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Original article

Safety and efficacy of percutaneous instrumentation combined with antibiotic treatment in spondylodiscitis

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ABSTRACT

Background: Patients with spondylodiscitis are treated with antibiotics and braces for 6 to 12 weeks. Braces aim to decrease pain and prevent kyphotic deformity due to vertebral body collapse. Percutaneous instrumentation could be an alternative to influence pain and patient's autonomy.
Purpose: The purpose of this study was to analyze back pain, quality of life, sagittal deformity, and complications after percutaneous instrumentation in spondylodiscitis.
Patients and methods: VAS for back pain, EQ-5D, radiographic sagittal index were assessed retrospectively for 28 patients who had a standardized follow-up at 5 days, 6 weeks, 3 months, 1 and 2 years. Probabilities > 0.95 indicated significant changes (Bayesian model).
Results: VAS was 7.0 preoperatively, 3.2 (day 5), 2.2 (6 weeks), 1.9 (3 months), 1.6 (1 year), 1.4 (2 years): probabilities > 0.95 within 6 weeks. EQ-5D was 0.229 preoperatively, 0.563 (6 weeks), 0.687 (3 months), 0.755 (1 year), 0.787 (2 years): probabilities > 0.95 within 1 year. Sagittal index was 15.1° preoperatively, 9.6° postoperatively: probability > 0.95. Inter-body fusion was: complete 60.7%, partial 17.9%, and nonunion 21.4%. Antibiotic treatment was stopped at 6 weeks in 82.1%, at 3 months in 17.9%, without septic complication.
Conclusion: Percutaneous instrumentation improved pain control, quality of life and prevented kyphosis. Antibiotic treatment was not influenced. Septic complications were not observed.
Level of evidence: IV.

1. Introduction

Spondylodiscitis has an incidence of 0.5 to 2.2/100,000 inhabitants per year, and represents 3% to 5% of osteo-articular infections [1,2]. An antibiotic treatment is usually administered for 6 to 12 weeks, according to the bacterium evidenced in a diagnostic intervertebral disc puncture or blood culture [3]. If these samples are negative, anterior approach can help to obtain a diagnosis by discectomy.

Brace treatment might be indicated for 3 months in patients presenting back pain and a risk for vertebral body collapse with subsequent kyphotic deformity of the thoracolumbar spine [4,5]. However, braces are not always tolerated and complications of prolonged immobilization might occur in elderly bedridden patients.

Percutaneous instrumentation and indications in infections have evolved over the last years [6–8]. This procedure avoids paravertebral muscle dissection and limits intraoperative bleeding and access morbidity. Recent retrospective data on a small cohort suggests that this internal fixation represents an advantage over brace treatment by lowering back pain and increasing patient's quality of life up to 3 months [9]. Walking ability and daily activities might improve more rapidly after a percutaneous procedure. Sagittal alignment could be better maintained by internal fixation, which might prevent progression into kyphosis.

Based on these assumptions, one could hypothesize that percutaneous instrumentation could be efficient on pain management and quality of life in spondylodiscitis patients, and further stabilize the spine in case of vertebral osteolysis.

The aim of this study was to analyze safety, back pain, quality of life, sagittal deformity, osseous healing and complications on a

