis was performed that included treatment results of 32 patients (25 (78 %) males and 7 (22 %) females) who have undergone surgical treatment in 2019–2022. The mean age of patients was 58.8 (36–86). The follow-up period for all patients was 12 months after surgery.

In 11 (34.4 %) patients, the main complaint at admission was back pain, in 21 (65.6 %) – back pain and neurological deficit. In regard to the mechanism, low-energy injuries were most common (falls from a standing height and from a sitting position), high-energy injuries (falls from a height of more than one meter and traffic accidents) were observed less frequently: 20 (62.5 %) and 12 (37.5 %) patients, respectively. AOSpine type B3 fractures were identified in 23 (71.8 %) patients, and type C translational fractures – in 9 (28.2 %) patients. The total number of damaged vertebrae was 39, including 23 (59 %) in the cervical spine, 14 (36 %) in thoracic spine, 2 (5 %) in lumbar spine, and 6 patients had multiple vertebral injuries.

Twenty six (81.2 %) patients had an isolated spinal injury; 6 (18.8%) patients had such injury combined with the following: thoracic injury (rib fracture; pneumo-, hydro-, or hemothorax; sternal fracture) – in four patients; traumatic right vertebral artery dissection and fracture of the pelvic bones – in one patient; moderate brain contusion and fracture of the lower jaw – in one patient.

*Diagnostics*

A CT scan of the spine with diagnosis verification was performed in 24 (75 %) patients within 24 hours after injury. The other 8 (25 %) patients were primarily diagnosed within 5–46 days (mean 19.8 ± 24.4 days); 6 of these patients did not seek medical care after a low-energy injury due to minor back pain. Subsequently, 4 (12.5 %) patients requested medical care reasoned by increased pain syndrome, and 2 (6.3 %) patients – the developed neurological deficit, i.e. lower extremity paraparesis. In other 2 (6.3 %) cases, the fractures were not identified on the initial CT scan; however, the patients returned to the medical organization due to increased back pain and were diagnosed with delay.

*Surgical treatment*

All patients underwent posterior instrumental vertebral fixation, with or without spinal cord decompression. The time of surgical intervention depended on the presence of neurological symptoms. 21 (65.6 %) patients with complicated injury underwent surgery within 8 hours after hospital admission. In 11 (34.4 %) non-operated patients with no neurological complications, surgeries were performed within 3.2 ± 1.4 days. For injuries to the thoracic or lumbar spine, fixation with 8–12 screws was used; for injuries to the cervical spine – exclusively posterior fixation with 8 screws. Eighteen (56.3 %) patients received an 8-screw system, 9 (28.1 %) patients – a 10-screw system, and 5 (15.6 %) patients – a 12-screw system. Percutaneous fixation was performed in 9 (28.0 %) cases of injuries to the thoracic and lumbar spine; cement augmentation of screws – in 7 (21.8 %) cases. Surgical treatment was successful in all cases with no intraoperative complications, such as damage to vascular or nervous structures. The mean duration of surgery with percutaneous fixation was 125.0 ± 57.0 minutes (65 to 170 minutes), that of open surgery – 145.0 ± 90.5 minutes (55 to 240 minutes); intraoperative blood loss volume during percutaneous fixation was 74.0 ± 25.0 mL (50 to 100 mL), during open surgeries – 760.8 ± 396.4 mL (420 to 1,200 mL).

*Clinical outcomes*

The analyzed group of patients amounts to 2 % of all patients who underwent surgical intervention for traumatic spinal injuries in our clinic in 2019–2022. Period of discharge from the hospital was 25.4 ± 16.0 days (min 9; max 42), with in-hospital mortality of 6.3 % (n = 2) and a 1-year mortality of 28.0 % (n = 9).

Changes in back pain severity over time assessed using VAS are provided in Table 1.

Eleven (36.7 %) patients demonstrated no neurological symptoms before and after surgery. 21 patients initially had neurological complications; 3 (14.3 %) of them demonstrated complete regression of neurological symptoms (AIS D to E), 4 (19.0 %) – incomplete regression (AIS C to D), and the other 14 (66.7 %) patients had no positive changes over time. No patients had negative neurological symptoms in the postoperative period (Table 2).

In the postoperative period, 13 (40.6 %) patients had complications that are provided in Table 3.

The occurred liquorrhea was managed by the placement of a lumbar drainage for 6 days and complete bed rest; drainage placement was a significant technical challenge because of ossification of the spinal ligaments. In case of surgical wound suppuration, it was revised, closed with VAC dressing, and sutured.

Instability of instrumentation, that is, loosening of pedicle screws, was observed withing 27.6 ± 10.8 days after surgery (15; 38); in all 5 cases of its development, posterior 8-screw fixation of hyperextension injuries (B3) in thoracic spine with no cement augmentation was performed (there is a significant correlation between the number of screws used and the instability of the instrumentation, $p < 0.05$). In three cases, a repeated surgery was performed with extension of the instrumentation up to 12 screws, as well as augmentation of loose screws with allograft chips and an orthobiologic material. Two patients were immobilized with a corset, because of the asymptomatic bone tissue resorption with small area (1–2 mm), and received vitamin D in high doses with a positive effect.

Five of the nine cases of the lower extremity vein thrombosis were accompanied by PE (pulmonary embolism); it was the cause of in-hospital mortality in two patients and of a 1-year mortality in one patient. Another six fatal cases were caused by pneumonia.

