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Long-term results of ventro-dorsal versus ventral instrumentation fusion in the treatment of spondylitis

Received: 24 January 2006 / Accepted: 28 February 2006 / Published online: 17 May 2006

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Abstract This study examines prospectively the randomised, long-term, clinical and radiological results of the treatment of spondylitis patients by ventro-dorsal or ventral spine fusion. Group 1 consisted of 12 patients who (after ventral removal of the focus of infection and autologous bone grafting) were treated by dorsal instrumentation. Group 2 consisted of ten patients who, after similar ventral removal and bone interposition, were stabilised by ventral instrumentation. The patients prospectively underwent clinical and radiological studies. In addition, they were asked to fill in self-assessment questionnaires such as the short-form (SF)-36 health survey, the Oswestry questionnaire, and the visual analog scales (VAS). The postoperative follow-ups were at 6 months, 2 years and 5.4 years. It proved possible to demonstrate clinically that patients with an isolated ventral spondylodesis feel significantly better and experience significantly less pain in the area of spinal fusion than patients with ventro-dorsal fusion 2 and 5.4 years after the operation. Over a number of years a stable fusion can be achieved through either operation. Ventral stabilisation yields more advantages than dorsal instrumentation in

the long term. These advantages result in a clinically smoother course after the operation. If, in the individual case, ventral instrumentation is feasible, this method should be used.

Résumé La présente étude a pour but d'examiner de façon prospective et randomisée le devenir à long terme, clinique et radiologique, du traitement des spondylites après greffe antérieure ou greffe postérieure. Le groupe I a inclus 12 patients après abord antérieur, évacuation de l'abcès et greffe antérieure puis mise en place une instrumentation postérieure. Le groupe II ayant inclus 10 patients après un abord antérieur similaire, la greffe osseuse a été stabilisée par une instrumentation antérieure. Les patients ont été examinés rétrospectivement sur le plan clinique et radiologique. Ils ont répondu au questionnaire SF-36, le questionnaire d'Oswestry et au VAS. Le suivi moyen post opératoire a été réalisé à six mois, deux ans et 5,4 ans. Cette étude a démontré de façon claire que les patients ayant bénéficié d'une greffe antérieure ont eu un résultat significativement plus intéressant en termes de douleur et de fusion que les patients ayant été traités par abord antérieur et une greffe postérieure. Si on la compare à l'instrumentation postérieure, cette stabilisation antérieure présente un certain nombre d'avantages à long terme. L'instrumentation antérieure est bien suffisante pour traiter ces pathologies.

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Introduction

Spondylitis is a common inflammatory disorder that accounts for 2% of all osteomyelitis.

Eysel and Peters [3] found that, even in spondylitis, a single ventral operation with ventral instrumentation is possible. This allows short fusion and early mobilisation without external support. In comparison with dorsal instrumentation, less blood loss and shorter operation times, without increase in complication rates, were seen. Until now only short-term and medium-term results of ventral instrumentation fusion have been reported.

This study examines prospectively the randomised, long-term, clinical and radiological results of the treatment of spondylitis patients either by ventro-dorsal or ventral spine fusion. Our conclusions indicate the best treatment of spondylitis.

Materials and methods

We asked 24 consecutive patients with spondylitis and indications for operative treatment to participate in the study. For randomisation 24 envelopes, with 12 cards stating ventro-dorsal spondylodesis and 12 cards stating ventral spondylodesis, were mixed by an independent person and drawn randomly for each patient.

Indications for ventro-dorsal or ventral fusion surgery were considered in patients with recurrence of infection after conservative therapy (11 cases), gross bone substance defects and instability (six cases), progressive kyphosis (four cases), therapy-resistant sepsis (one case). There were no cases of neurological deficits, epidural- or psoas abscess or unclear diagnosis.

From February 1997 to December 1998, of the randomly assigned patients with spondylitis 12 underwent ventro-dorsal instrumentation fusion and ten underwent ventral instrumentation fusion. The patients were treated at one institution by two different surgeons.

The group that was treated by *ventro-dorsal spondylodesis* (group 1) consisted of eight male and four female patients. At the time of the operation the age of the patients ranged from 20 years to 75 years, the average age being 57.2 years. After the removal of autologous bone from the iliac crest or fibula, the ventral focus of inflammation was removed, followed by interposition of the bone graft. Dorsal instrumentation took place in the same session, using a Universal Spine System, usually with hook fixation above T8 and with transpedicular screwing caudal to T8. When hook-anchored stabilisation systems were being used, according to the recommendations of Aebi and others [1], two segments in each case (cranially and caudally to the affected vertebra) were stabilised. Where pedicles were intact, monosegmental instrumentation was carried out. If destruction of the pedicle had already taken place, or bone resources were insufficient, adjacent vertebral bodies underwent instrumentation.