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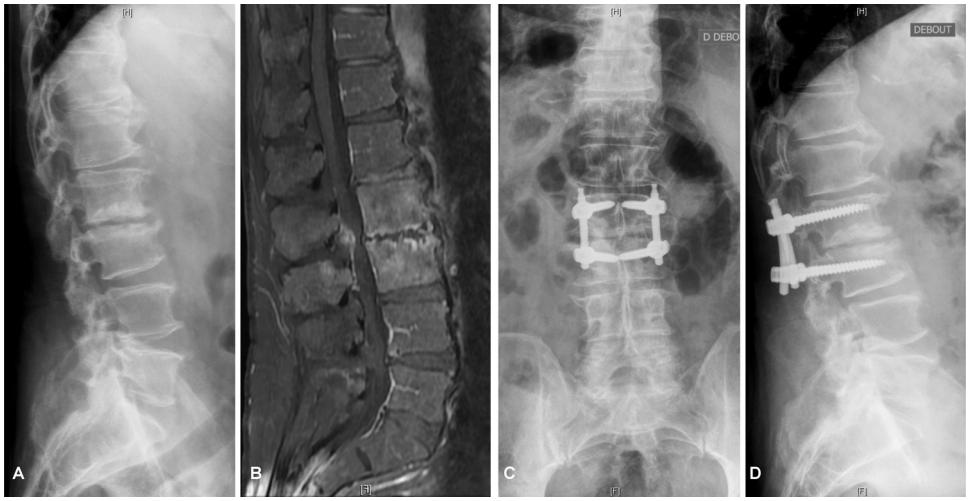

Fig. 1. Preoperative lateral lumbar radiograph (A) and MRI (B) of a 62-year old male with a L2-L3 spondylodiscitis with minor deformity but VAS back pain 9/10, postoperative anterior-posterior (C) and lateral radiographs (D) showing a single level percutaneous instrumentation.

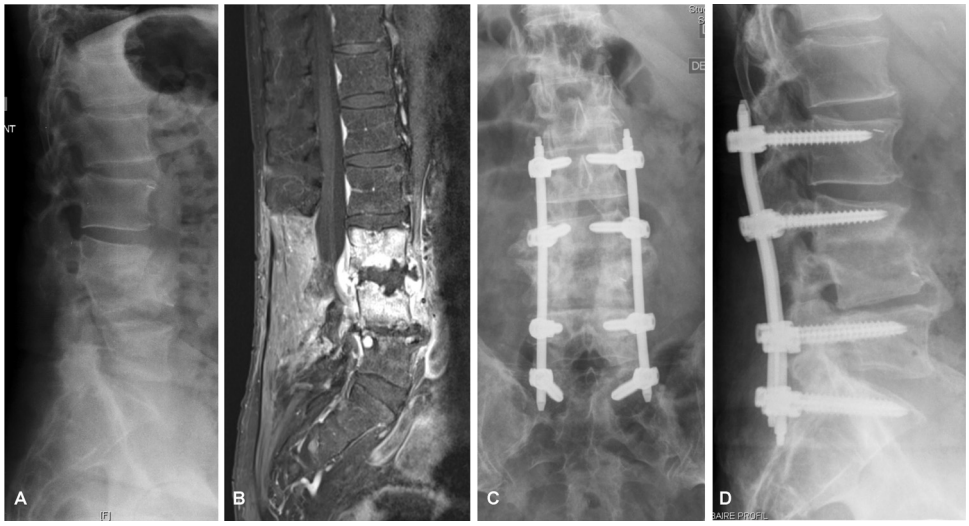

Fig. 2. Preoperative lateral lumbar radiograph (A) and MRI (B) of a 68-year old male with a L3-L4 spondylodiscitis with segmental kyphotic deformity, postoperative anterior-posterior (C) and lateral radiographs (D) showing an L2-S1 percutaneous instrumentation at 1-year follow-up.

cohort of patients with spondylodiscitis treated by antibiotics in combination with percutaneous instrumentation.

2. Materials and methods

2.1. Study type

A retrospective observational monocentric study was conducted on 28 consecutive patients treated for acute thoracolumbar spondylodiscitis between May 2012 and May 2016. Clinical and radiographic follow-up was routinely performed at 6 weeks, 3 months, 1- and 2-year follow-up.

2.2. Patients

There were 14 males and 14 females. The average age was 67.8 (42 to 85) years. The index level was lumbar in 18 cases (64.2%), at T12-L1 in 5 cases (17.9%), and thoracic in 5 cases (17.9%).

