Failure modes in conservative and surgical management of infectious spondylodiscitis

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Abstract

Purpose and methods We reviewed the management, failure modes, and outcomes of 196 patients treated for infectious spondylodiscitis between January 1, 2000 and December 31, 2010, at the Spinal Unit, Aarhus University Hospital, Aarhus, Denmark. Patients with infectious spondylodiscitis at the site of previous spinal instrumentation, spinal metastases, and tuberculous and fungal spondylodiscitis were excluded.

Results Mean age at the time of treatment was 59 (range 1–89) years. The most frequently isolated microorganism was *Staphylococcus aureus*. The lumbosacral spine was affected in 64 % of patients and the thoracic in 21 %. In 24 % of patients, there were neurologic compromise, four had the cauda equina syndrome and ten patients were paraplegic. Ninety-one patients were managed conservatively. Treatment failed in 12 cases, 7 patients required re-admission, 3 in-hospital deaths occurred, and 5 patients died during follow-up. Posterior debridement with pedicle screw instrumentation was performed in 75, without instrumentation in 19 cases. Seven patients underwent anterior debridement alone, and in 16 cases, anterior debridement was combined with pedicle screw instrumentation, one of which was a two-stage procedure. Re-operation took place in 12 patients during the same

hospitalization and in a further 12 during follow-up. Two in-hospital deaths occurred, and five patients died during follow-up.

Patients were followed for 1 year after treatment. Eight (9 %) patients treated conservatively had a mild degree of back pain, and one (1 %) patient presented with mild muscular weakness. Among surgically treated patients, 12 (10 %) had only mild neurological impairment, one foot drop, one cauda equine dysfunction, but 4 were paraplegic. Twenty-seven (23 %) complained of varying degrees of back pain.

Conclusions Conservative measures are safe and effective for carefully selected patients without spondylodiscitic complications. Failure of conservative therapy requires surgery that can guarantee thorough debridement, decompression, restoration of spinal alignment, and correction of instability. Surgeons should master various techniques to achieve adequate debridement, and pedicle screw instrumentation may safely be used if needed.

Keywords Infectious spondylodiscitis · Vertebral osteomyelitis · Surgical management · Spine infection · Spondylodiscitis complications

Introduction

The annual incidence of infectious spondylodiscitis in Western societies ranges from 0.4 to 2.4 cases per 100,000 population. The condition is being diagnosed with increasing frequency due to the increasing numbers of elderly and immunocompromised patients, increasing use of invasive spinal procedures, and the greater availability of magnetic resonance imaging (MRI) [4]. Etiologically, spinal infections can be described as pyogenic, granulomatous

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(tuberculous, brucellar, fungal), and parasitic. Pyogenic infection is most frequent, and *Staphylococcus aureus* is the predominant pathogen, infecting spine mostly through the hematogenous arterial route from a distant focus. Spinal infection is dangerous and can be devastating. Early diagnosis and prompt management are crucial. Consensus regarding the diagnosis exists. A combination of history, clinical, laboratory and microbiological findings are crucial, and MRI has become the imaging modality of choice [7]. Contrary to diagnostics, treatment measures are still widely discussed. If spondylodiscitis is diagnosed early and there are no complications, it can be successfully treated conservatively [2, 18]. It is also obvious that the failure of conservative measures, compression of neural elements, mechanical derangement (instability, malalignment, severe bone destruction), and intractable pain demands surgery that can guarantee thorough debridement, decompression, restoration of spinal alignment and correction of instability [7, 8, 18]. However, surgeons still discuss staging, surgical access, and usage of instrumentation or cages [3, 14, 15, 20]. Furthermore, minimally invasive and endoscopic surgeries are being promoted [9, 11]. Treatment of infectious spondylodiscitis in children, geriatric patients, and patients with multiple risk factors can be very challenging and gives cause for intense discussions [10, 13, 19].

With this paper, we share our knowledge on the management of infectious spondylodiscitis. We present the experience based on 10-year period, from 2000 to 2010. Furthermore, we discuss the changes in our strategies and treatment that have taken place since the study by Karadimas et al. [12] that reviewed the treatment of spondylodiscitis treated at our clinic between 1992 and 2000.

