TRANSPEDICULAR FIXATION FOR HEMATOGENOUS PYOGENIC VERTEBRAL OSTEOMYELITIS

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Objective. To analyze the effectiveness of conservative treatment and extrafocal transpedicular fixation in patients with uncomplicated hematogenous pyogenic vertebral osteomyelitis (PVO).

Material and Methods. Ninety seven medical records of in-patients who were treated for hematogenous PVO in 2007—2017 were analyzed. Among them, men accounted for 73.2 % (n = 71) and women — 26.8 % (n = 26). The acute and subacute forms of the disease were diagnosed in 62 (63.9 %) patients and chronic — in 35 (36.1 %). Type A according to Pola classification totaled 45 patients, type B — 49 and type C — 3. Sixty four (66.0 %) patients were treated conservatively, 33 (34.0 %) — using transpedicular fixation and 25 (75.8 %) — using minimally invasive technique. No fixators were placed in the affected vertebrae. All patients underwent antibacterial therapy lasting 6—12 weeks.

Results. Good treatment results were obtained in 89 (91.8 %) patients. There were no differences in the severity of pain between the comparison groups before the start of treatment and after one year. However, the pain severity was significantly reduced (p = 0.001) over the time of treatment. Positive results of transpedicular fixation were obtained in 28 (84.8 %) cases, and after three repeated interventions — in 32 (94.1 %), and those of conservative treatment — in 61 (95.3 %) cases. The total number of relapses was 8 (8.2 %), of complications — 3 (3.1 %). The risk of relapse among operated drug addicts was significantly higher (p = 0.033). There were no deaths in the comparison groups, which is explained by the study inclusion and exclusion criteria. All discharged patients were followed-up on an outpatient basis for at least a year, and 72.2 % of them — from 1 year to 8 years.

Conclusion. Transpedicular fixation is indicated for uncomplicated hematogenous pyogenic vertebral osteomyelitis, monosegmental lesions and in cases of demands on improved quality of life. The use of such a technique in drug addicts is not recommended.

Key Words: pyogenic vertebral osteomyelitis, spondylitis, spondylodiscitis, transpedicular fixation, conservative treatment.

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Hematogenous pyogenic vertebral osteomyelitis, nonspecific spondylitis, or spondylodiscitis is a rare inflammatory disease. Its incidence appears to be on the rise, making up 3–5 % of all cases of osteomyelitis [1]. According to some researchers, annual incidences vary within 2.2–2.4 new cases per 100,000 population [2]; the increase in the incidence rate is associated with greater age [3, 4]. In the literature, the average duration between the first symptoms and diagnosis has been reported to be between two and six months [5]. The estimated mortality does not exceed 5%; the main reason for death is generally related to sepsis [6]. Pyogenic diseases are diagnosed in 65.7 % cases [7–9]; they are associated with such predisposing risk factors as diabetes mellitus, immunodeficiency states, and previous surgical interventions [7].

The most effective treatment of uncomplicated hematogenous pyogenic vertebral osteomyelitis is still a conservative method [10]. Pola et al. report on 90 (36 %) operated patients out of 250 treated ones. The main surgical indications were segmental spinal instability, epidural abscess, and neurological deficit. The relapse and mortality rates in their study were distributed in the following way: 9.52 % and 3.57 % for type A, 4.35 % and 6.52 % for type B, and 3.33 % and 5.00 % for type C, respectively [11]. At the same time, there are more frequent publications devoted to instrumented fixation of the affected spine department, including those without debridement. A distinctive transfer from hook systems to transpedicular fixation systems has been observed [12–14]. In case of single-level lesions, minimally invasive bridging (extrafocal) posterior instrumentation of the spine are an alternative approach to a long-term immobilization by rigid bracing. Supposed benefits of this method are faster recovery and increased quality of life after minimal surgical intervention [14, 15].

The objective of the study was to compare the effectiveness of conservative treatment and extrafocal transpedicular fixation in patients with uncomplicated hematogenous pyogenic vertebral osteomyelitis (PVO).