The following inclusion criteria were considered: severe functional impairment because of back pain, diagnostic magnetic resonance imaging demonstrating spondylodiscitis, vertebral body osteolysis on computed tomography (CT), a disc puncture and/or blood culture were required for microbiological analysis.

The following exclusion criteria were considered: postoperative infection after spinal instrumentation, spinal tuberculosis or mycosis, general septic conditions, acute endocarditis, contraindications for general anaesthesia, epidural abscess with neurological symptoms requiring drainage, absence of vertebral body osteolysis on CT.

2.3. Surgical technique and perioperative follow-up

A short osteosynthesis (4 screws) was performed in 9 patients (32.1%), if the segmental sagittal index was < 15° and vertebral body osteolysis was < 1/3 of the anterior wall height (Fig. 1). In others patients (67.9%), a longer construct (6–8 screws) was performed (Fig. 2). Infectious disease physicians conducted the antibiotic treatment according to the bacterial spectrum. The average hospital stay in the surgical department was 4.3 (1 to 9) days.

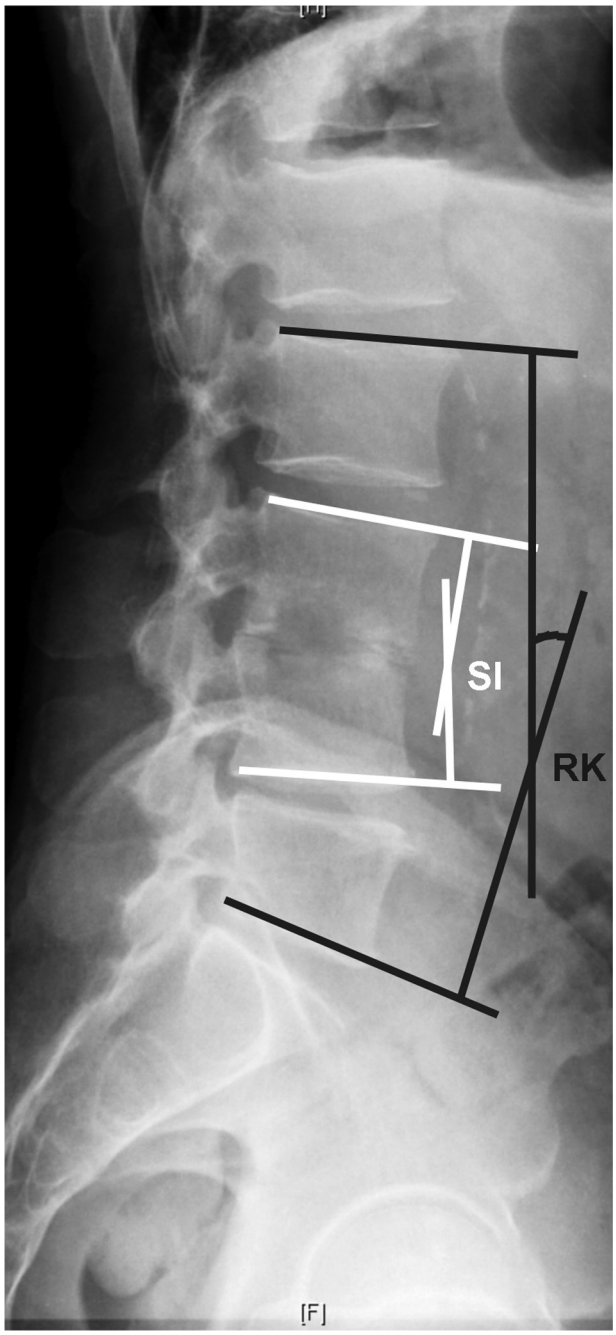

Fig. 3. Measurement of regional kyphosis (RK) and the sagittal index (SI) on preoperative lateral radiograph.

