



EVALUATION OF DIAGNOSTIC CRITERIA AND CHOICE OF TREATMENT TACTICS FOR PATIENTS WITH INFECTIOUS SPONDYLODISCITIS BASED ON A CASE SERIES

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Objective. To present a brief description of a series of clinical cases of infectious spondylodiscitis with an assessment of the used diagnostic criteria in terms of their influence on the choice of sanitizing treatment tactics.

Material and Methods. A continuous retrospective study of 39 cases of spondylodiscitis was carried out. Level of evidence is IIIC. The level of ESR, serum C-reactive protein, the results of the study of biopsy materials, and CT and MRI data were evaluated. Criteria of neurological deficit, instability of the spinal motion segment, and recommendations for assessing the clinical and radiological severity of the disease were used to select the treatment tactics. Treatment success was defined as primary wound healing, absence of recurrent infection and/or death, and satisfaction with treatment according to the EQ-5D and EQ-VAS scales at a follow-up period of 22.5 months.

Results. The average age of patients was 57.4 years. Primary spondylodiscitis accounted for 82 %, the predominant localization of the pathological focus was the lumbar spine (56.4 %), and staphylococci were predominant etiologic agents (59.1 %). On average, the increase in ESR was 45 mm/h, C-reactive protein — 57 ng/l, and D-dimer — 1235 pg/ml. The level of pain before sanitation according to the VAS scale was 6.79 points, after the operation it was 2.3 points ($p < 0.05$). Instability of the spinal motion segment according to the SINS scale was revealed in 36 cases, paravertebral abscess according to MRI — in 51.3 % of cases, and neurological deficit — in 38.5 % of cases. Severe spondylodiscitis according to the SponDT scale was noted in 53.8 %, moderate — in 43.6 %, and mild — in 2.6 % of patients. According to the clinical and radiological classification of infectious spondylodiscitis severity (SSC), grade I was present in 2 patients, grade II — in 21, and grade III — in 6. Compliance of the chosen treatment tactics with current recommendations was noted in 94.9 % of cases. Recurrence of infection was observed in 7.7 %; lethal outcome — in 5.1 %. Satisfaction with the quality of life according to EQ-5D was 0.74 points, and according to EQ-VAS — 73.88 points.

Conclusions. The integrated use of criteria for neurological deficit, instability of spinal motion segments, and severity of the disease according to the SponDT classification with the account of Pola's recommendations on treatment tactics made it possible to choose the optimal treatment tactics and achieve satisfactory results in the sanitation of patients with infectious spondylodiscitis.

Key Words: infectious spondylodiscitis, diagnosis of spondylodiscitis, spinal infection, paravertebral abscess.

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Infectious spondylodiscitis is an inflammatory disease of the vertebrae and intervertebral discs associated with the hematogenous, lymphogenic, or contact introduction of microorganisms. The inflammatory process often involves adjacent structures with the formation of paravertebral abscesses. The disease results in a disruption of two main functions of the spine: ensuring a stable vertical position of the trunk and protecting spinal nerves.

The incidence of infectious spondylodiscitis has grown in recent years, which,

according to a number of researchers, is associated with an increased frequency of invasive spinal procedures [1]. Other factors contributing to the increase in the incidence of spondylodiscitis are the following: an increase in the number of people with weakened immune systems associated with general diseases; taking immunosuppressants; the consequences of the COVID-19 pandemic; an increase in the population over the age of 70 with a burdened comorbid history (diabetes mellitus, oncological disease, chronic infections); an increase in people's

addiction (drug addiction, alcoholism, smoking) [2–5]. According to the German register, the incidence of infectious spondylodiscitis has been 10.4–14.4 per 100,000 people over the past decade [6]. High mortality rates (from 2 to 20 %) and the pathogenesis of the disease give consideration to the nonspecific infectious process as septic and categorize the disease as potentially life-threatening [7, 8]. Early mortality is most often associated with uncontrolled sepsis [9, 10]. The total number of admissions to the hospital, according to statistics from the National

Service of England, increased by 41 % in 2012–2021 and amounted to 4.4 per 100 thousand population in 2021 with a total incidence rate of septic spondylodiscitis of 10.3 per 100 thousand population [11].

