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Primary stable anterior instrumentation or dorsoventral spondylodesis in spondylodiscitis?

Results of a comparative study

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Abstract The operative results of 23 patients with a specific or unspecific spondylodiscitis were documented over 2 years after the focus of the inflammation had been eradicated, bone chip had been interposed and a CDH instrumentation had been performed by an anterior approach only. These outcomes were compared with the results of 32 patients in whom the focus had been removed and the defect had been filled with bone graft from an anterior approach, followed by stabilisation with CD instrumentation through an additional dorsal approach. In the cases where CDH instrumentation was applied, the range of fusion averaged 1.3 segments. This was clearly less extensive than in dorsoventral stabilisation, in which on average 3.5 segments were fused. In 47 of 55 cases mobilisation was

achieved without orthosis. Eight months after the operations bony fusion could be observed radiologically in all patients. The mean preoperative kyphotic angle of the affected segments was 14.4°, compared to 4° after the operation. The mean loss of reposition was measured to be about 2.7° in both groups. Average operation time and blood loss were about 50% higher in the patients treated dorsoventrally. We conclude that even in the case of florid spondylodiscitis, a short-range anterior fusion of the affected spinal segment may be performed by use of a stable-angle implant without an increased risk of infection-related loosening.

Key words Spondylodiscitis · Operative therapy · Anterior instrumentation

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Introduction

Osteomyelitis affects the spine in the form of spondylitis or spondylodiscitis in up to 3.4% of all cases [55]. The basic principles of the therapy include immobilisation of the affected spinal segment, and administration of antibiotics over a period of months [11, 12].

Some authors prefer conservative therapy [11, 18, 39, 40, 43, 52, 56, 59], requiring a period of bed rest of 7–12 weeks first. Afterwards the patient is mobilised in a brace [31, 39, 52, 59].

Operative therapy aims at eradicating the inflammation focus and filling the subsequent bony defect with bone

graft, thus offering the advantage of a more rapid healing. Furthermore the operation gives a chance to correct any emerging deformity. Neurological deficiencies [7, 10, 27, 30, 39, 52], intraspinal abscess [39, 52], complete destruction of the vertebral body with spinal deformity [27, 39] or inability to rule out a tumorous lesion with imaging techniques or bioptically [12, 20, 37, 58] are regarded as urgent indications for an operative procedure.

Early operation procedures required immobilising the patient, usually for several months [3, 4, 12, 19, 27, 28, 31, 35, 38, 39, 47, 48], after the inflamed tissue had been taken out anteriorly and the deformity had been corrected by interposing autologous bone chip. Later in the course of treatment a brace was inevitable.

Nowadays spinal instrumentation allows stabilisation of even extended vertebral body defects and shortening of the postoperative immobilisation period, although fixing an implant in an inflamed area was long considered to be counter-indicated [4, 31, 50].

The aim of our study was to compare the clinical and radiological results of patients treated dorsoventrally with those treated ventrally alone for the diagnosis of spondylodiscitis.

Materials and methods

Combined anterior and posterior approach (group 1)

From 1987 to 1992, 32 patients with spondylodiscitis of the thoraco-lumbar spine were operated by a combined anterior and posterior approach (group 1).

The group comprised 15 women and 17 men with an average age of 53.4 years (20–80 years). Twenty-six patients suffered one damaged segment, seven patients had two damaged segments and in one patient three spinal segments were affected. The distribution of the affected disc location is given by group in Fig. 1.

The operative strategy was to approach and remove the inflamed tissue via an anterior approach, and to bridge the defect with an autologous bone graft taken from the iliac crest ($n = 21$), fibula ($n = 7$) and rib ($n = 4$). Afterwards an additional dorsal stabilisation with CD instrumentation was carried out in a one-step procedure ($n = 28$) or in a two-step procedure ($n = 4$) 10 days later (Fig. 2). In order to avoid a metal implant in direct contact with the inflamed area, no (stable-angle) transpedicular implantation anchor was used. Instead hooks were employed to fix the CD rods, with the range of fusion often including the adjacent disease-free segment. In such cases the instrumentation was removed about 1 year after the first operation. Patients were mobilised at an average of 5 days after the operation (3–days). Eight patients had to wear a brace for 6 months, predominantly those with polysegmental damage. At the last follow-up 24 patients did not need an orthosis. Patients suffering from tuberculosis (Table 1) were treated with antibiotics for at least 1 year, and all other cases for at least 2 months after the blood parameters had returned to normal.

Anterior approach alone (group 2)

From 1992 until 1994, 23 patients with spondylodiscitis were operated and stabilised through an anterior approach alone (group 2).

Fig. 1 Distribution of the spondylodiscitis location by group (Gr. I group 1, Gr. II group 2)

Table 1 Bacterial source of the inflammation in 55 patients with spondylodiscitis

Bacteria	Group 1 (n = 32)	Group 2 (n = 23)
<i>Mycobacterium tuberculosis</i>	7	5
<i>Staphylococcus epidermidis</i>	5	5
<i>Staphylococcus aureus</i>	7	3
<i>Escherichia coli</i>	3	2
β -hemolytic streptococcus	3	4
Unknown	7	4

Minimum follow-up was 24 months. The average patient age was 48.9 years (13–72 years), the sex distribution was 11 males and 12 females. Location of the defects is displayed in Fig. 1. Eighteen patients suffered damage of only one segment, in three patients two segments were damaged and in two patients three segments were affected. The underlying bacteriology is given in Table 1.