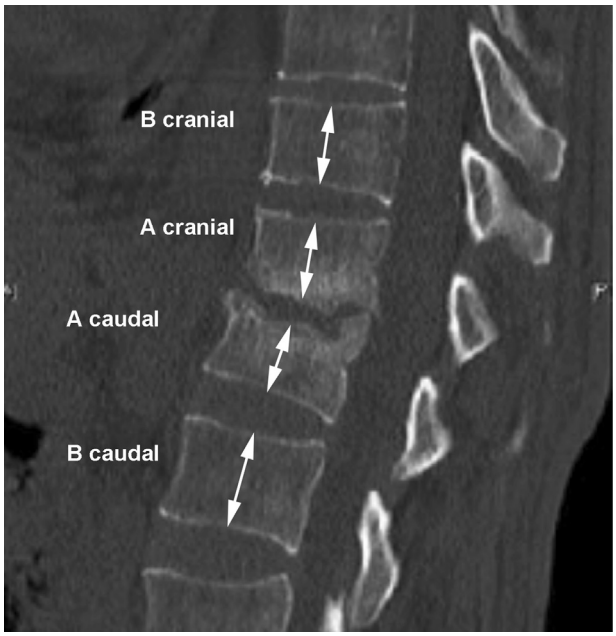

Fig. 4. Evaluation of vertebral body height on preoperative CT: the average ratio between A-cranial/B-cranial and A-caudal/B-caudal was calculated.

2.4. Methods of assessment

Clinical outcome measures were assessed in a standardized manner using patient questionnaires. Back pain was evaluated on a Visual Analogue Scales (VAS) from 1 to 10 [10] preoperatively and postoperatively at day 5, 6 weeks, 3 months, 1 and 2 years. Quality of life was studied using the EQ-5D-3L questionnaire [11] at the same time points (except 5th postoperative day).

Radiologic deformity assessment was performed on lateral thoracolumbar radiographs in standing position prior to treatment, at day 5, 6 weeks, 3 months, 1 and 2 years. Regional kyphosis was measured as the angle between cranial vertebra and the caudal vertebra adjacent to the infected vertebral segment. A modified sagittal index measuring the angle between cranial and caudal endplates of both vertebrae at the infected index level (Fig. 3). The sagittal index was normalized to 0° with regard to physiologic segmental kyphosis or lordosis: measured angle at T12-L1, angle −5° at thoracic and angle +10° at lumbar levels [12]. It would allow comparison over the entire thoracolumbar spine compared.

Osteolysis of vertebral bodies was assessed on CT prior to treatment. It was expressed as a ratio of vertebral body height in the mid-sagittal plane in comparison to non-infected vertebral bodies adjacent to the index level (Fig. 4). The average extent of osteolysis of both vertebral bodies adjacent to the infected disc was graded as < 1/3, between 1/3 and 2/3, or > 2/3 of vertebral body height. Assessment of fusion was performed on CT at 1-year follow-up. Fusion was rated as "complete", as "partial" if there were remaining zones of osteolysis combined with zones of bony bridging between vertebral bodies. Nonunion was defined as a complete absence of inter-body fusion (Fig. 5).

2.5. Statistical analysis

Statistical evaluation was performed with R Software Version 3.1.3 and OpenBUGS Software Version 3.2.3. A Bayesian inference with Markov chains Monte Carlo technique was used. A mixed model including potential explanation covariates and a random subject effect modeled as a precise zero-mean normal prior was carried on, jointly for all variables, with normal likelihood for each continuous variable. Clinical scores and radiographic measurements were compared preoperatively versus postoperatively at day 5, and in the postoperative course. Probabilities of difference between time points were estimated from posterior distributions and considered as significant if they were > 0.95. Weak priors were used.

