Surgical treatment of spondylodiscitis in the cervical spine: a minimum 2-year follow-up

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Abstract Cervical spine spondylodiscitis is a rare, but serious manifestation of spinal infection. We present a retrospective study of 20 consecutive patients between 01/1994 and 12/1999 treated because of cervical spondylodiscitis. Mean age at the time of treatment was 59.7 (range 34–81) years, nine of them female. In all cases, diagnosis had been established with a delay. All patients in this series underwent surgery such as radical debridement, decompression if necessary, autologous bone grafting and instrumentation. Surgery was indicated if a neurological deficit, symptoms of sepsis, epidural abscess formation with consecutive stenosis, instability or severe deformity were present. Postoperative antibiotic therapy was carried out for 8–12 weeks. Follow-up examinations were performed a mean of 37 (range 24–63) months after surgery. Healing of the inflammation was confirmed in all cases by laboratory, clinical and radiological parameters. Spondylodesis was controlled radiologically and could be achieved in all cases. One case showed a 15°kyphotic angle in the proximal adjacent segment. Spontaneous bony bridging of the proximal adjacent segment was observed in one patient. In the other cases the adjacent segments radiologically showed neither fusion

nor infection related changes. Preoperative neurological deficits improved in all cases. Residual neurological deficits persisted in three of eight cases. The results indicate that spondylodiscitis in cervical spine should be treated early and aggressive to avoid local and systemic complications.

Keywords Spondylodiscitis · Cervical spine · Spinal fusion · Spinal infection

Introduction

Spondylodiscitis is a rare infectious disease of the axial skeleton [11, 15]. It can endanger the patient either locally because of severe destruction, often with concomitant neurological deficits [25, 29, 32], or systemically as a consuming general disease [11, 12]. The involvement of spinal segments decreases in order of the lumbar to the thoracic and cervical spine [7, 17, 34]. The rate of epidural abscesses or neurological complications increases in the same order [5]. All series about spondylodiscitis report only a small number of cervical manifestations [12, 23, 25, 26]. In case of an infection however, the specific anatomy of the cervical spine with its vascular and lymphatic connections and their proximity to important anatomic structures put this region at a particularly high risk [23].

Spondylodiscitis first manifests itself at the vertebral endplates and then spreads to the intervertebral disc and the vertebral body [10, 23]. Pathogens are usually disseminated through the blood stream [2, 11, 12]. The triggering foci cannot always be reliably detected. Possible causes may include iatrogenic procedures,

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such as surgical interventions or other invasive measures [7, 20].

Recommendations for treatment of spondylodiscitis remain controversial. Various authors recommend conservative treatment with immobilization and antibiotics in cases with minor destruction, aiming at a spontaneous fusion of the vertebral bodies or at least fibrous stiffness [10–12, 17, 29]. Another treatment option is minimally invasive abscess reduction with local antibiotic instillation and subsequent immobilization by brace or fixateur externe [9, 36]. Radical surgery with debridement, autologous bone grafting and stable stabilization with the possibility to correct deformities is increasingly recommended [3, 6, 8, 10–12, 20]. By that, in addition, representative tissue specimen can be gained for histological and microbiological examinations [24]. Literature regarding recommendations in the treatment of cervical spondylodiscitis is limited [25, 26]. Schimmer et al. [25] reported a larger series of 15 operatively treated patients with cervical osteomyelitis. Because of the high number of neurological complications with an increased high morbidity and mortality rate in cervical spine involvement, a more aggressive surgical approach was suggested [23, 25, 32].

Materials and methods

Between 1/1994 and 12/1999, 332 consecutive patients with the diagnosis of spondylodiscitis underwent treatment in our Department of Spinal Surgery. The cervical spine was involved in 20 cases (6%), nine of whom were females. Nineteen of these patients had nonspecific spondylodiscitis and one patient presented with specific tuberculous spondylodiscitis. Mean age at the time of surgery was 59.7 years with a minimum of 34 and a maximum of 81 years. Fifteen patients had risk factors, as shown in Table 1. There were a number of concomitant diseases, as shown in Table 2.