## Discussion

Specific aspects that are typical for patients with ankylosing spondylitis make it more difficult to diagnose and surgically treat their spinal fractures. Such patients have progressive kyphosis and impaired muscle strength that lead to sagittal imbalance and, consequently, to the increased risk of falls from a standing height [13]. Ectopic ossification and low BMD also result in the increased risk of fractures [14]. Patients with ankylosing spondylitis have the 11.4-fold risk of spinal cord injury compared to the overall population [15], while the most common mechanism of injury is hyperextension – AOSpine type B3 [16]. We obtained the following results in our research: low-energy injuries (falls from a standing height or from a sitting position) – 62.5 %, and hyperextension mechanism of injury – 71.8 %. It correlates with the abovementioned figures.

The increased exposure of the ossified spine to injury (the number of damaged vertebrae in our research was 21.8 % higher than the number of patients, 39 and 32, respectively) necessitates the need to perform a CT scan of the whole spine in patients diagnosed with ankylosing spondylitis in case of injury [17]. According to Chaudhary et al. [18], fallen patients with ankylosing spondylitis and diffuse idiopathic skeletal hyperostosis should be considered to have a spinal injury until confirmed otherwise.

Delay in diagnosis of spinal injury is common in patients with ankylosing spondylitis [19]. In our research, fractures were not initially identified or were detected after a long time period in 25.0 % of patients; in the trial performed by Westerveld et al. [20], a delay in diagnosis was observed in 17.1 %; according to Kobayashi et al. [21], this value reached up to 40.0 %.

Conservative treatment for spinal injuries associated with ankylosing spondylitis is contraindicated due to the extremely unstable nature of the fractures and the high risk of secondary spinal cord injury [22]. For fractures of the cervical spine, anteroposterior, posteroanterior, or posterior surgical intervention with the use of instrumentation is recommended [23]; for thoracic and lumbar spine injuries – posterior extended open fixation or percutaneous fixation, with or with no nerve decompression [24]. In our research, only posterior stabilization (if there was no neurological deficit) and stabilization with decompression (if there was neurological deficit) were used. Depending on the level and nature of the fracture, stabilizing instrumentation with 8, 10, or 12 screws were used; its instability, i.e. loosening of the screws, was observed only in the thoracic and lumbar spine when using 8-screw systems. When the instrumentation was extended, the zones of screw loosening were strengthened using allograft chips and regenerative material (Trombogel) [25]; however, the 8-screw system was stable in all patients with cervical spine injury throughout the follow-up period.

Unfortunately, regardless of the surgical treatment strategy, the incidence of postoperative complications and mortality in patients with ankylosing spondylitis is significantly higher than in control patients [20]. According to Caron et al. [26], 87.5 % of patients with ankylosing spondylitis and 85.7 % of patients with diffuse idiopathic skeletal hyperostosis experienced at least one complication after surgical treatment, with in-hospital mortality rate of 7.1 %. The range of complications mentioned in the literature (respiratory failure, pneumonia, PE, lower extremity vein thrombosis, surgical wound suppuration, instability of the instrumentation) fully corresponds to those recorded in our research. Moreover, special aspects associated with spinal fractures and the consequences of complications worsen the prognosis for the disease outcome.

## Conclusion

Patients with ankylosing spondylitis have a high risk of fractures, even in cases of low-energy injuries. Diagnosis in such cases is based on clinical findings (increased pain after a fall and/or developed neurological deficit) and radiological results (CT scan of whole spine). Fractures associated with ankylosing spondylitis most often correspond to 3-column distraction injuries, with or without diastasis in the fracture zone, and are characterized by absolute instability and high risk of developing secondary neurological deficit in case of conservative treatment or delayed surgical interventions. The essence of the surgery is the use of extended fixation of not less than 8 screws in the cervical spine and 10 or more screws in the thoracic and lumbar spine. Complications in the postoperative period significantly worsen treatment results and contribute to increased mortality rate both in the early and long-term period.

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*All authors contributed significantly to the research and preparation of the article, read and approved the final version before publication.*

**Table 1**
VAS scores before and after surgery (M ± SD, Wilcoxon signed rank test)

| Period | VAS, points | Z, p value |
|---|---|---|
| Before surgery (n = 32) | 7.3 ± 1.2 | – |
| At hospital discharge (n = 30) | 3.2 ± 0.4 | Z = -3.865; p < 0.001 |
| 12 months after (n = 23) | 2.1 ± 0.2 | Z = -2.43; p < 0.001 |

**Table 2**
Changes of AIS values at patient admission to a hospital and at discharge

| AIS | On admission (n = 32) | At discharge (n = 30) |
|---|---|---|
| A | 5 (15.6 %) | 3 (10.0 %) |
| B | 2 (6.3 %) | 2 (6.8 %) |
| C | 6 (18.8 %) | 2 (6.7 %) |
| D | 8 (25.0 %) | 9 (30.0 %) |
| E | 11 (34.4 %) | 14 (46.7 %) |

**Table 3**
Complications in patients in the postoperative period, n (%)

| Complications | Patients (n = 13) |
|---|---|
| Acute renal failure | 1 (3.1) |
| Gastrointestinal bleeding | 2 (6.3) |
| Wound liquorrhea | 2 (6.3) |
| Surgical wound suppuration | 4 (12.5) |
| Instability of the instrumentation (screw loosening) | 5 (15.6) |
| Pulmonary embolism | 5 (15.6) |
| Pneumonia | 6 (18.8) |
| Vein thrombosis of the lower extremities | 9 (28.1) |

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