3. Results

3.1. Bacterial spectrum and antibiotic treatment

All 28 patients underwent a preoperative diagnostic intervertebral disc puncture. In 3 cases (10.7%), the bacterium was not evidenced. A probabilistic antibiotic therapy was prescribed. In the

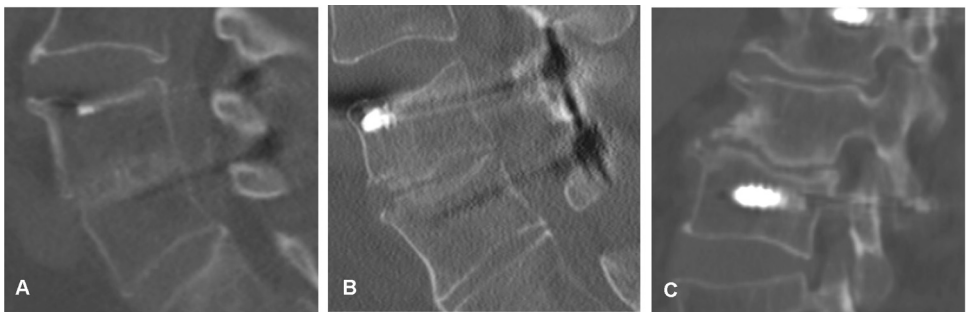

Fig. 5. Postoperative CT at 1-year follow-up showing complete inter-body fusion (A), partial fusion (B), or nonunion (C).

Table 1
Clinical parameters for back pain (VAS) and quality of life (EQ-5D). A probability of change > 0.95 was considered significant between to time points.

VAS	Preoperative	Day 5	6 weeks	3 months	1 year	2 years
Average ± SD	7.0 ± 1.2	3.2 ± 1.8	2.2 ± 1.4	1.9 ± 1.5	1.6 ± 1.5	1.4 ± 1.3
Range	5 to 9	0 to 8	0 to 5	0 to 5	0 to 4	0 to 4
Probability		1.0000	0.9742	0.9279	0.9023	0.9601

EQ-5D	Preoperative	6 weeks	3 months	1 year	2 years
Average ± SD	0.229 ± 0.209	0.563 ± 0.210	0.687 ± 0.216	0.755 ± 0.253	0.787 ± 0.244
Range	−0.036 to 0.687	0.075 to 0.780	0.073 to 1	0.075 to 1	0.070 to 1
Probability		1.0000	0.9992	0.9605	0.9875

Table 2
Radiographic sagittal alignment at the level of spondylodiscitis. Positive values indicate kyphosis and negative values lordosis. A probability of change > 0.95 was considered significant between to time points.

	Preoperative	Day 5	6 weeks	3 months	1 year	2 years
Regional kyphosis						
Average ± SD	8.7° ± 2.9°	3.3° ± 2.8°	4.3° ± 2.7°	4.8° ± 2.5°	5.0° ± 2.8°	4.7° ± 2.6°
Range	0° to 19°	0° to 18°	0° to 17°	0° to 17°	0° to 17°	0° to 19°
Probability		1.0000	0.0695	0.2270	0.4268	0.8344
Sagittal index						
Average ± SD	15.1° ± 13.0°	9.6° ± 13.5°	10.8° ± 13.3°	10.7° ± 12.5°	11.0° ± 13.9°	10.8° ± 12.1°
Range	−12° to 38°	−19° to 32°	−16° to 35°	−17° to 31°	−17° to 35°	−17° to 35°
Probability		1.0000	0.0436	0.3162	0.3008	0.4265

other 25 patients, the bacterial spectrum was: 6 *Staphylococcus aureus* (21.4%), 4 *Staphylococcus epidermidis* (14.3%), 4 *Streptococcus* (14.3%), 4 *Echerichia coli* (14.3%), 3 *Enterococcus* (10.7%), *Proteus mirabilis* (7.1%), *Pseudomonas aeruginosa* (3.6%) and *Eikenella korrodens* (3.6%).

The efficiency of the antibiotic treatment was adjusted to the antibiogram and C-reactive protein. Antibiotics were stopped after 6 weeks in 23 patients and after 12 weeks in the other 5 patients.