The main objective of the treatment of infectious spondylodiscitis is the elimination of the focus of infection and relief of pain syndrome. Conservative treatment, which is based on etiotropic antimicrobial therapy, is aimed only at achieving this objective. Additionally, a biological material is sampled for microbiological and histopathological examinations and the restoration of injured spinal structures is performed during debridement. Conservative treatment is indicated in the absence of foci of aggressive lesions, signs of spinal cord compression, and instability of the spinal motion segment in the findings of CT and MRI in the presence of severe general pathology that prevents surgical treatment (in addition, external immobilization with a removable orthosis can be used).

Surgical treatment is indicated for the progression of the disease against the background of antimicrobial therapy in the presence of neurological disorders associated with spinal cord compression by epidural abscess, sequestra, etc. in the chronic course of spondylitis, accompanied by clinical complaints (back pain, fistulae), laboratory-assessed activity, and/or the formation of instability or deformity of the spine [12].

The difficulty of verifying the diagnosis, the lack of a reasoned protocol for choosing treatment strategies, and the low alertness of doctors in relation to infectious spondylodiscitis maintain interest in selecting diagnostically significant criteria when deciding on the choice of treatment.

The objective is to present a brief description of a series of clinical cases of infectious spondylodiscitis with an assessment of the diagnostic criteria used in terms of their influence on the choice of sanitizing treatment tactics.

Material and Methods

The continuous retrospective study (level of evidence: IIIC) included patients

who received surgical or conservative treatment for infectious spondylodiscitis at the Federal Center for Traumatology, Orthopedics and Arthroplasty (Cheboksary) in 2019–2022.

The classification of infectious spondylodiscitis and other materials from the draft clinical guidelines for the diagnosis of infectious spondylitis were used in the study [12].

According to a patient's history, concomitant diseases, suspected causes of infectious spondylodiscitis, the fact of antimicrobial therapy before admission to the hospital or at the stage of diagnosis verification, and the period from the onset of the first symptoms of the disease to confirmation of the diagnosis were analyzed. According to the clinical examination, physical findings were evaluated: the level of pain syndrome during admission to the hospital and at the stage of follow-up according to VAS [13], the presence of fever and neurological disorders according to the Frankel scale [14].

The following parameters of the SINS (Spinal Instability Neoplastic Score) were used to evaluate the instability of the spinal motion segment: location, pain, spinal lesion, shape of the spine, condition of the vertebral body and posterolateral structures of the vertebra. The condition of the spine was considered stable at 0–6 points, potentially unstable at 7–12 points, and unstable at 13–18 points [15].

At the preoperative stage, the indicators of a complete blood count with ESR, the level of C-reactive protein (CRP), presepsin and procalcitonin (regardless of the presence of signs of a septic process), and the results of a triple blood culture for sterility were evaluated. CT and MRI findings of the involved spine region were of interest.

During debridement, a biological material (tissue biopsy slices) was taken from all patients, followed by the isolation of microorganisms in accordance with approved standards for microbiological examinations. The sampling of biological material from patients receiving conservative therapy was performed in the operating room by needle aspiration from the disc space under the con-

trol of an electron-optical converter with X-ray navigation.

The severity of spondylodiscitis was assessed on the SponDT (Spondylodiscitis Diagnosis and Treatment) scale, which includes an assessment of the results of CRP and pain according to VAS and MRI data [16].

An overall assessment of the spine lesion type to identify possible treatment strategies was performed using the classification of Pola et al. [17] based on three criteria: visualized destruction of vertebrae with mechanical instability, epidural component, and neurological disorders.

When choosing the final treatment strategy, guidelines based on the clinical and radiological classification of the severity of spondylodiscitis (SSC, 2010) were used, including a comprehensive evaluation of the criteria of the SponDT scale, neurologic deficit, and bone destruction, depending on the severity of the process [18, 19].

The treatment outcomes were assessed based on the results of an examination or telephone survey with a patient at the follow-up stage. Primary wound healing, absence of recurrence of the infectious process and/or lethal outcome (for any cause) were considered to be the success of treatment. Patients' satisfaction with the quality of life was evaluated on the EQ-5D and EQ-VAS scales, as well as on the changes in the severity of pain syndrome before and after surgery according to VAS. The period of follow-up of patients from the moment of debridement averaged 22.5 months (CI = 95 %; SD = 2.6; 16.4–27.0).