Patients and methods

We retrospectively reviewed 219 patients who underwent treatment for infectious spondylodiscitis between January 2000 and December 2010. All patients were treated at the Department of Orthopedic Surgery, Spine Unit, Aarhus University Hospital, Denmark. Patients with infectious spondylodiscitis at the site of previous spinal instrumentation procedures, eight patients with spinal metastases or primary tumors, and two cases of fungal and 13 cases of tuberculous spondylodiscitis were excluded. We reviewed medical records, radiological imaging, and bacteriologic results. Data were analyzed regarding demographics, risk factors, diagnostics, level of spinal injury and complications, bacteriology, management and hospitalization, and outcome. After exclusions, 196 patients were available for the study, 106 men and 90 women. Mean age at the time of treatment was 59 (range 1–89) years. Only 8 patients were younger than 18 years, whereas 24 were 80 years or older

(Table 1). No risk factors were seen in 72 patients, whereas at least one was found in all the others. Table 2 shows the most common risk factors and concomitant diseases identified in 124 patients.

The diagnosis of infectious spondylodiscitis was established by a combination of clinical history, physical examination, results of the tests of inflammatory markers, radiological assessment, and MRI. Patients were symptomatic for an average of 7.5 (SD $\pm$ 6) weeks before admission to the Spine Unit. Back pain was the most common sign at debut of symptoms and was found in 142 (72.4 %) patients. In 39 patients (19.8 %), back pain was accompanied by fever, and in 8 patients, varying degrees of neurological impairment (weakness or mild dysesthesia) were seen. On the day of diagnosis, 177 (90.3 %) patients had back pain, 47 patients (24 %) had neurologic compromise: 4 had the cauda equina syndrome, 10 (5.1 %) were paraplegic. One-hundred and thirty-seven (69.8 %) patients were treated for other infectious diseases before diagnosis of infectious spondylodiscitis was established. Ninety patients were treated for infectious disease with antibiotics without a definite known focus, others for evident reasons (pneumonia in 15, bacteremia in 12, endocarditis in 8, infectious arthritis plus surgery in 7, and subcutaneous abscesses in 5). Before admission to the Spine Unit, 154 patients (78.5 %) had been hospitalized for an average of 15 (SD $\pm$ 15) days. The majority (130 patients) had been hospitalized in medical departments, 20 in surgical departments and four in an intensive therapy unit. In 9 cases, the diagnosis was established by the family doctor, in 33 cases at outpatient clinics.

Lumbosacral spine was affected in 125 patients (63.7 %) and was the most commonly involved region. Forty-two (21.4 %) patients had involvement of the thoracic and 9 (4.5 %) of the cervical spine, 427 infected levels being identified (see Table 3). In 12 (6 %) cases, the spine was affected at multiple levels, with a total involvement of 54 levels (average 4.5). In 75 (38.2 %) cases, infectious spondylodiscitis was complicated by epidural abscess, whereas in 35 (17.8 %) patients, psoas and in 16 (8 %) paravertebral abscesses were found. Radiology revealed vertebral body destruction in 31 (15.8 %) patients, 24 (12.2 %) of them had a significant deformity associated with segmental instability. MRI detected spinal-cord compression signs in 36 (18.3 %) cases.

On the day the diagnosis was made, 137 (69.8 %) patients were receiving antibiotics. Needle biopsy under CT guidance was performed in 19 (9.6 %) cases, only two were positive. Perioperative biopsies were diagnostic in 61 cases (52.1 % of all patients undergoing surgery). Eighty patients with negative biopsy cultures had positive blood cultures that led to the identification of the causative microorganism in altogether 143 (72.9 %) patients.