Patients from group 2 were treated by *ventral spondylodesis*. There were eight male and two female patients, having an average age at the time of the operation of 59.5 years (range 25–70 years). First, autologous bone was removed from the iliac crest or fibula. The bone was then interposed, after ventral removal of the focus of infection. Following this, the VentoFix hardware was implanted through the same approach. Depending on the localisation, either single-rod or double-rod instrumentation was used. Ventral spondylodesis could be limited to the inflamed spinal section when there was sufficient bone to implant fixation in the infected vertebra. If destruction of the vertebra had taken place, or bone resources were insufficient, adjacent vertebral bodies underwent instrumentation.

The patients were examined clinically and radiologically before surgery and 6 months, 2 years and 5.4 years postoperatively. In addition, the patients of both groups were asked to fill in questionnaires—the short-form (SF)-36 health survey [8], the Oswestry low-back pain disability questionnaire [5, 6] and the visual analog scales—both before the operation and 6 months, 2 years and 5.4 years after the operation.

The X-ray pictures were taken before and after the operation to register the kyphotic or lordotic angle. On this basis the sagittal correction, the correction gain and the correction loss in the spondylodesis segment could be determined. Assessment of fusion was done according to the criteria of Lin and Gill, using standard radiographs in two planes [11]. Fusion was assumed if trabecular bone, bridging the affected motion units, was apparent.

Statistical evaluation of the SF-36 health survey, the Oswestry low-back pain disability questionnaire and the visual analog scales (VAS) was carried out by Student's unpaired *t*-test. A significant difference was indicated if $P < 0.05$.

Results

In two patients of group 1 it was possible to show that spondylitis had specifically arisen from tuberculosis. In the other ten cases the form of the disease was non-specific. Eight patients showed a focus of inflammation affecting just one vertebral segment; in two patients it extended over two segments and in another two patients over three segments, the average being 1.6 segments.

In group 2 the ratio of tubercular to non-specific spondylitis was 3 to 7. In eight patients one vertebral segment was affected, and in two patients two segments were affected by the inflammatory process, yielding an average of 1.2 segments.

Of our patients, 14 had been treated with antibiotics before the operation.

Intraoperatively and postoperatively antibiotics were administered according to antibiotic sensitivity for a mean of 23.8 weeks (range 3–52 weeks) in group 1 and 24.1 weeks (range 12–52 weeks) in group 2, depending on the improvement of clinical symptoms and the inflammatory markers in the blood laboratory tests [9]. Patients suffering from tuberculosis were treated with antibiotics for at least 1 year.

After operative removal of the ventral focus of inflammation over an average of 1.6 segments, in ten patients in group 1 autologous bone from the iliac crest removed, while, in two patients, an autologous bone graft was removed from the fibula. This was then interposed over an average of 1.6 segments. The dorsal instrumentation extended over one vertebra in six cases, over two segments in two cases, over three segments in three cases and over five segments in one case, averaging 2.0 segments. The instruments were inserted in a thoracic position in six patients, in a thoracolumbar position in four and in a lumbar position in four. The extent of the fusion covered,

on average, 1.6 segments (one segment in eight patients, two segments in one patient, and three segments in three patients). In group 1 fusion rate was 100% (Table 1).

In group 2 the removal of the ventral focus of infection was, on average, 2.1 segments. The subsequent filling of the ventral zone extended, on average, to 2.1 segments, bone being taken from the iliac crest in five cases and from the fibula in another five. For ventral stabilisation the one-rod and two-rod techniques were both used, on five patients each. In three patients the instrumentation covered one segment, in three patients it was two segments and in four patients, three segments, yielding an average of 2.1 segments. The hardware was localised in the thoracic region in seven cases; in one case it was the thoracolumbar and in two cases the lumbar region. In three patients the fusion extended over one segment, in three patients it was two segments and in four patients three segments, so that, on average, the fusion covered 2.1 segments. In group 2 the fusion rate was 100% (Table 1).

One patient from group 1 showed reactivation of the spondylitis at 1-year follow-up, with higher C-reactive protein (CRP) values being registered in laboratory testing. After revision and antibiotic treatment the infection healed without any complications. In another patient fever and higher inflammation parameters indicated a spondylitic condition in another spinal segment, which healed after immobilisation with orthosis and antibiotic treatment. On an average of 5.4 years after the operation it was possible to exclude inflammatory reactions in all patients on the basis of specific blood testing (Table 1). Neither pain on palpation nor pain on percussion over the spondylodesis segment—which might have indicated lack of stability or loosening of the structure—could be triggered in any of the patients at this time.