Material and Methods

Ninety-seven medical records of in-patients who had been treated for vertebral osteomyelitis in the lumbar and thoracic spine in 2007–2017 were analyzed. Among them, men accounted for 73.2 % and women for 26.8 %, with a male : female ratio of 2 : 1 in the comparison groups. The mean age of male and female patients was 47.8 ± 14.9 and 52.0 ± 17.7, respectively. Lesion types were assessed according to the classification proposed by Pola et al.; pain severity was assessed using the Visual Analogue Scale (VAS); and changes in everyday activities of daily living were assessed by Oswestry Disability Index (ODI).

The following inclusion criteria were used: adult patients who had been treated for hematogenous vertebral osteomy-

elitis in the lumbar and thoracic spine in 2007–2017, both treated conservatively and operated by transpedicular fixation, without intervention on the affected area.

The following exclusion criteria were used: patients with septic infections and neurological impairment (as contraindications to conservative treatment), as well as patients who had undergone other surgical interventions (drainage, debridement, 360-degree reconstruction, or their combination with instrumented fixation). Patients were divided into two groups: 64 (66.0 %) patients were treated conservatively and 33 (34.0 %) patients were operated using extrafocal transpedicular fixation. All the patients underwent antibacterial therapy lasting for 6–12 weeks.

No fixation devices were placed in the affected vertebrae, transpedicular screws were inserted into adjacent intact vertebrae. Four-screw instrumentation with monoaxial screws was used in case of single-segmental lesion, with the exception of patients who underwent fixation of the S1 vertebra. External transpedicular fixation was not used. Twenty-five (75.8 %) patients underwent minimally invasive instrumentation. Patients were activated on day 2–3 after surgery without external immobilization. All the surgeries were performed by the same orthopedic surgeon. The general characteristics of the clinical outcomes are presented in Table 1.

Statistical analysis was carried out using the IBM SPSS Statistics 21.0 and Statistica 6.0 software packages. Quantitative data were presented as the mean and standard deviation of the mean (M ± SD). The Kolmogorov–Smirnov test was used to check the distribution of the quantitative data. The data with normal distribution were compared using Student's t-test for independent samples, and the data with non-normal distribution were compared using the Mann – Whitney test. The data trend was assessed using the Wilcoxon test. The square and Fisher's exact test were used to reveal differences between qualitative parameters. The differences were considered statistically significant at $p < 0.05$.

Results

Good treatment results were obtained in the majority of the patients. Healing was considered as the absence of relapse for a year and recovery of the supporting and motor functions of the spine (91.8 %). Criteria for the termination of the inflammatory process in the spine were significant decrease in the pain severity and general manifestations of the disease, as well as normalization of laboratory inflammation markers (CBC, ESR, and CRP). Procalcitonin test was used as a marker of systemic inflammatory response syndrome (SIRS); however, it was not used to assess the dynamics of the primary disease management because its sensitivity is lower than that of CRP in case of spinal infections [16–18]. The age of patients, number of bed days, pain severity, and assessment according to ODI are presented in Table 2.

There were no differences in pain severity between the comparison groups of the patients who were treated conservatively and underwent stabilization surgery before the start of the treatment and one year after. However, pain severity was significantly reduced ($p = 0.001$) over the time of treatment both in conservatively treated and operated patients. Pain severity was not recorded in the early postoperative period.

The assessment using ODI was carried out in a year or later after treatment initiation because both acute and subacute forms excluded obtaining of correct data during the hospital treatment due to a significant pain syndrome. The main types according to the classification proposed by Pola et al. are as follows. Type A includes cases without biomechanical instability, neurological impairment or epidural abscess. Type B includes cases with radiological evidence of significant bone destruction and/or biomechanical instability without neurological impairment or epidural abscess. Type C includes cases with acute neurological impairment and/or epidural abscess. The distribution of patients according to the classification proposed by Pola et al. is presented in Table 3.

Patients with lesions in the thoracic spine and patients with lesions in the lumbar spine underwent surgical interventions equally as often. However, conservative treatment was more frequently used when the pathologic process affected the lumbar spine and the lumbosacral junction ($p = 0.041$).

The total number of relapses was 8.2 % (n = 8), and that of complications – 3.1 % (n = 3).

Positive results of transpedicular fixation were obtained in 28 (84.8 %) and after three repeated interventions in 32 (94.1 %) cases. In case of conservative treatment, positive results were obtained in 95.3 % (n = 61) of cases.