Table 1 Distribution of patients according to age and sex

	0–10 years	11–20 years	21–30 years	31–40 years	41–50 years	51–60 years	61–70 years	71–80 years	81–90 years
Total (n)	7	1	0	15	24	48	45	34	22
Men (n)	3	0	0	8	17	29	25	15	9
Women (n)	4	1	0	7	7	19	20	19	13
Total (n)		8			87			101	

Table 2 Risk factors and concomitant diseases

	Patients (n)	A	B
Diabetes mellitus	23	7	16
Cancer	17	6	11
Chronic back pain	13	3	10
Adipositas	12	3	9
Renal insufficiency (dialysis)	7	1	6
Polyarthritis	6	3	3
Immunosuppression	22	9	13
Prednisolone	13	6	7
Methotrexate	4	2	2
Biological anti-inflammatory agents	2	0	2
HIV	1	0	1
Cancer chemotherapy	2	1	1
Tobacco abuse	56	19	37
Alcohol abuse	29	6	23
Intravenous drug abuse	13	2	11

A patients (n) treated conservatively

B patients (n) treated surgically

Table 3 Distribution of affected spine levels

	Patients (n)	1 level	2 levels	3 levels	≥4 levels
Cervical	9	–	7	2	–
Cervicothoracic	1	–	1	–	–
Thoracic	42	10	31	–	1
Thoracolumbar	7	0	4	2	1
Lumbar	101	5	90	4	2
Lumbosacral	24	–	20	4	–
Sacral	0	–	–	–	–
Multiple regions	12	–	–	1	11
Patients (n)	196	15	153	13	15

Staphylococcus aureus was the most frequently isolated microorganism, 81 strains (56.6 %). Twenty (13.3 %) strains were diagnostic for *Enterobacteriaceae* (17 *Escherichia coli*), 13 (9 %) for non-hemolytic streptococci, and 8 (5.5 %) for hemolytic streptococci. Six (4.1 %) cases of coagulase-negative staphylococci, three (2 %) *Propionibacterium*, and two (1.3 %) cases of *Pseudomonas* were identified. Various kinds of *Proteobacteria*, *Corynebacterium*, *Peptostreptococcus* and *Clostridium* were detected as

single cases. One case was polymicrobial. In most cases, it was not possible to detect a distant focus of the spinal infection on the basis of medical records. In 15 patients, the focus was in the oral cavity. Endocarditis was the source of infection in 8 patients, skin infections in 19. An iatrogenic etiology was established in 20 (10.2 %) cases (5 epidural procedures, 3 facet joint blocks, 12 prolapsed intervertebral disk surgeries).

Results

Conservative treatment

Conservative treatment was applied to 91 (46.4 %) patients. The average age in this group was 58 years, range 1–88 years. Fifty-six (61.5 %) were men. Patients were symptomatic for an average of 8 weeks, range 1–30 weeks, before diagnosis was established. Before diagnosis was achieved, 69 (75.8 %) patients had been hospitalized for an average of 15 days, range 1–57 days. On the day of diagnosis, 60 (65.9 %) patients were being treated with antibiotics, 80 (87.9 %) patients complained of back pain, five (5.4 %) patients had mild neurological impairment, and one (1 %) presented with the cauda equina syndrome. In 15 (16.4 %) patients, spondylodiscitis was complicated by epidural abscess, whereas in 11 (12 %), psoas, and in 6 (6.5 %), paravertebral abscesses were found. One (1 %) patient had vertebral body destruction. MRI detected spinal cord compression in two (2.1 %) patients. Diagnostic needle biopsy under CT guidance was done in 18 cases. Only two were positive, but the causative bacteria were identified in 49 (53.8 %) patients based on positive blood strains and a known infectious agent at a distant focus.

Treatment consisted of immobilization with a spinal brace in 83 (91.2 %) patients, and antibiotics were administered to all patients. Psoas abscesses were drained by a radiologist under ultrasonographic guidance. Intravenous antibiotics were administered until a significant decrease in C-reactive protein (CRP) was seen and for a minimum for 2 weeks. Parenteral therapy was followed by oral antibiotics for a total of 3 months. In several cases, up to 6 months depending on time for CRP, white blood cell count (WBC), and the erythrocyte sedimentation rate

(ESR) level returned to normal. Antibiotic therapy was coordinated and adjusted by specialist from microbiological department during weekly interdisciplinary meetings regarding spondylodiscitis patients. Dicloxacillin was the drug of the choice for the initial empirical antibiotic therapy, which was then adjusted after identification of microorganisms and their sensitivity to antibiotics. In the case of penicillin intolerance, cefuroxim was used. The patients' family doctors monitored CRP, WBC, and ESR every 2 weeks. If infectious parameters increased, patients were admitted for intravenous antibiotic therapy.