The histories showed mean disease duration of 12 weeks prior to admission to our department. Seven of the 20 patients transferred to our department from

Table 1 Risk factors in our patient population ($n = 20$) with spondylodiscitis of the cervical spine

Risk factors	Patients
Diabetes mellitus	9
Tumor	2
Alcohol abuse	2
Nicotine abuse	2
Immunosuppressive therapy	1
Polyarthritis	1

Table 2 Concomitant diseases of the patients ($n = 20$), enrolled in our series

Concomitant diseases	Patients
Heart disease	6
Hypertension	4
Endocarditis	1
Renal insufficiency	1
Hepatomegaly	1

other facilities had already undergone diagnostic and therapeutic measures for cervical spine symptoms. In two cases the inflammatory process had not yet been detected. The other five patients received prior treatment with a stabilizing cervical collar and a broad-spectrum antibiotic. In 5 of 12 patients referred on an outpatient basis, infection was diagnosed before hospitalization, but in all cases with a delay. All five patients were hospitalized immediately after the diagnosis had been established. Two of the remaining patients were hospitalized under the diagnosis of a suspected tumor and one patient with a suspected pathological fracture. The other four patients before presentation to our outpatient department were misdiagnosed and treated as therapy-resistant cervical syndrome.

Two patients had had previous cervical spine surgery, one of them with spinal canal stenosis who underwent ventral decompression and spondylodesis at C3–C7 in our department. The other female patient had had three surgical interventions elsewhere because of spinal canal stenosis at C5–C7.

Examination steps included a cervical X-ray in at least two planes and contrast MRI. In all cases a CT-scan was performed for better assessment of bony defect.

The analyses of preoperative infection parameters included leucocytes, blood sedimentation rate and C-reactive protein.

All patients in this series underwent surgery. The surgical procedure was individually determined according to the following criteria: segment involvement, defect size with deformity or instability, neurological deficit and stenosis related to epidural abscess formation. Wound healing, revision surgery, mortality, pathogen isolation, duration of antibiotic application and wearing period of the orthosis were recorded postoperatively.

Subjective complaints, neurological state and radiological parameters were recorded at follow-up, on mean average 37 (range 24–63) months after surgery. Radiological parameters included consolidation of spondylodesis, segmental alignment, implant position and state of adjacent segments compared to the preoperative situation. This involved standard X-rays of

the cervical spine in two plains. Specific parameters (blood sedimentation rate, C-reactive protein and leukocytes) were recorded to assess if there were still signs for an infection.

Results

Preoperative findings

The infection parameters checked preoperatively showed the following increases above the normal range: leukocytes in 13 of 20 cases, blood sedimentation rate in 19 of 20 cases and C-reactive protein in 16 of 20 cases. Eleven patients had an increased temperature. Three of these patients were admitted with a septic temperature. Seventeen cases involved monosegmental and three cases bisegmental disease manifestation (Fig. 1). Nine patients had preoperative neurological impairments, as shown in Table 3. A paravertebral soft-tissue abscess was seen in five cases. Seven of 12 patients with an epidural abscess were discovered to have myelon compression (Fig. 2).

Nine patients were admitted with neurological deficits, as shown in Table 3.

An inflammatory focus was localized in four of 20 cases. There was one patient with diabetic gangrene in the forefoot, one with malum perforans plantaris, one sacral decubitus and one tonsillary abscess. In all four cases, the pathogens from a smear of the inflammatory focus coincided with the intraoperative pathogen spectrum.

Fig. 1 Spondylodiscitis C5/6 with partial destruction of C5, kyphotic deformity and abscess, both paravertebral and epidural

Treatment modalities

All patients in this series underwent surgery, due to neurological deficits (9×), septic symptoms (3×), epidural abscess formation with consecutive stenosis (7×), extent of bony defect and resulting deformity. Emergency interventions were performed in two patients with pronounced sepsis, one with tetraparesis and the other with increasing paraparesis.

The inflammatory foci at the cervical spine were removed in all cases together with decompression of neural structures. Abscesses were rinsed and granulation tissue was removed. Autologous bone as tricortical iliac crest graft, autologous fibula graft or cancellous bone with an additional titanium cage were introduced for bridging and an instrumentation was added from a dorsal, ventral or combined approach (Table 4). Autologous bone graft was harvested from the iliac crest using a separate isolated operating field and new instruments. The defect was filled with an antibiotic sponge.

The patient previously operated in our department underwent ventral metal removal at C3–C7, debridement, graft interpositioning at both intermediate levels and dorsal stabilization at C2–Th1. For the female patient who had had surgery elsewhere metal removal was submitted as well as ventral debridement, ventral bone graft interpositioning and dorsal stabilization at C5–Th1. There were no intraoperative complications.