Intraoperative and postoperative complications

Intraoperative and postoperative complications are summarised in Table 2

In the SF-36 health survey, low values stand for poorer results. The results derived from both groups are listed in Figs. 1, 2, 3 and 4. Preoperatively and 6 months postoperatively no significant differences between the groups (except “role emotional” preoperatively, $P=0.038$) were seen. After ventro-dorsal and ventral spondylodesis higher scores were obtained for all domains in comparison to preoperative values. In group 2 the results were significantly better for all domains 2 years and 5.4 years postoperatively.

The Oswestry questionnaire measures the restrictions caused by back pain. Higher scores indicate a worse result. In group 2 significantly better results were seen 2 years ($P=0.031$) and 5.4 years ($P=0.039$) postoperatively (Fig. 5).

VAS measures the average intensity of back pain. Higher scale values indicate a worse result.

The preoperative average value in both groups came to 70% (SD 10 and SD 8). Group 1 showed an average value of 47% (SD 22) 6 months, 41% (SD 23) 2 years and 35% (SD 16) 5.4 years postoperatively. In group 2 the postoperative values were 43% (SD 15) after 6 months, 26% (SD 16) after 2 years and 17% (SD 14) after 5.4 years. A significant difference between both groups was seen after 2 years ($P=0.046$) and 5.4 years ($P=0.021$).

An average osseous fusion time of 6 months (range 6 months) in group 1 and 6.2 months (range 6–8 months) in group 2 was found (Table 1).

Average sagittal correction and correction loss are listed in Table 1.

Table 1 Comparison of C-reactive protein level, duration of fusion, range of fusion and instrumentation, sagittal correction and correction loss in both groups

Parameter	Ventro-dorsal Spondylodesis ($n=12$)	Ventral Spondylodesis ($n=10$)
Ø Range of fusion	1.6 Segments (1–3 segments)	2.1 Segments (1–3 segments)
Ø Range of instrumentation	2.0 Segments (1–5 segments)	2.1 Segments (1–3 segments)
Ø C-reactive protein level 6 months postoperatively (norm 0.5 mg/dl)	1.2 mg/dl (0.5–2.6 mg/dl)	1.0 mg/dl (0.5–2.0 mg/dl)
Ø C-reactive protein level 2 years postoperatively (norm 0.5 mg/dl)	1.4 mg/dl (0.5–6.7 mg/dl)	0.6 mg/dl (0.5–1.8 mg/dl)
Ø C-reactive protein level 5.4 years postoperatively (norm 0.5 mg/dl)	1.2 mg/dl (0.5–2.4 mg/dl)	0.9 mg/dl (0.5–1.7 mg/dl)
Ø Fusion in spondylodesis segment after:	6.0 months (6 months)	6.2 months (6–8 months)
Ø Sagittal correction, thoracic spine	4°	2°
Ø Sagittal correction, lumbar spine	0°	6°
Ø Correction loss, thoracic spine, 6 months, 2 years and 5.4 years postoperatively	2°	4°
Ø Correction loss, lumbar spine, 6 months, 2 years and 5.4 years postoperatively	2°	3°

Table 2 Intraoperative and postoperative complications

Complications	Ventro-dorsal spondylodesis (n=12)	Ventral spondylodesis (n=10)
Transitory lesion of the peroneal nerve (fibula graft)	3	3
Urinary tract infection	0	1 (immediate postoperatively)
Adynamic ileus	0	1 (immediate postoperatively)
Postoperative psychosis	0	1 (immediate postoperatively)
Pull out of instrumentation	0	1 (3 months postoperatively)
Reactivation of spondylitis	1 (1 year postoperatively)	0
Death 3 months postoperatively	1 (sepsis)	1 (suicide)
Death 4 years postoperatively	2 (ileus and cardiac infarction)	0
Superficial wound infection	2 (3 years postoperatively)	0
Spondylitis in another spine segment	0	1 (4 years postoperatively)

Discussion

Open debridement and anterior fusion in severe osteomyelitis of the spine offers the advantage of eradication of the focus of infection and improvement of conditions for bony fusion of the affected vertebral bodies [2, 7, 10, 13]. However, primary stability of isolated ventral fusion in the thoracolumbar spine is poor, compared with instrumented fusion resulting in loss of correction [14, 16]. In order to overcome these difficulties Meurer et al. [12] and Oga and co-workers [13] recommended additional dorsal fixation. Eysel and Peters [3] found that, even in spondylitis, a single ventral operation with ventral instrumentation is possible without increased complication rates.