3.2. Clinical results

Table 1 summarizes the clinical results. The average VAS for back pain decreased from 7.0 (5 to 9) preoperatively to 3.2 (0 to 8) at day 5. This score was 2.2 (0 to 5) at 6 weeks, 1.9 (0 to 5) at 3 months, 1.6 (0 to 4) at 1-year and 1.4 (0 to 4) at 2-year follow-up. The probability of VAS decrease was > 0.95 within the first 6 weeks. The probability of decrease was < 0.95 between 6 weeks and 1 year.

Quality of life, calculated by the EQ-5D, increased progressively. The average score was 0.229 preoperatively, 0.563 at 6 weeks, 0.687 at 3 months, 0.755 at 1-year and 0.787 at 2-year follow-up. The probability of increase was > 0.95 between each time point.

3.3. Radiographic sagittal alignment

Table 2 demonstrates values of radiographic angle measurements. The average regional kyphosis decreased from 8.7° preoperatively to 3.3° at day 5, and kept stable in the postoperative course: 4.3° at 6 weeks, 4.8° at 3 months, 5.0° at 1-year and 4.7° at 2-year follow-up.

The average sagittal index was 15.1° preoperatively, 9.6° at day 5, 10.8° at 6 weeks, 10.7° at 3 months, 11.0° at 1-year and 10.8° at 2-year follow-up. The probability of variation was 1 from pre- to post-operative and it was < 0.95 in the postoperative course.

3.4. Osteolysis and inter-body fusion

The preoperative extent of vertebral body osteolysis was < 1/3 in 15 cases (53.6%), between 1/3 and 2/3 in 10 cases (35.7%), and > 2/3 in 3 cases (10.7%). Only these 3 patients were treated by a complementary iliac crest graft through a mini-open anterior approach in order to reconstruct the anterior column defect.

At 1-year follow-up, CT showed that inter-body fusion was complete in 17 cases (60.7%) and partial in 5 cases (17.9%). Nonunion was evidenced in 6 cases (21.4%).

3.5. Complications

Four complications were registered: 2 pulmonary atelectases, 1 pedicle screw migration, and 1 hematoma of paravertebral muscles. Revision surgery was not indicated. Septic complications or recurrent spondylodiscitis was not encountered in any patient on follow-up.

4. Discussion

Spondylodiscitis is treated with antibiotics in combination with a brace in patients presenting back pain and a risk for vertebral body collapse [3]. Bettini et al. [4] reported satisfying clinical and radiographic results in 87.6% of their patients, and 12.4% required surgical treatment. Surgery is indicated in major abscess formation, vertebral body destruction, or neurologic impairment [5–13]. Anterior debridement, followed by bone grafting, may enhance the efficacy of antibiotic treatment. This procedure can be performed by a mini-open anterior approach in combination with a posterior percutaneous instrumentation [14]. Spondylodiscitis does not contra-indicate posterior osteosynthesis if an adapted antibiotic treatment is administered [15]. The bacterium identification by a CT-guided or surgical biopsy is recommended to prior to instrumentation [16,17]. Our results confirmed that the course of infection was not influenced by the presence of instrumentation with adequate antibiotic treatment. No recurrence of infection was observed, which is in line with the findings of Deininger et al. [7] and Nasto et al. [9].