Conservative treatment failed in 12 (13.1 %) patients (8 women), aged from 39 to 83 years (average 62). The microorganism involved was identified in eight. In six patients, surgery was performed due to the progression of infection verified by laboratory tests and MRI. Progressive neurologic deficits in two, deformity in one, and incapacitating pain in three patients made surgery necessary. One patient required surgery 6 months after establishing the diagnosis; in the others, the average was 35 (SD $\pm$ 24) days. We had three in-hospital deaths among the patients treated conservatively. A 61-year-old man was admitted to the Spine Unit with severe septic shock and died 5 days later due to pulmonary embolism. A 79-year-old woman was transferred to the Spine Unit in a critical condition due to severe bilateral pneumonia and respiratory failure. This patient died 12 days after verification of the spinal infection. The treatment of an 80-year-old man was complicated by septic shock and heart failure and resulted in death 4 days after the diagnosis of infectious spondylodiscitis. A detailed review of all in-hospital complications is listed in Table 4. Average stay at the Spine Unit was 20 ± 15 days. After discharge from the Spine Unit, 19 (20.8 %) patients continued treatment at the department of primary hospitalization.

Table 4 In-hospital complications in patients managed conservatively

	Patients (n)
Hypersensitivity reaction to dicloxacillin	7
In-hospital death	3
Pneumothorax (due to central venous catheter)	2
Atrial fibrillation	1
Endocarditis	1
Hepatic coma	1
Infectious coxitis	1
Pleuritis	1
Pulmonary edema	1
Quinckes ødem	1
Renal failure	1

Five (5.4 %) patients died during follow-up due to the causes not directly related to the spinal infection. Seven (7.6 %) patients managed conservatively were readmitted during the follow-up period due to an increase in infectious markers and were treated with a course of intravenous antibiotics. Eleven patients were lost to follow up, eight died and three were lost due to unknown causes. At 1-year follow-up, eight (8.7 %) patients had a mild degree of back pain, and one (1 %) patient presented mild muscular weakness.

Surgical treatment

The indications for surgery include one or combination of the following: neurologic compromise, significant vertebral body destruction with segmental instability, epidural abscess formation, intractable back pain, or failure of medical treatment. Surgical debridement was combined with antibiotic therapy using the same algorithm as for the conservative management of spondylodiscitis. During surgery, biopsies were always taken and sent for microbiological, pathological and polymerase chain reaction (PCR) examination. Only 61 (52.1 %) perioperative biopsies were diagnostic. A total of 117 (59.6 %) patients needed surgery. The average age in this group was 61 years, range 32–89 years; 66 (56.4 %) were men. Twelve patients underwent surgery after failure of conservative treatment. In 20 patients, surgery was carried out on the day the spinal infection was diagnosed and in 57 patients, within 48 h after verifying the diagnosis of spinal infection. Patients were symptomatic for an average of 7 weeks, range 0–34 weeks, before the diagnosis was established.

Before the spinal infection was diagnosed, 85 (72.6 %) patients were hospitalized for an average of 14 days (range 1–77 days). On the day of diagnosis, 80 (68.3 %) patients received antibiotics; all complained of back pain. Forty-six (39.3 %) had neurologic compromise, 3 (2.5 %) of them presented with the cauda equina syndrome, 10 (8.5 %) were paraplegic. In 60 (51.2 %) cases, infectious spondylodiscitis was complicated by epidural abscess. Psoas abscess was present in 24 (20.5 %), paravertebral in 10 (8.5 %) patients. Radiology revealed vertebral body destruction in 30 (25.6 %) patients, 24 (20.5 %) of them had significant deformity associated with segmental instability. MRI detected spinal cord compression signs in 34 (29 %) cases.