Compared with the severity of the initial clinical findings, the intraoperative and postoperative complications in our patients were minor and not solely connected with the operation. Many complications that arose after ventral spondylodesis were complications of a general surgical nature.

Krödel and others [9] have described the possible failure of ventral fixation in patients with an osteoporotic bone structure. In one of our patients, the distal screw was

observed to have broken away from an osteoporotic thoracic vertebral body 3 months after the operation. It might have been possible to prevent the ventral implants from breaking away by involving a further, stable vertebral body in the ventral spondylodesis, or through additional dorsal instrumentation.

In all, three patients in group 1 and one patient in group 2 died in the first and fourth year after the operation. These deaths bore no relation to the choice of therapeutic method.

Twelve months after ventro-dorsal spondylodesis, one patient developed reactivation of the infection in the same segment. To avoid contact between the inserted implant and infected bone, Oga and others [13] recommend dorsal instrumentation with a hook-anchored system at an adequate distance from the focus of inflammation.

The probability of recurrence of an infection in the spondylodesis segment should theoretically be higher in ventral instrumentation than in dorsal instrumentation due to the more direct contact with the former focus of infection [9], but Eysel et al. [4], and own experiences revealed a practically identical reinfection rate in patients with ventro-dorsal and ventral spondylodesis.

Fig. 1 SF-36 health survey, average preoperative results with standard deviations (SD) and *P* values

Fig. 2 SF-36 health survey, average results 6 months post-operatively, with standard deviations (*SD*) and *P* values

Three years after dorsal instrumentation, on the other hand, two patients suffered superficial infection in the region of the scar, probably because of internal mechanical irritation of the implant. In comparison with Sanford and Myers [15], who reported superficial infection of the wound in 1.1% of 486 patients after fixateur interne implants, our infection rate (17%) differs significantly. In our patients, healing without complications was observed after a revision involving the removal of the dorsal instruments.

To maintain mobility in vertebrae that have not been grafted, in our study removing the metal is only indicated with long-segment dorsal instrumentation after ventral bony regrowth in the lumbar spinal region [12]. Nevertheless, our results show that mechanical irritation of the tissue by the dorsal instruments results in a higher risk of developing infection or a fistula. For this reason material

removal should be discussed with all patients who have dorsal instrumentation after bony regrowth either in the thoracic or in the lumbar sections of the spinal column.

In summary, the self-assessment questionnaires showed, on average, an increase in spinal column function, an improvement in the general state of health, an increased sense of well-being, a reduction of back pain and increased mobility both for ventro-dorsal spondylodesis and for ventral spondylodesis over an extended period of time. Here, ventral spondylodesis showed significantly better results than ventro-dorsal spondylodesis 2 years and 5.4 years postoperatively. A possible reason is the more invasive procedure involving two operations on the spinal column in the patients of group 1.

Six months after the operation we found no significant differences in the results of the self-assessment questionnaires between groups. Obviously, at this time, patients

Fig. 3 SF-36 health survey, average results 2 years post-operatively, with standard deviations (*SD*) and *P* values

Fig. 4 SF-36 health survey, average results 5.4 years post-operatively, with standard deviations (*SD*) and *P* values

were not fully integrated into normal life, and an accurate assessment of general state of health and pain is not possible.

In our patients, after ventro-dorsal spondylodesis, the results of the SF-36 lay slightly below the results for a group of healthy controls. On the other hand, after ventral spondylodesis, better results were obtained in comparison with a group of healthy persons. Possibly, these patients had been severely restricted in their quality of life before the operation as a result of the discomfort of the spondylitis. Following the operative treatment the results of the SF-36 scoring system showed a dramatic improvement.

Instrumentation of the fused sector of the spinal column is intended to bring about a lasting straightening of the deformed spinal segments. Eysel and Peters [3] report an average correction loss of 2.5° after dorsal instrumentation and 2.8° after ventral instrumentation, and we found similar radiological results for our patients in both groups.

Our experiences with ventral VentroFix instrumentation yield advantages over dorsal stabilisation, even when

observed in the long term. Thus, it could be clinically established that patients had significantly more well-being and less pain after ventral spondylodesis, possibly as a result of the less invasive treatment with only one operation.

The radiological evaluation showed that a stable fusion can be achieved through either type of operation over several years.

Both types of operation showed an approximately identical rate of complications. A conspicuous feature, however, was superficial wound infection, caused by internal mechanical irritation of the dorsal instruments. In these circumstances the removal of the metal should be discussed in all patients with dorsal instrumentation after bony regrowth.

To sum up, it may be asserted that, if in individual cases ventral spondylodesis is feasible, this method should be used.

Fig. 5 Oswestry low-back pain disability questionnaire with standard deviations (*SD*) and *P* values

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