Statistical data processing. The data obtained was recorded in the spreadsheets, visualization of the data structure and their analysis were performed using the MS Office Excel 2007 (Microsoft, USA) and GrafPad software. To describe the quantitative indicators, the normality of the distribution was verified according to the Kolmogorov-Smirnov test. If the distribution was normal, its mean value and standard deviation with a 95% CI were used to describe the sign. Categorical data (gender, type of confirmed disability progression, outcome) were described by conditional codes of

unmeasured categories that were not to be ordered.

Results

The study group included 39 patients aged 50–60 with septic spondylodiscitis; male patients predominated. In general, overweight/obesity and comorbidity were reported in the cohort with a predominance of type 2 diabetes mellitus as a concomitant pathology (23.1 % of cases). The incidence of hepatitis C and HIV infection was reported only in male patients ($p = 0.4899$ and $p = 0.1100$, respectively). The period from the moment of clinical manifestations of the disease to the verification of septic spondylodiscitis was more than 3 months, while 2/3 of patients received antimicrobial therapy at the prehospital phase, which complicated the clarification of the etiology of the infectious process (Table 1).

There was an increased incidence rate of septic spondylodiscitis with an upsurge during the COVID-19 pandemic (2021–2022): 48.7 % of 39 cases of septic spondylodiscitis were detected in 2022 (Fig.).

Primary septic spondylodiscitis occurred 4.6 times more often than secondary (after surgery). 11 (28.2 %) out of 39 cases of septic spondylodiscitis developed after coronavirus infection, equally in men ($n = 5$) and women ($n = 6$). Patients started treatment at the subacute or chronic stage of the disease. Septic spondylodiscitis mainly had a pyogenic etiology with a prevalence of the pathological process in the lumbar spine (Table 2).

Spinal instability according to SINS (more than 12 points) was detected in 36 cases, potentially unstable spinal motion segment in 2 cases and lack of instability in 1 case.

Among the diagnostic criteria, attention was drawn to the clinical combination of neurological signs, pronounced pain syndrome, and a high temperature response (up to febrile values). Neurological symptoms (deficit) of the study group (38.5 %) were characterized by a decreased or increased muscle tone,

decreased or brisk tendon or periosteal reflexes, reduction of sensory, including by the conductor type, hypotrophy, and a reduction of muscle strength up to 3.5 points. There were also changes in statics and flattened curvature of the spine, limited motion in the spine, the impossibility of independent walking, painfulness of palpation in the affected area, a positive straight leg raising test, radiculopathy or radicular ischemia, paresis of the foot or hip, and contractures. There were no neurological signs in 61.5 % of cases. Laboratory tests show the increased ESR to an average of 45 mm/h, CRP at 57 ng/l, and D-dimer up to 1,235 pg/ml. According to MRI findings, every second patient suffers from a paravertebral abscess in the soft tissues of the affected spine region with a mean longitudinal size of up to 20.05 mm (95 % CI: 10.12–29.28; Table 3).

MRI findings were compared with the morphological stages of spondylodiscitis [1]: type 1 (spondylitis or discitis) was detected in 2.6 % of cases; type 2 (spondylodiscitis) in 46.2 %; and type 3 (spondylodiscitis with paravertebral abscess) in 51.3 %.

The negative result of the bacteriological examination of tissue biopsy slices in infectious spondylodiscitis was 41 %, which is probably associated with antimicrobial therapy at the prehospital phase. Tuberculosis was later verified in one of these patients. Microbial associations amounted to 2.6 % of all cases. The leading place among the pathogens of the infectious process was taken by *Staphylococcus* (59.1 %), followed by gram-negative microorganisms (18.2 %). A blood culture for sterility was taken and showed a positive result in two examined patients.

In the study group, patients with a severe degree of pathological process prevailed (Table 4).

According to the clinical and radiological classification of the severity of infectious spondylodiscitis (SSC, 2010), patients were divided as follows: 2 patients with severity grade I, 21 patients of grade II, 6 patients of grade III.

According to the NCPS classification [17], 2 cases belong to type A, 10 cases to type B, and 17 cases to type C (Table 5).

Conservative treatment was performed in 4 patients, surgical treatment in 35 patients.