Clinical course

One patient, who had to be treated in an emergency situation because of pronounced sepsis and tetraparesis, died in septic shock due to multiorgan failure seven days after surgery. Primary wound healing was seen in 17 of 19 cases. One patient had superficial disturbed wound healing which healed conservatively. One patient with deep infection required another two operations before healing. Consolidation and healing in this case was achieved by initial implant removal with debridement and additional dorsal instrumentation, followed by a second operation with ventral re-revision and fibula interpositioning.

Postoperatively, the majority of patients ($n = 18$) were treated with a semi-rigid cervical collar. Treatment time with collar was around 6 weeks for mono- and bisegmental interventions. In multisegmental interventions, the decision was made individually by the surgeon. Here the treatment time was 8–12 weeks. Patients with fibula interpositioning, in one case as a primary intervention and in another after the third

Table 3 Neurological states of the nine from our 20 patients with neurological impairment

Patient	Preoperative	Follow-up	Recovery
1	Hyposensitivity C5 bilat. C5 and C6 bilat. paresis	Sensitivity and motoricity intact	Complete
2	Incomplete sub-C5: upper extremity bilat. and lower extremity bilat. paresis, generalized hyper-sensitivity (ASIA C)	Sensitivity and motoricity intact (ASIA E)	Complete
3	Incomplete sub-C5: left arm complete paralysis, lower extremity paresis, generalized hyper-sensitivity (ASIA B)	left arm paresis, otherwise intact (ASIA D)	Incomplete
4	Incomplete sub-C6: paresis all extremities, bedridden (ASIA C)	Incomplete sub-C6: paresis, partially mobilized (ASIA D)	Incomplete
5	Incomplete paraparesis: both legs paresis, hyposensitivity, (ASIA C)	Sensitivity and motoricity intact (ASIA E)	Complete
6	Hyposensitivity C6–C8 and reduced force C5–C8 on the left	C7 left, partial paresis otherwise intact	Incomplete
7	Paraparesis sub-C6, upper extremity paresis, Hyposensitivity C8 bilat. (ASIA D)	Sensitivity and motoricity, Intact (ASIA E)	Complete
8	Lower extremities paresis, Sensitivity intact (ASIA D)	Sensitivity and motoricity, Intact (ASIA E)	Complete
9	Tetraparesis sub-C6	Exitus letalis post surgery	

Comparison of the preoperative and the follow-up state

Fig. 2 Number and localisation of the segments of the cervical spine, involved in the infection process in case of spondylodiscitis ($n = 20$)

intervention (as described above), were provided with a halo fixateur.

Pathogen isolation\antibiotic therapy

Intraoperative pathogen isolation was achieved in 15 cases (75%). *Staphylococcus aureus* were isolated most frequently followed by different types of *staphylococci* and *streptococci*, as shown in Table 5. Postoperative

Table 4 Surgical procedure due to the extend of involved segments and the performed surgery in our patients with spondylodiscitis of the cervical spine ($n = 20$)

	Monosegmental	Bisegmental	Polysegmental
Anterior alone	6	1	–
Combined	2	3	8
Posterior alone	–	–	–

antibiotic therapy was done based on the antibiogram. A combined broad-spectrum antibiotic therapy was performed in five cases where pathogen isolation was unsuccessful. The average length of postoperative antibiotic therapy was 10 weeks from minimally 8 to maximally 12 weeks. Isolated mycobacteria were treated by triple combination therapy for 6 months followed by dual-therapy for another 6 months.

Follow-up results

Mean follow-up time was 3.1 years with a minimum of 24 and a maximum of 63 months. Nineteen patients were recorded; one patient died seven days postoperative as described above. One patient who died of cardiac failure 28 months after surgery could be followed up for 2 years. All patients were controlled by

Table 5 Intraoperativ isolated pathogens in 15 of 20 cases (75%) with spondylodiscitis of the cervical spine

Pathogen	Patients
<i>Staphylococcus aureus</i>	6
<i>Staphylococcus epidermidis</i>	2
<i>Staphylococcus saprophyticus</i>	1
<i>Staphylococcus capitis</i>	1
<i>Streptococcus group A</i>	1
<i>Streptococcus group B</i>	2
<i>Streptococcus group D</i>	1
<i>Mycobacterium tub.</i>	1

an independent orthopedic surgeon, who was not involved in this study.