Four surgical methods were used: posterior debridement alone, posterior debridement with pedicle screw instrumentation, anterior debridement alone, and anterior debridement combined with pedicle screw instrumentation. The term “anterior debridement” indicates operations reaching the spine through real anterior-retroperitoneal, transthoracic, and Smith–Robinson approaches. Radical

debridement was combined with collagen sponges containing the aminoglycoside antibiotic gentamicin. An allogeneous cancellous bone graft (frozen femoral head) was usually used to achieve anterior interbody and posterolateral bone fusion. In cases we applied anterior debridement, three-cortical bone graft was used to achieve anterior column reconstruction. Psoas abscesses were drained perioperatively or by a radiologist using ultrasonographic guidance. In 19 patients, posterior decompression and debridement were performed without pedicle screw instrumentation. Patients were placed in the prone position after administration of a general anesthesia. A posterior midline approach was used to expose the posterior spinal elements. A laminectomy was then performed. Pus, if encountered, was drained, and infected discs, endplates, and soft tissues were debrided. The average operating time was 128 min (range 60–240 min). Intraoperative blood loss was 430 ml (range 100–1,500 ml). No perioperative complications were observed. A spinal brace was used in 17 cases. Surgical wounds became infected in two patients, one needed revision. Posterior decompression alone failed in two cases. Due to increasing deformity and pain, patients were re-operated on during the same hospitalization (7 and 23 days after the first operation). The spine was stabilized with the pedicle screws system.

Posterior debridement with pedicle screw instrumentation was performed in 75 cases. Patients were operated on in the prone position via a posterior midline approach. Continuous X-ray fluoroscopy was used to achieve certain screw positioning. Infected discs, endplates, and soft tissue were revised. Allogeneous bone graft was used to achieve posterolateral bone fusion, and in 40 cases also for anterior interbody fusion, which in 32 cases was achieved through a transforaminal lumbar interbody fusion (TLIF) procedure. On average, posterior debridement and decompression with pedicle screw instrumentation took 210 min (range 120–390 min). The average blood loss was 1,050 ml (range 150–4,600 ml). A supplementary brace was applied to 14 patients. Perioperative complications included one case of dura mater lesion and four cases of profuse bleeding. There was one in-hospital death in this group. An 89-year-old man died 4 days after operation due to acute respiratory failure. Nine patients needed urgent re-operation, three due to postoperative hematoma formation compromising neurological status and another three due to surgical wound insufficiency. A further three patients were re-operated because of progression of spinal infection verified by MRI. During follow-up, eight patients were re-hospitalized via the out-patient clinic due to material failure (six due to loosening, one to skin irritation, and one to screw fracture). In these patients, bone fusion had already been achieved, making possible removal of pedicle screw systems.

All seven patients who underwent anterior debridement alone had affected cervical spine. Anterolateral approach by the edge of the sternocleidomastoid muscle was achieved with patients in the supine position. The average operating time was 195 min (range 60–300 min). The average blood loss was 340 ml (range 100–800 ml). Anterior plate stabilization was used in five cases, bone graft in four. No perioperative complications were registered. One patient needed acute re-operation due to postoperative hematoma formation. This 57-year-old man developed renal and respiratory failure postoperatively. Despite intensive therapy, the patient died 17 days after re-operation.

In 15 cases, anterior debridement was combined with pedicle screw instrumentation during the same anesthetic session. In one patient, a two-stage procedure was performed. In 11 cases, surgery began with anterior debridement. The average operating time was 375 min (range 180–560 min). The average blood loss was 1,470 ml (range 300–3,600 ml). A cage was used in three patients and an anterior and posterior graft in all. There were no perioperative complications. One patient had surgical wound insufficiency and needed revision. During follow-up, one patient needed removal of instrumentation due to loosening. Another patient needed extension of instrumentation.

Table 5 gives a review of all in-hospital complications among the surgically treated patients. Details regarding surgical methods and complications are given in Table 6. The average stay at the Spine Unit was 25 ± 13 days. Only 37 (31.6 %) patients were discharged to their homes; the others received continued care at the department of primary hospitalization. Five (4.2 %) patients died during follow-up due to causes not directly related to the spinal infection. A further eight patients were lost to follow-up due to unknown causes, another three continued follow-up at other hospitals. At 1-year follow-up, 18 (15.3 %) patients had neurological impairment. Twelve had only mild impairment (weakness or dysesthesia), but one had foot drop, one cauda equine dysfunction, and four were paraplegic. Twenty-seven (23 %) patients treated surgically complained of varying degrees of back pain.