The efficacy of posterior osteosynthesis on early pain reduction has been described. Lin et al. [18] demonstrated that the average VAS for back pain decreased from 7.2 preoperatively to 2.2 postoperatively, when using an open instrumentation and fusion. Lin et al. [19] compared percutaneous and open instrumentation in the short-term follow-up of patients with spondylodiscitis. They reported an average VAS of 5.5 versus 4.0 at day 1, and 3.5 versus 2.8 at day 7 for open and percutaneous instrumentation respectively. Deininger et al. [7] reported their preliminary experience on 8 patients treated by percutaneous instrumentation and showed an average pain reduction from 9.1 to 1.7 in the early postoperative period. These authors emphasized the fact that this minimal invasive surgical treatment enabled their patients to ambulate without a brace the first day after surgery. A similar observation was made in our patients. Nasto et al. [9] compared pain in 12 patients treated by percutaneous instrumentation and in 15 patients treated with a brace. The VAS was around 8.5 in both subgroups before treatment. A significant VAS difference was evidenced between operated and braced patients: 2.76 versus 5.20 respectively at 1 month ($p = 0.001$), and 2.34 versus 2.85 at 3 months ($p = 0.016$). There were no significant differences between surgical and brace treatment after 3 months. Our findings are consistent with these previous findings, indicating that percutaneous instrumentation has a significant effect on pain reduction in the short-term follow-up.

In the same study, Nasto et al. [9] demonstrated that the decrease of pain was associated with an improvement of quality of life. The average EQ-5D at diagnosis was close to 0.1 in both subgroups. Post treatment, the score was significantly better after percutaneous instrumentation compared to brace treatment during the first 3 months: 0.763 versus 0.458 at 1 month ($p = 0.001$), and 0.889 versus 0.688 at 3 months ($p = 0.001$). A similar effect of minimal invasive surgery was observed in our patients, over the first year.

Lin et al. [18] reported an average kyphosis correction of 8.5° and a loss of correction of 3.0° over 64 months. A similar amount of correction was measured in our patients. Although kyphosis correction is not the main objective of percutaneous instrumentation in spondylodiscitis, our results confirmed that sagittal alignment was stabilized and that further progression of kyphosis could be avoided. A longer construct might be recommended in cases of major osteolysis. An anterior reconstruction was only indicated if more than 2/3 of the vertebral body was involved. Hadjipavlou et al. [2] reported that a brace treatment could lead to anterior fusion within 6 to 24 months. Frederickson et al. [13] observed a fusion rate of 35% after conservative management. Percutaneous instrumentation seems to improve the likelihood of inter-body fusion. Deininger et al. [7] reported a consistent fusion in their 8 patients. Tschugg et al. [20] showed that minimal invasive debridement and subsequent implantation of titanium TLIF cages was safe in spondylodiscitis treated by antibiotics. Blondel et al. [21,22] demonstrated that anterior bone grafting was mandatory in major osteolysis. This procedure might further prevent the risk for segmental kyphosis. Fusion rates were below 80% in our cohort. Nevertheless, clinical results of patients that evidenced a nonunion were comparable to outcomes of patients with fusion.

The present study has limitations, as the analysis of clinical and radiologic data has been performed retrospectively although our institutional follow-up was standardized at fixed time points. Furthermore, this study does not compare percutaneous instrumentation to conservative treatment.

5. Conclusion

Percutaneous instrumentation seems safe and efficient in the treatment of spondylodiscitis. It improved back pain and quality of life significantly in the early postoperative period and prevented kyphotic deformity. Septic complications were not observed among our patients and the course of antibiotic treatment was not influenced.

A larger prospective randomized trial comparing the effect of brace treatment versus percutaneous instrumentation might be helpful to better formulate indications for minimal invasive surgery in spondylodiscitis.

Disclosure of interest

Yann Philippe Charles: consultant Stryker related to percutaneous instrumentation.

The other authors declare that they have no competing interest.

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None.

Contribution

Arnauld Lambert: study design, data collection and article writing.

Yann Philippe Charles: study design, patient's clinical follow-up and article writing.

Yves Ntilikina: patient's clinical follow-up and review of manuscript.

Nicolas Lefebvre: patient's clinical follow-up and review of manuscript.

Yves Hansmann: patient's clinical follow-up and review of manuscript.

Erik André Sauleau: study design and statistical evaluation.

Jean-Paul Steib: study supervision and review of manuscript.

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