The reported complaints were very inhomogeneous. Only one female patient had to take analgesics regularly. Only one patient complained of functional deficits due to restricted cervical mobility after monosegmental fusion. None of the other patients with mono ($n = 8$)—or bisegmental ($n = 4$) fusions reported any major functional restrictions in their daily activities. All patients with multisegmental fusions ($n = 7$) reported marked functional deficits with regard to rotation and inclination. Neurological findings from the follow-up period are shown in Table 3 [1, 18]. Improvement of preoperative neurological deficits was achieved in all cases. Complete neurological restitution was achieved in five patients. Three patients retained residual neurological deficits.

Leukocytes, C-reactive protein and blood sedimentation rate were in a normal range. Only one patient with chronic polyarthritis had increased blood sedimentation values.

All X-rays were evaluated by an independent radiologist. X-rays revealed reliable consolidation of spondylodesis in all cases (Figs. 3a–c, 4a, b). There was no radiological indication of persistent inflammation. One patient had a 15° kyphotic angle in the proximal

adjacent segment after bisegmental fusion. Spontaneous ventral bone bridging of the proximal adjacent segment was observed in one patient.

Two of the four employed patients were reintegrated into their former occupation, one patient was retrained but is unemployed and the other patient has retired in the meantime.

Discussion

Nonspecific pyogenic spondylodiscitis is more frequent than specific infections like tuberculous spondylodiscitis [11, 21, 25, 29]. The cases recorded by us included one tuberculous case among 19 nonspecific pyogenic ones. Bacterial spondylodiscitis mainly affects older patients. The mean age of our patient population of 59.7 years is in agreement with the literature [14, 25, 26, 36].

There are various predisposing risk factors like diabetes mellitus, rheumatic diseases, immunosuppressive diseases, therapies (steroid applications), urogenital or pulmonary infections as well as drug abuse [2, 5, 10, 20, 23, 29]. Multimorbidity in terms of so-called geriatric diseases seems to be a general risk factor [10, 36]. Risk factors were found in 16 of 20

Fig. 3 **a** Spondylodiscitis C5/6 with partial destruction of the C5 and C6 vertebra, MRI. **b** ap and lateral X-ray of the patient preoperatively **c** ap and lateral X-ray of the patient after operative treatment with a combined approach; complete bony fusion was achieved 6 months post operatively

Fig. 4 **a** preoperative lateral X-ray and MRI of a patient with spondylodiscitis C5/6 with partial destruction of the vertebra C5 **b** lateral and ap X-ray 6 months postop. of the patient from **a** after combined surgery; complete bony fusion was achieved

patients of our population and a combination of two in one case (Table 1). Comparable data on predisposing factors are reported in studies regarding spinal abscesses [13, 22]. Thirteen patients had additional concomitant diseases, as shown in Table 2. Foci of infection in the order of 29 and 41% have been reported [5, 22]. Localization of foci often facilitates the isolation of identical pathogens [15, 17]. In our series a focus of infection was identified in four cases (20%). Identical pathogens to the pathogens obtained intraoperatively were isolated in all four cases mentioned.

Spondylodiscitis is often detected only at an advanced stage because of its uncharacteristic clinical symptoms initially and delayed visualization by con-

ventional X-ray diagnostics [2, 7, 10, 15, 20, 23, 26, 29]. In agreement with our experience, intervals of 12–15 weeks to establish a final diagnosis have been reported [11, 17, 12, 20, 32, 36]. In our series, all cases within these time intervals were classified as subacute or chronic, according to the classification published by Tay et al. [33]. Clinical courses with a sudden rise in temperature and chills have been described [11, 12]. Patients with chronic courses of nonspecific spondylodiscitis usually have no elevated temperatures or only subfebrile ones [10, 26]. Fever is the exception in tuberculosis [34]. Eight of our patients were admitted with slightly elevated temperatures. Three patients had septic temperatures and two of them had to undergo

emergency surgery due to sepsis, courses as described in the literature [26, 31]. Regarding the laboratory parameters, the literature reports frequently but not regularly increased blood sedimentation rates and increased C-reactive protein [5, 11, 15, 23, 29], but only irregular detection of leukocytosis [11]. Blood sedimentation rates are reported to be more sensitive in nonspecific than in tuberculous spondylodiscitis [11]. While the increased blood sedimentation rate in 19 of 20 patients in our population proved to be a reliable parameter, the changes in C-reactive protein (increase in 16 of 20 cases) and leukocytes (increase in 13 of 20 cases) were less specific. Pathogens are often difficult to isolate especially in subacute or chronic courses [5, 10, 32]. This applies not only to blood counts but also to biopsies or intraoperatively obtained samples. *Staphylococci aureus* are the most commonly detected nonspecific pathogens [5, 17, 20, 22, 23, 25, 29, 36]. We isolated pathogens in 75% of the cases: different types of *Staphylococci* in 30% followed in frequency by different types of *Streptococci* (Table 5).