Compliance of the treatment strategy with the current guidelines was noted in 94.9 % of cases; inconsistency was noted in two cases of treatment of type C.4 spondylodiscitis with neurological signs and spinal instability. In the first case, a conservative treatment technique was selected due to the incidence of concomitant cancer with metastasis; in the second case, a debridement was performed without subsequent stabilization of the spine (in a patient with an advanced HIV infection). Two more patients with type C.4 spondylodiscitis underwent 2-stage stabilization by anterior and posterior fusion with spinal cord decompression with an interval between stages of 1.5 and 6 months, which does not contradict the recommendations of Pola [17].

The mean duration of antimicrobial therapy performed at the inpatient stage was 12 days and 72 days at the outpatient stage (the total course was about 12 weeks).

Physical therapy, breathing exercises, polarized light, and pneumocompression were mainly used for the rehabilitation of patients.

Recurrences in the form of deep surgical site infection at the stage of follow-up were detected in 3 (7.7 %) patients; the wounds underwent debridement.

The fatal outcome was registered in 2 (5.1 %) cases: one patient died 14 months after primary debridement from the progression of the bladder cancer process with liver metastases; the second one had a burdened comorbid history (HIV infection) and died one year after conservative treatment of recurrence due to mesenteric artery thrombosis with peritonitis.

Therefore, the debridement was successful in 33 (94.3 %) out of 35 cases.

In case of successful debridement, the patients were satisfied with quality of life at 0.74 points (95 % CI 0.67–0.80)

Table 1

Features of patients with septic spondylodiscitis

Parameters		Group with spodylodiscitis
Gender, n (%)	Male	21 (53.8)
	Female	18 (46.2)
Mean age, years		57.38 (95 % CI; 53.55–61.22)
Mean BMI, kg/m ²		27.4 (95 % CI; 25.7–29.2)
Concomitant pathology, n (%)		
Diabetes mellitus		9 (23.1)
Oncological disease		3 (7.7)
HIV infection		2 (5.1)
Hepatitis C		4 (10.3)
General diseases		3 (7.7)
Patients who received antimicrobial therapy at the prehospital phase, n (%)		26 (66.7)
Time from the disease onset to diagnosis verification, days		109.2 (95 % CI; 79.1–139.3)

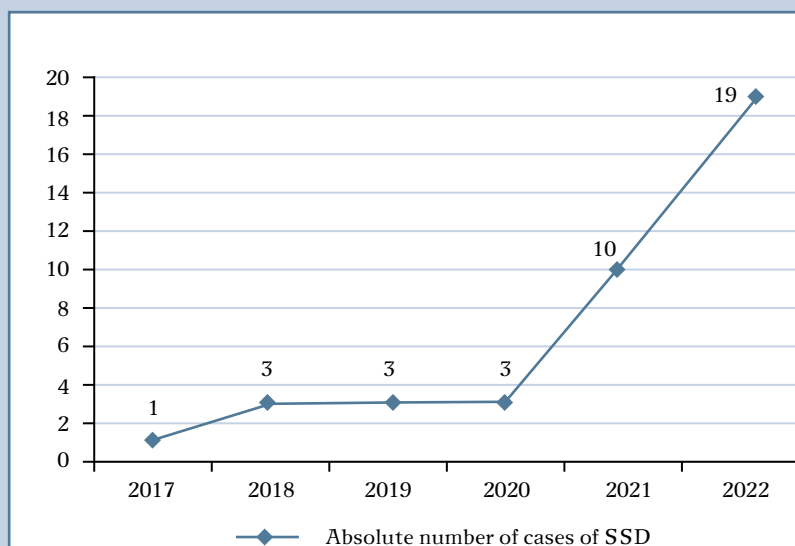


Fig.

Dynamics of cases incidence of septic spondylodiscitis (SSD) identified and treated in 2017–2022

according to the EQ-5D questionnaire (from 0 to 1 points), at 73.88 points (95 % CI; 67.7300–80.03) according to the EQ-VAS scale (from 0 to 100 points). Moreover, patients reported a significant reduction in pain syndrome according to VAS with points dropping to 2.3 (95 % CI; 1.76–2.85), $p < 0.05$.

Discussion

The problem of infectious spondylodiscitis has become more urgent in recent years due to the increasing incidence and difficulties in diagnosis. Infectious spondylodiscitis can be referred to as a chameleon, since the primary process

can be masked by various diseases unrelated to the spine.