Among the operated patients of a younger age, there is a tendency to increase the number of relapses ($p = 0.056$) because this age group contains a significant number of i.v. drug abuse patients. They do not always strictly follow the prescribed treatment and doctor's recommendations. The total number of drug addicted patients in the current study was 33 (34.0 %), including 22 (34.9 %) conservatively treated patients and 11 (33.3 %) operated on ones. HIV infection was identified in 78.8 % (n = 26) of drug addicted patients. A combination of viral hepatitis with HIV was found in 38.1 % (n = 37) of the total number of patients.

The risk of relapse in operated drug addicted patients was significantly higher (36.4 %) compared to that in operated patients without addiction (4.5 %; $p = 0.033$).

During conservative management, disease progression was recorded in three patients; later two of them underwent surgical interventions (minimally invasive transpedicular fixation and debridement through the anterior approach because of the development of acute spondylogenic epidural abscess). Five cases of relapse were recorded in the group of operated patients, including four patients with drug abuse.

Disease progression with the formation of psoas abscess due to transpedicular fixation was observed in three patients. They underwent debridement through the retroperitoneal approach;

Table 1

Distribution of patients by sex, forms of disease, and level of spinal lesion, n (%)

Parameters		Type of treatment		p
		conservative	isolated transpedicular fixation	
Sex	male	50 (78.1)	21 (63.6)	0.150
	female	14 (21.9)	12 (36.4)	
Form of disease	acute	24 (37.5)	2 (6.1)	<0.001
	subacute	25 (39.1)	11 (33.3)	
	chronic	15 (23.4)	20 (60.6)	
Department of the spine	thoracic	17 (26.6)	17 (51.5)	0.015
	lumbar	47 (73.4)	16 (48.5)	

There were no differences in terms of sex between groups of conservative and surgical treatment. Surgical treatment prevails significantly ($p < 0.001$) in case of chronic disease form. Surgical treatment prevails significantly ($p = 0.015$) in case of lesions in the thoracic spine.

one patient underwent a revision transpedicular fixation and debridement of bilateral psoas abscesses. Infection in the area of the posterior instrumentations was revealed one year and 10 months after the surgery; the fixation device was removed due the achievement of solid fusion.

The following complications were observed: transpedicular hardware failure (two cases) and purulent coxitis after the course of conservative therapy (one case).

There were no deaths in the comparison groups, due to compliance with tinclusion and exclusion criteria. After the discharge from the hospital, six patients died, including four persons with acute heart attack (within the period from one week to three years); another cause of death was meningoencephalitis, and one case of unknown cause. All the discharged patients were followed up on an outpatient basis for at least a year, and 72.2 % of them were followed up from one to eight years.

Discussion

The key principles of treatment of hematogenous pyogenic vertebral osteomyelitis are antibacterial therapy and immobilization of the affected department of the spine. The presence of complications, such as sepsis or neurological deficit, requires the use of emergency procedures, including emergency surgical treatment after the stabilization of the patient's state. The stage of the pathologic process and presence of complications determine the indications for treatment methods. Conservative treatment is still one of the most effective methods to treat uncomplicated forms of disease [11]. It should be noted that the mean time of diagnosis is subject to significant fluctuations even within the same region, including urban population. However, late diagnosis and the presence of complications make this method ineffective.

Mohamed et al. [19] reported on 15 patients, who had undergone only multilevel rigid transpedicular fixation without debridement of the affected area. In four cases, spinopelvic fixation was implemented; a reoperation was required due to the loss of fixation in the iliac bones in one case. Two more revision surgeries were performed for epidural hematoma and postoperative surgical site infection. The authors recommended multilevel transpedicular fixation as an effective method to treat osteomyelitis of the spine in combination with antibacterial therapy. In the majority of cases, the fixation was present during the entire follow-up period. The effectiveness of transpedicular fixation as the main method of

Table 2

Patient characteristics in terms of age, duration of hospital stay, pain severity, and functional state depending on treatment methods

Parameters	Type of treatment		p
	conservative	isolated transpedicular fixation	
Age, years	51.20 ± 16.00	44.60 ±14.53	0.034
Bed days	26.3 ± 12.1	26.5 ± 13.0	0.647
VAS score before treatment	8.15 ± 2.35	8.53 ± 2.23	0.502
VAS score after treatment	2.45 ±1.82	1.53 ± 1.36	0.125
ODI score a year after	22.7 ± 15.9	16.7 ± 14.0	0.280

Younger patients were operated significantly ($p = 0.034$) more frequently. There were no differences in the duration of hospital stays; this fact can be associated with the duration of parenteral antibacterial therapy.