Discussion

During a 10-year period, we treated 219 patients with infectious spondylodiscitis. After exclusion of 8 patients with spinal metastases or primary tumors, 2 with fungal, and 13 with tuberculous spondylodiscitis, we were left with a study population of 196 patients. Our study is quite similar to our previous study by Karadimas et al. [12] that was based on 163 patients (of these 22 had tuberculous and one fungal spondylodiscitis) treated during an 8-year

Table 5 Distribution of in-hospital complications in patients managed surgically

	Patients (n)				
	A	B	C	D	Total
In-hospital death		1	1		2
Pneumonia	3	3	1	2	9
Pleuritis	2	3		2	7
Hypersensitivity reaction to dicloxacillin	2	2		1	5
Atrial fibrillation		4			4
Renal failure		3	1		4
Deep venous thrombosis		2		1	3
Ileus/bowel obstruction	1		1		2
Ischemic brain stroke		2			2
Meningitis	1				1
Pneumothorax (due to central venous catheter)	1				1
Pyelonephritis		1			1

A posterior decompression alone, B posterior decompression and pedicle screw instrumentation, C anterior debridement alone, D anterior debridement was combined with pedicle screw instrumentation

period from 1992 to 2000. We noted as did Karadimas that the disease primarily affects middle-aged males (mean age 59 years), and more than 60 % of our population had several risk factors and a series of concomitant diseases. Our patients were symptomatic for an average 7.5 weeks before admission to the Spine Unit, and back pain was the most common symptom. More than 66 % of them were receiving antibiotics at the time of surgery, and for this reason, culture of biopsies was diagnostic in only half of the cases. The lumbosacral spine was the most affected, and *S. aureus* was the most frequently isolated microorganism.

The same tendencies were found by Karadimas et al. [12] and by other authors [1, 2, 5, 8]. We found no relation between specific infectious microorganism and the quantity or spectrum of complications, nor did specific organisms present special treatment challenges. We did, however, excluded patients with tuberculous and fungal spondylodiscitis. These infectious agents are known for their long, non-symptomatic periods, which lead to marked bone destruction and complications requiring specific surgery and prolonged multidrug chemotherapy.

Conservative treatment with antibiotics and bracing was applied to 91 patients and was successful in 79 cases. Twelve patients needed surgery, and thus conservative treatment failed in 13.1 % of patients. Karadimas et al. [12] noted 17.1 % failures among patients managed non-surgically; other authors have reported failure rates from 12 to 16 % [1, 4, 7]. We had three in-hospital deaths in this group. All three patients had been transferred to the Spine Unit from other departments in a debilitated condition and needed hospitalization in an intensive care unit. In general, we found conservative measures safe and effective for carefully selected patients without spondylodiscitic complications.

In the previous study by Karadimas et al. [12], 61.9 % of patients needed surgery; in our population, 117 (59.6 %) patients underwent surgery. Posterior decompression alone was done in 19 (16.2 %) cases. In the study by Karadimas et al. [12], the same surgical technique was used in 56 patients (55.4 % of patients treated surgically) and 55.3 % of them needed revision with spinal instrumentation afterwards. In our current study, one patient needed surgical wound revision and two needed revisions with instrumentation. The low number of patients subjected to posterior decompression alone and the low revision rate

Table 6 Overview of surgical complications and surgery parameters

	Patients (n)				
	A	B	C	D	Total
Early re-operation ^a	1	9	1	1	12
Late re-operation ^b	2	8		2	12
Surgical wound insufficiency	2	3		1	6
Postoperative hematoma formation		3	1		4
Profuse perioperative bleeding		4			4
Dura mater lesion		1			1
Operation time (min/range)	128/60–240	210/120–390	195/60–300	375/180–560	
Blood loss (ml/range)	430/100–1,500	1,050/150–4,600	340/100–800	1,470/300–3,600	
Length of stay in Spine Unit (days $\pm$ SD)	23 $\pm$ 13	25 $\pm$ 14	16 $\pm$ 7	30 $\pm$ 10	