In 2022, at the request of the French Infectious Diseases Society (SPILF, Société de Pathologie Infectieuse de Langue Française), clinical guidelines for the diagnosis and treatment of disco-vertebral infections in adults were published. According to them, clinical situations have been identified that give reasons to suspect an infection in the spine: a recent-onset or increasingly pronounced pain in the infected spine. This analysis was performed in two intact patients who did not receive antimicrobial therapy. Moreover, the blood culture results of both individuals were positive, which confirms the high diagnostic value of this laboratory test.

The diagnostic value of MRI examinations, discussed in the draft clinical guidelines for the diagnosis of infectious spondylitis (2018), is estimated at 95 % sensitivity with 81 % specificity [18]. Meanwhile, Homagk et al. [1] note that spondylodiscitis is not detected in 6.1 % of patients during MRI with contrast. Our results showed 100 % visualization that may be associated with diagnosis at a late stage of the disease.

According to Bettini et al. [25], the diagnosis verification occurs with a significant delay after the onset of the first symptoms and can reach 2–6 months. In a French study directed by Le Pluart et al. [26], the mean diagnostic delay was 22 days in a cohort of 250 patients [27]. Meanwhile, in the Italian cohort (207 cases of septic spondylodiscitis treated from 2008 to 2016, followed by a 2-year follow-up) the median diagnostic delay was 30 days [27]. Unfortunately, in our study the mean delay in diagnosis reached 109.2 days, which proves less difficulties of verifying the diagnosis than the persistent domestic problem of timely diagnosis of the pathology under consideration.

According to the literature, men are affected 1.5–2 times more often than women. In the German population, this ratio has not fluctuated over the past 11 years and remains at the level of 1.0:1.5 [6]. According to information from the English register, from 2012 to 2021, there

Table 2

Classification features of spondylodiscitis [12] in the study group

According to the focus of infection		
Primary — 32 (82.05 %)	Hematogenous — 31	After herpetic infection — 1; after COVID — 11; after hypothermia — 8; HIV associated — 2; no visible focus — 9
	From adjacent foci of infection — 1	Intestinal obstruction with abscess — 1 (according to the pathogenesis such spondylitis can be classified as hematogenous, since infection occurs through the system of Batson veins, unless there is direct contact of the retroperitoneal abscess with the spine)
Secondary — 7 (17.95 %)	After surgery	
According to the clinical course		
Acute	5 (12.8 %)	
Subacute	18 (46.2 %)	
Chronic	16 (41.0 %)	
According to the localization		
Cervical spine	1 (2.6 %)	
Thoracic spine	8 (20.5 %)	
Lumbar spine	22 (56.4 %)	
Sacrum	8 (20.5 %)	
According to the etiology		
Pyogenic	38 (97.4 %)	
Granulomatous	1 (2.6 %)	
Parasitic	0 (0.0 %)	

Table 3

Diagnostic criteria

Clinical picture		
Types of neurological deficit according to the Frankel scale, n (%)	A (no sensory and motor function below level of lesion)	1 (2.6)
	B (incomplete loss of sensory function below level of lesion, no motor function)	5 (12.8)
	C (incomplete loss of sensory function below level of lesion, some motor function)	3 (7.7)
	D (incomplete loss of sensory function below level of lesion, muscle strength sufficient to walk with assistance)	6 (15.4)
	E (motor and sensory function are fully preserved)	24 (61.5)
Febrile temperature response, degrees		38.3 (95 % CI; 38.08–38.52)
Pain before debridement according to VAS scale, points		6.79 (95 % CI; 6.45–7.15)
Laboratory research		
Blood leukocytes, 10 ⁹ cells/l		7.9 (95 % CI; 7.1–8.8)
ESR, mm/h		45.6 (95 % CI; 35.8–55.4)
CRP, ng/l		57.6 (95 % CI; 38.5–72.9)
D-dimer, pg/ml		1235.2 (95 % CI; 927.0–1543.0)
MRI picture		
Paravertebral abscess, n (%)		20 (51.3)
Longitudinal size of paravertebral abscess, mm		20.05 (95 % CI; 10.12–29.28)

was an increase in the imbalance in the incidence of spondylodiscitis in men and women (from 1.79 to 1.82). The authors associate the increased prevalence of infectious spondylodiscitis in men with a high incidence of diabetes mellitus, immunosuppression, and renal failure among the male population [11]. In our study, the ratio of women and men is slightly biased towards the male gender (1.00 : 1.17) in the absence of a statistically significant difference in comorbidity.