The affected segment was exposed anteriorly for the operation, the inflamed tissue was removed and an autologous bone graft from the iliac crest ($n = 21$) or from the fibula ($n = 2$) was inserted. Finally, the angle-stable CDH instrumentation [29] was implanted in the affected segment only (Fig. 3), limiting the range of fusion to one ($n = 18$), two ($n = 3$) or three segments ($n = 2$). The CDH plates were fixed to the vertebra with two screws each, the blocks were interlocked with two rods. If possible, titanium implants were used for spondylodiscitis to allow for the possibility of postoperative MRI control. All patients were mobilised on the 4th postoperative day without orthosis. Antibiotic therapy was equivalent to that administered in group 1.

Results

Clinical and radiological investigations were performed before and immediately after the operation and at least 24 months later. The mean follow-up was 48 (26–78) months for group 1, and 33.4 (24–43) months for group 2. None of the patients experienced a recurrence of the inflammation, documented by a normalisation of the laboratory parameters (leucocytosis, bloodcell sedimentation, C-reactive protein).

The average intraoperative blood loss amounted to 1550 ml in group 1, markedly higher than the 750 ml in group 2. Operation time in group 1 averaged 211 min and in group 2, 154 min. Average hospitalisation time was 27.4 days for group 1 patients and 24.3 days for group 2 patients. Twenty-four of 32 patients in group 1 and all patients in group 2 enjoyed an orthosis-free mobilisation (Table 2).

A bony fusion of the spondylodesis was observed in all cases. There was no evidence of a pseudarthrosis. The average range of fusion was 3.5 segments in group 1 and 1.3 segments in group 2.

Radiologically the kyphotic angle of the affected spinal segment was determined pre- and postoperatively (Fig. 4). For group 1 there was an average preoperative kyphotic angle in the affected segment of 18.4° (thoracic

Fig. 2 **A** Plain radiographs of the thoracolumbar spine of a 54-year-old patient with spondylitis of T11 (*Staphylococcus aureus*) and paraplegia. **B** Plain radiographs of the thoracolumbar spine 18 months after anterior removal of the focus followed by interposing autologous fibula graft and dorsal CD spondylodesis

Fig. 3 **A** Plain radiographs of the lumbar spine of a 53-year-old patient with spondylodiscitis of L2/L3 (*Staphylococcus epidermidis*) with psoatic and epidural abscess. **B** Plain radiographs of the lumbar spine 8 months after anterior removal of the focus followed by interposing autologous iliac crest and ventral CDH spondylodesis

28.8°, lumbar 4.4°), improving by a mean 11.9° (thoracic 17.4°, lumbar 8.1°). The loss of reposition until bony spondylodesis amounted to an average 2.7° (thoracic 4.7°, lumbar 0.5°). Thus, a mean angle of 9.2° kyphosis was observed at the last follow-up. Group 2 showed an average preoperative angle of 10.4° kyphosis (thoracic 12.8°, lumbar 7.2°). The average improvement achieved by the operation was 8.9° (thoracic 4°, lumbar 11.5°). The loss of reposition until bony spondylodesis was a mean of 2.8° (thoracic 2.2°, lumbar 1.7°).

Table 2 Comparison of intraoperative blood loss, duration of the operation, hospitalisation time and postoperative treatment in the two groups

Bacteria	Group 1 (n = 32)	Group 2 (n = 23)
Intraoperative blood loss (ml)	1550	750
Duration of operation (min)	211	154
Period of hospitalisation (days)	27.4	24.3
Treatment without orthosis (n)	24	All patients

Fig. 4 Radiological course of the affected spinal segment (kyphotic angle). The angles of the thoracic and thoracolumbar spine and of the lumbar spine with lumbosacral junction were measured separately

In two patients in group 1 an incomplete paraplegic syndrome had developed before the operation. They both had specific spondylitis of the thoracic spine with a gibbus deformity. One patient achieved functional improvement, in the other the neurological defects persisted. Four patients in group 1 and three patients in group 2 felt radicular pain prior to the operation, which was no longer demonstrated during the follow-up examinations. Twenty-two patients in group 1 declared that they were free from pain in the affected segment, ten patients still felt slightly painful. In group 2, 19 patients were pain free, 3 patients described slight local pain in the fused segment, 1 patient reported painful sensations in the thoracotomy scarring process.