A posterior decompression alone, B posterior decompression and pedicle screw instrumentation, C anterior debridement alone, D anterior debridement was combined with pedicle screw instrumentation; SD standard deviation

^a Re-operation during primarily hospitalization

^b Re-operation during follow up

(15.7 %) may be because in our current study, 75 (64.1 %) patients treated with posterior decompression were supplied with pedicle screw instrumentation. Although nine patients (12 %) in this group were re-operated on at the same hospitalization because of early postoperative complications, instrumentation was not changed or removed in any of them. A further eight patients (10.6 %) were revised via an out-patient clinic because of material failure. Solid fusion was achieved in these patients, allowing material removal in all. Pedicle screw instrumentation was used in a further 15 cases in which debridement had been achieved via an anterior approach as single-stage surgery. Only one (6.6 %) patient needed early revision due to surgical wound insufficiency. Another two (13.3 %) had late revisions due to material failure. In total, 17 (22.6 %) patients who underwent posterior decompression and debridement supplied with pedicle screws were revised, and 3 (20 %) were revised in the group of patients in which anterior debridement was supplied with posterior instrumented stabilization. Overall, 20 (22.2 %) patients in whom pedicle screws were used needed revision surgery. In a study by Karadimas et al. [12], 27 % of patients treated in this way needed revision. We had no cases in which revision was done because of persistent infection due to the instrumentation used. This is in accordance with the consensus among other authors that the use of instrumentation in an infected area of the spine is safe and does not lead to persistence or recurrence of infection [3, 16, 17]. Seven patients with affected cervical spine were subjected to anterior debridement and stabilization. All patients but one were treated successfully. This one patient developed a postoperative hematoma. Emergency re-operation was done, but complications ensued that required treatment in an intensive care unit and that later resulted in death 17 days after re-operation. Furthermore, one in-hospital death occurred among patients treated with posterior decompression and instrumentation.

Anterior debridement combined with posterior instrumentation was the most time-demanding operation and had the largest perioperative blood loss. The spectrum and number of per- and postoperative complications were the largest among patients who underwent posterior decompression and debridement with pedicle screws instrumentation. The duration of the hospitalization period was similar in the different groups of surgically treated patients.

Patients treated conservatively were hospitalized in the Spine Unit for an average of 20 days; those who underwent surgery for an average of 25 days, the same as that reported by Gonzalvo et al. [6], but shorter than in other studies [1, 2]. Before admission to the Spine Unit, 81 % of patients had been hospitalized for an average of 15 days, and 53 % of all patients continued management at the department of primary hospitalization after the completion of treatment in

the Spine Unit. Overall, five patients died during hospitalization; a furthermore ten died during follow-up due to the causes not directly related to the spinal infection. This represents 7.6 % of our study population, whereas Karadimas et al. [12] reported that 12 % of patients died during 1-year follow-up period. On the day of admission, back pain was the main symptom in 90 % of patients. At 1-year follow-up, this percentage was reduced to 19 %. At the time of diagnosis, ten (5 %) patients were paraplegic, and four (2 %) had the cauda equine syndrome. These figures were reduced to four (2 %) and one (0.5 %), respectively, at 1-year follow-up. Overall 24 % of patient had neurological compromise on admission and 10.4 % at follow-up. Control of infection was obtained in all patients.

Conclusions

Infectious spondylodiscitis is still diagnosed with a delay, and devastating complications can result if the condition is not treated urgently and adequately. Conservative measures are safe and effective for carefully selected patients without spondylodiscitic complications. Failure of conservative measures, compression of neural elements, mechanical derangement (instability, malalignment, severe vertebra destruction), and intractable pain require surgery that can guarantee thorough debridement, decompression, restoration of spinal alignment, and correction of instability. Surgeons should master various techniques to achieve adequate debridement, and pedicle screw instrumentation may safely be used if needed.

Conflict of interest None.

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