Table 3

Distribution of patients by the type of lesion depending on treatment type and disease outcome, n

Type	Conservative treatment			Surgical treatment			Total, n (%)
	healing	relapse	total	healing	relapse	total	
A.2	28	–	28	9	1	10	38 (39.18)
A.3	5	–	5	–	–	–	5 (5.15)
A.4	2	–	2	–	–	–	2 (2.06)
B.1	18	3	21	10	2	12	33 (34.02)
B.2	3	–	3	6	–	6*	9 (9.28)
B.3.1	3	–	3	2	2	4	7 (7.22)
C.1	1	–	1	–	–	–	1 (1.03)
C.2	1	–	1	1	–	1	2 (2.06)
Total	61	3	64	28	5	33	97 (100.00)

Types of lesions are given according to the classification proposed by Pola et al. [11].

There were no statistically significant differences in terms of relapse in patients who were operated and treated conservatively depending on types of lesions.

*The number of patients operated on for lesions of the B.2 type ($p = 0.058$) tends to increase.

treatment of osteomyelitis of the spine has been proved by other researchers [14]. The authors reported on a series of 30 cases, meanwhile, only 14 patients underwent interventions through the posterior approach. The mortality was reported to be 10 % of cases. Two patients (7 %) required additional surgical revisions (50 % due to instrumentation failure and 50 % due to surgical site infection).

Herren et al. [1] presented clear criteria of instability at hematogenous pyogenic vertebral osteomyelitis. The instability criteria are segmental kyphosis > 15°, vertebral body collapse > 50 % of its height, and translation > 5 mm. Pola et al. [11] described the criteria of severity of the kyphosis associated with destructive spondylodiscitis with biomechanical instability (B.3.1 < 25°, B.3.2 > 25°).

We practice transpedicular fixation in case of inflammatory lesions of the spine since 2007. Ninety-seven patients were included in the study. Thirty-three patients (34.0 %) were treated using this surgical method only. Minimally invasive transpedicular fixation was performed in 25 (75.8 %) patients. In all cases, the patients underwent antibacterial therapy lasting for 6–12 weeks, including three weeks of parenteral administration.

When a single motion segment in the thoracic or lumbar spine was affected, a short-segment fixation technique with four monoaxial screws was used. Polyaxial screws were used to fix the S1 vertebra or as intermediate fixation devices for minimally invasive insertion of extended instrumentations. The fixation devices were removed in a year or a year and a half after the transpedicular fixation, if there were no relapses and if a solid fusion was achieved. As a result, two spinal motion segments returned to function, and the patients reported decrease in spinal stiffness and improvement of general well-being.

In the group of patients operated with transpedicular fixation, relapses were observed in five (15.2 %) patients. It should be mentioned that four of them were constant i.v. drug abusers. An aspiration biopsy of the affected area was carried out during the instrumented fixation in two patients. The number of relapses was 4.7 % (n = 3) in case of conservative treatment. So, it is necessary to take into consideration a high risk of relapse in drug addicted patients in case of instrumented fixation for uncomplicated vertebral osteomyelitis. This treatment technique may be recommended for patients with uncomplicated hematogenous pyogenic vertebral osteomyelitis with monosegmental lesion and with the absence of paravertebral and epidural abscesses, as well as with a high demand on improved quality of life. The affected spinal segment stabilization contributes to early relief of pain, makes it possible to activate patients as early as on the first few days after the surgery, saves the trouble of wearing spinal braces for a long time, and makes rehabilitation easy at all the treatment stages.

Conclusion

Transpedicular fixation and conservative therapy have demonstrated comparable results in treating uncomplicated hematogenous pyogenic vertebral osteomyelitis within timeframes of more than a year. There were no statistically significant differences in number of relapses among patients who were operated on and treated conservatively, and in different types of lesions. In cases with posterior instrumentation, the risk of relapse is significantly ($p = 0.033$) higher among drug abuse patients; the number of relapses tends to increase in younger patients. Transpedicular fixation is indicated for uncomplicated hematogenous pyogenic vertebral osteomyelitis, monosegmental lesions, and in case of demands on improved quality of life. Using this technique in drug addicted patients is not recommended.

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