As far as complications (Table 3) are concerned, the following points were registered: two patients in group 1 and one patient in group 2 had delayed wound healing and were treated conservatively. Three patients suffered reversible incomplete paresis of the m. quadriceps femoris after spondylodesis of the L4/L5 segment on either side of the access. The reason was a hook putting pressure on the root of L3 and L4. In one patient of group 1 with purulent spondylodiscitis of L2/L3, the aorta abdominalis was damaged during the operation, but could be sutured without any further problems. In a 70-year-old patient of

Table 3 Comparison of intra- and postoperative complications in the two groups

	Group 1 (n = 32)	Group 2 (n = 23)
Superficial infection	2	1
Reversible paresis M. quadriceps femoris	1	2
Peripheral dysaesthesia	1	—
Intraoperative aorta rupture	1	—
Fracture, lamina L2	1	—
Ulcer duodeni	1	—

group 1 with spondylitis tuberculosa of L1/L2, the vertebral arch of L2 fractured during the operation so that the hook-anchored instrumentation had to be extended by one segment.

Discussion

There is much controversy around the choice of operative or conservative treatment of spondylodiscitis. A comparison of the treatment results is not possible, as details concerning the sagittal spinal profile or the extent of vertebral body defects are not available.

Conservative treatment is accompanied by a long period of immobility as well as an incomplete rate of bone fusion. The rate of pseudarthrosis and instability is reported as up to 50% [39, 46, 51, 53, 58].

Since the studies made by Ito et al. [30] and especially those of Hodgson and Stock [28], anterior removal of the focus followed by interposing autologous bone graft without additional instrumentation and postoperative long-term immobilisation has been the standard operative procedure. The fusion rate of this treatment is reported to be more than 90% [7, 27, 28, 36, 39, 44].

In cases where it is necessary to carry out a polysegmental anterior fusion, with appropriately longer bone grafts, the rate of graft dislocation increases, along with the ensuing kyphosis [42, 50, 54]. To avoid these complications Oga et al. [50] treated 11 patients with spondylitis tuberculosa by combining anterior fusion with an additional dorsal instrumentation, either Harrington or CD. Prior to the operation an average of 3.5 segments were affected by the inflammation, the average fusion extended over 8.5 segments. In all cases there was a bony fusion without kyphotic angulation of the segment. In spite of an additional inflammation in the posterior parts of the spine in 7 of the 11 patients, all of them enjoyed complete healing of the inflammation without relapse.

When implanting a foreign body in inflamed tissue, the bacteria start to gather on the metal surface [49]. The adherence properties of the bacteria depend on their ability to synthesise a polysaccharide biofilm [9, 50]. *Mycobacterium tuberculosis* is less adhesive than *Staphylococcus*

epidermidis [50], for example. An implant that has become colonised may, therefore, cause persistence of an inflammation [24, 25]. If the implant bed is well perfused, as, for example, in the area of the vertebral body spongiosa, and if the necrotic diseased tissue has radically been removed before the metal is implanted, the gathering of bacteria on the metal surface can be prevented by activating the body's own defence system [50].

Our own results underline this opinion. In all patients there was a normalisation of the inflammation based on laboratory-chemical parameters such as blood sedimentation, leucocytosis and C-reactive protein, and bone fusion of the operated spinal segments occurred. Over a minimum of 24 months there has been no recurrence of the inflammation.

In contrast to conservative treatment or operation without instrumentation, performing the instrumentation immediately after removing the infection and implanting the bone graft permits early mobilisation of the patient. In our study this was possible on the 4th or 5th day after the operation on average. Since the introduction of the exclusively ventral procedure, we have dispensed with orthosis. A comparison of the radiological process shows that there was no significant difference between our two groups (2.7° vs 2.8°). The shortening of the fusion extent by using stable-angle CDH instrumentation is, however, appreciable. The spondylodesis could be limited to the inflamed spinal section (an average of 1.3 segments), whereas when stabilising ventrodorsally with hook-fixed implants intact segments also had to be incorporated in the fusion (an average of 3.5 segments). The angle stability of fixation with transpedicular screwing also allows the fusion span to be reduced.

Other advantage of instrumenting anteriorly alone lie in the shorter operation time and lower blood loss associated with a single-approach procedure.

Use of anterior stabilisation exclusively demands an implantation system with rotation and angle stability. The fixation should be performed bicortically in the vertebral body to avoid dislocation, even in patients with osteoporosis [16]. In our patients (age 13–72 years) we did not find any implant dislocation.

The use of anterior implants, especially in the area of the lower lumbar spine, is, however, limited on account of the close proximity to the aorta and a. and v. iliaca. As there is a danger of vessel erosion, immediate contact between vessel and implantation should be avoided. This is underlined by the negative experiences with the Dunn anterior double-rod system [2, 13, 14–16, 32, 61]. Even the mobilisation of the big vessels and protection with Teflon flaps cannot avoid the risk of vessel erosion [15]. A low-profile instrumentation with a smooth surface can therefore be of advantage. Other serious risks of an anterior access to the spine should not be disregarded, including neurological complications [22, 23, 26, 33, 34, 41], direct injury of the bowels [17], of the ureter [8] and postoperative scar stricture [1, 5, 6, 45, 57].

However, our first experience points to the clear advantages of this method. It appears to be superior to use of an additional posterior stabilisation and, of course, to spondylodesis without instrumentation, resulting in no increase in complication rates, but allowing short-distance fusion together with orthosis-free early mobilisation.

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