Contrast MRI is the method of choice for a reliable diagnosis in clinically and radiologically suspicious cases [9, 15, 23, 27, 29]. This helps to exclude mainly differential diagnoses like erosive osteochondrosis and tumors [10]. Epidural abscesses found in up to one-third of the cases can be visualized just as reliably by MR imaging as paraspinal abscesses [12, 13, 20]. T1-sequences with contrast are helpful to evaluate abscess formation in the soft tissue [7, 23]. Fat-suppressed sequences are recommended by Ruiz et al. [23] to adequately evaluate enhancement of the vertebral body. In agreement with the literature [5, 7, 13, 23], we performed T1 sequences with and without contrast, as well as T2 sequences. The extent of bony destruction can be demonstrated by computed tomography [9, 11]. We believe that the possibility of 3D reconstruction is particularly advantageous for preoperative planning of patients with severe destruction. Scintiscanning is not specific but is recommended to exclude multilocular involvement [11]. According to Moser [19], skeletal scintigraphy is only of subsidiary importance in the diagnosis of spondylodiscitis.

Today, various treatment modalities offer a broad spectrum of therapeutical options, depending on the extent of defect, instability, abscess formation with or without consecutive stenosis and the presence of neurological deficits. In cases without neurological deficit and distinct substance loss conservative treatment with immobilization by orthosis has been reported to be successful in the thoracolumbar spine [11, 17, 29, 30, 36]. Moreover, in cases without instability and severe deformity ventral debridement and spondylodesis was

suggested [10, 15, 17]. Patients with multisegmental involvement or distinct substance loss were reported to benefit from a combined approach with ventral debridement and bony bridging, including the additional dorsal stabilization [5, 6, 10, 20].

Every of the above-mentioned therapeutic regimen is accompanied by antibiotic therapy recommended for 6–12 weeks [3, 5, 8, 15, 16]. Three-drug or four-drug combination therapy for 6 months is recommended for tuberculous spondylodiscitis followed by mono- or two- drug combination therapy for 12–18 months [34].

Shad et al. [28] demonstrated asymptomatic persistent bacterial colonization close to the removed anterior plates one year after surgery in cervical spondylodiscitis in four of five cases. In contrast, other studies encouraged the use of titanium implants in anterior spine surgery when treating spondylodiscitis. In this regard, both titanium mesh implants, as well as anterior plate or rod systems, have been reported to be reliable devices [4, 10, 16, 24, 26, 31, 35].

Our series confirm previous reports, suggesting that spondylodiscitis of the cervical spine is associated with a higher risk in developing neurological deficits [25, 28, 32]. Symptoms often dramatically progress emphasizing that time interval to diagnosis appears to be one of the most important prognostic factors [2, 7, 10, 15, 20, 23, 26, 29, 31].

In accordance with this conclusion and the fact, that spondylodiscitis of the cervical spine is associated with a high morbidity and mortality rate [23, 25, 31, 32], early and aggressive operative treatment is critical to achieve a positive outcome.

In contrast to the thoracic and lumbar spine, where conservative treatment is an established beneficial treatment option [11, 17, 29, 36], our data arguments in strong favour of treating cervical spine spondylodiscitis operatively to avoid complications in this sensitive area. Operation with radical debridement and stable fusion shows good results regarding the partial or complete resolution of neurological deficits, bony fusion and healing of inflammation [25, 28].

Conclusion

Spondylodiscitis of the cervical spine is a rare, but serious manifestation of this disease. Localization at the cervical spine is associated with high morbidity and mortality rates, especially involving neurological deficits. Operative treatment of spondylodiscitis seems to be the preferable therapeutic option by restoring spinal alignment and stability, as well as curation of the inflammatory process. Thus, partial or complete

resolution of neurological deficits can be achieved. Operative treatment should address meticulous debridement, bony fusion, restoration of the normal alignment and stable fixation.

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