The etiology of lumbar spondylodiscitis is very heterogeneous and remains unknown in 34 % of patients [28]. In our study, the absence of growth of the pathogen was 41 %, which we attribute to preventive antimicrobial therapy at the prehospital phase, including uncontrolled use of antimicrobial drugs by patients during the COVID-19 pandemic. Indirectly, this hypothesis may be supported by the fact that the maximum increase in the number of spondylodiscitis occurs exactly from 2020 to 2022. The issue of defining the etiology of the disease, in turn, results in irrational antimicrobial therapy and an increase in the duration and cost of treatment.

The issue of treatment strategy for infectious spondylodiscitis remains disputable. Prolonged persistence of symptoms before diagnosis increases the risk of ineffective treatment [29]. In a study by Hohenberger et al. [30], which consisted of 54 cases of infectious spondylodiscitis, it was shown that choosing posterior spinal fusion in the early stages of diagnosis results in recovery in a shorter period of time.

The proposed treatment strategy for spondylodiscitis, depending on the degree of bone destruction or instability of the spinal segment and the incidence of a paravertebral abscess or neurological deficit [17], may be useful for spine surgeons.

A.Yu. Bazarov [19] proposed to supplement the classification of Pola with subtypes reflecting the incidence of sepsis in types A and B. Previously in the literature, sepsis was not considered in the treatment of spondylodiscitis, although the systemic inflammatory response syndrome may require debridement

Table 4

Assessment of the spondylodiscitis severity according to the SponDT scale

Severity	Points	Patients, n (%)
Mild	1–2	1 (2.6)
Moderate	3–5	17 (43.6)
Severe	6 or more	21 (53.8)

of the lesion and additional delayed stabilization.

Despite the existing differences between our treatment strategy (mainly debridement with a posterior approach followed by spine stabilization) and the guidelines of Pola, the success of the debridement was achieved in 94.3 % of cases.

Fatal outcomes were 7.7 %. Similar data with the successful infection debridement at 90.9 %, residual disability at 23.5 %, and mortality at 7.8 %, were obtained by Pola et al. [27].

In a recent study by Behmanesh et al. [31], the quality of life after surgical and conservative treatment of 210 cases of infectious spondylodiscitis according to the SF-36 questionnaire showed the best outcomes in operated patients. According to our data, the assessment of the effectiveness of both surgical and conservative treatment showed satisfactory outcomes in terms of the quality of life of the treated patients with a significant decrease in the severity of pain syndrome and restoration of motion activity.

Conclusion

A brief description of a series of clinical cases of infectious spondylodiscitis has allowed an evaluation of the used diagnostic criteria and their impact on the choice of debridement. The comprehensive use of criteria for neurological deficit, instability of the spinal motion segment, and severity of the disease according to the SponDT classification in the light of Pola recommendations on treatment strategies has provided satisfactory outcomes in the debridement of patients with infectious spondylodiscitis.

The study had no sponsors. The authors declare that they have no conflict of interest.

The study was approved by the local ethics committees of the institutions. All authors contributed significantly to the research and preparation of the article, read and approved the final version before publication.

Table 5

Distribution of patients depending on the type of spondylodiscitis according to the NCPS classification [17] and type of treatment

Type of spondylodiscitis	Patients, n	Type of treatment					
		Conservative therapy + external fixation	Debridement	Debridement + TPF	Debridement + TPF + spinal fusion	Spinal fusion + discectomy	Decompression + staged anterior and posterior spinal fusion
A.1	1	1	—	—	—	—	—
A.2	1	—	—	1	—	—	—
A.3	0	—	—	—	—	—	—
A.4	0	—	—	—	—	—	—
B.1	1	1	—	—	—	—	—
B.2	0	—	—	—	—	—	—
B.3	9	—	—	4	5	—	—
C.1	0	—	—	—	—	—	—
C.2	11	1	—	—	9	1	—
C.3	0	—	—	—	—	—	—
C.4	16	1	1	—	10	2	2
Total	39	4	1	5	24	3	2

TPF — transpedicular fixation.

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