

# Minimally invasive spine surgery in the treatment of pyogenic spondylodiscitis: an initial retrospective series study

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## Abstract

**Introduction:** Pyogenic spondylodiscitis is a bacterial infection affecting the intervertebral disc and its adjacent vertebrae. Although relatively rare, it is a challenging medical disease with a poor prognosis that requires immediate diagnosis and treatment with suitable antibiotics.

**Aim:** To evaluate the clinical outcome of minimally invasive spine surgery (MIS) for pyogenic spondylodiscitis.

**Material and methods:** The retrospective study cohort consisted of 10 consecutive patients who had undergone MIS decompression and/or discectomy for thoracic or lumbar pyogenic spondylodiscitis in our hospital. Data including patient characteristics, symptoms, visual analog scale (VAS) score, surgical approach and postoperative outcomes were obtained for retrospective analysis.

**Results:** Between January 2005 and December 2013, 10 patients underwent MIS decompression in the Department of Orthopedics in our medical university. Seven of these patients had lumbar infections and 3 had thoracic infections. All 10 patients had improved VAS scores immediately after surgery and after discharge. The VAS score (respectively on postoperative day 1 and day 7) suggested that the patients in this study had significantly less pain than preoperatively (day 1: 5 vs. 9,  $p < 0.001$ ; day 7: 2.9 vs. 9,  $p < 0.001$ ). The organism was obtained in 10 (100%) patients by the operative cultures. All patients achieved an excellent clinical recovery without the need for further spine surgery. All patients underwent postoperative imaging during follow-up and showed complete resolution or dramatically improved magnetic resonance imaging changes.

**Conclusions:** Minimally invasive spine surgery is a safe and effective surgical approach for pyogenic spondylodiscitis.

**Key words:** minimally invasive spine surgery, pyogenic spondylodiscitis, spinal infection.

## Introduction

Pyogenic spondylodiscitis is a bacterial infection affecting the intervertebral disc and its adjacent vertebrae. It is a challenging medical disease with a poor prognosis that requires immediate diagnosis and treatment with suitable antibiotics [1]. However, it is relatively rare [2].

The incidence of pyogenic spinal infections is increasing over the last few years and is associated with immunocompromised status, advanced age, invasive

medical procedures, and underlying medical comorbidities [3, 4]. Pyogenic spondylodiscitis has a mortality rate up to 5% and a morbidity rate more than 7% [5]. So far, there is no consensus on the type of intervention which could act as the optimum management for spondylodiscitis. Surgical intervention is necessary when non-surgical treatment fails, neurologic deficit develops, or tissue biopsy is required. Treatment either involves a computed tomography (CT)-guided biopsy with antibiotics or extensive surgery with spinal reconstruction and instrumentation [6].

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Traditionally, anterior debridement and interbody fusion with bone graft have been reported to serve as an effective treatment for pyogenic spondylodiscitis [6], followed by one- or two-stage posterior instrumentation in the event of posterior element deformity or spinal instability [7]. However, it may cause serious perioperative complications and significant comorbidities as it can involve extensive soft tissue dissection and posterior element destruction [7].

In recent years, there has been a marked trend in spine surgery away from open procedures towards minimally invasive spine surgery (MIS) [8], due to the development of special instruments and techniques for percutaneous instrumentation of the thoracic and lumbar spine [9–11]. Compared with open approaches, MIS allows for reductions in blood loss, length of stay, recovery time, and complications [12, 13]. However, MIS for pyogenic spondylodiscitis has not been discussed in China. This study reports the first series of patients with spinal infection in China. We evaluated the clinical outcomes of MIS for pyogenic spondylodiscitis patients who had undergone MIS. The MIS afforded a quick diagnosis that enabled appropriate antibiotic therapy and faster recovery from pain. This surgical approach could reduce the disease burden, and avoid a potentially larger operation.

## Aim

Pyogenic spondylodiscitis is a rare disease with increasing incidence. The MIS for pyogenic spondylodiscitis has not been discussed in China. This study reports the first series of patients with spinal infection in China. The aim of this study was to evaluate the clinical outcome of MIS for pyogenic spondylodiscitis.

## Material and methods

This study was acknowledged by the Institutional Review Board at the our medical university. This work has been reported in line with the STROCSS criteria [14]. The patients were well informed and consent was obtained. The retrospective study was performed according to the principles of the Declaration of Helsinki and its revisions. This single-centre study covered the period between January 2005 and December 2013. All patients underwent surgery for spontaneous pyogenic spondylodiscitis be-

tween the first thoracic and first sacral vertebrae in our medical university. The MIS treatment was selected as the patients had neurological deficits such as spinal cord compression, abscess formation, and bony structures. These patients failed to respond to adequate conservative treatment, which consisted of repeated blood cultures and biopsies with microbiological testing and subsequent specific antibiotic treatment. Patients were excluded from the present study if the infection was due to previous spinal surgery.

Preoperative data included the common patient data such as age, gender, body mass index (BMI), preoperative visual analog scale (VAS) scores; laboratory variables such as white blood cell (WBC) count and C-reactive protein (CRP), symptoms at the time of presentation, and any spinal destruction, including major spinal destruction with resulting spinal instability (kyphosis or scoliosis), and immobilizing back pain that responded inadequately to pain-relieving treatment. The surgical procedure data included estimated blood loss (EBL), total operation time (OT), duration of intraoperative fluoroscopy, and the bacterial organism cultured (BOC). The follow-up data included the VAS scores, laboratory variables of blood in the 4 weeks postoperatively, postoperative imaging and the development of perioperative complications within 30 days of the operation. All these data were subjected to analysis.

All patients underwent a physical examination, plain X-rays and a magnetic resonance imaging (MRI) scan of the whole spine. Their blood samples were taken. Computed tomography scans of the affected area were also performed to evaluate the degree of bony destruction. All enrolled patients were diagnosed with pyogenic spondylodiscitis and received posterior procedures involving percutaneous pedicle screw fixation, according to their own decision after receiving sufficient information regarding MIS approaches.

## Surgical technique

The patient was placed in the prone position after general anesthesia. The Sextant system (Medtronic Sofamor Danek) was used for each percutaneously treated patient. Fluoroscopy was used to localize the correct level, and after determining the skin entry point, a 1.0–1.5 cm incision was made using a 1 cm diameter tubular retractor [15]. This was fol-

lowed by incision of the fascia and blunt dilation of the muscles. The Jamshidi needle was placed according to the modified method that was previously described by Wiesner *et al.* [16]. Thereafter, a K-wire was placed through the Jamshidi needle to guide the screws. After screw insertion, the rods were inserted from the cranial to the caudal and well fixed. If endplate erosion and vertebral bone destruction were relatively subtle, the involved vertebral levels were instrumented. However, if vertebral bone destruction was severe, screws were inserted at one level above and one level below the involved vertebral levels. Four paraspinous skin incisions, each approximately 1.5 cm in length, were made. Under C-arm guidance, the Jamshidi needle was gradually advanced through the pedicle at the optimal entry point, and then the guide wires were inserted. Then the needle was removed and the pedicle preparation cannula was placed after dilatation. The pedicle screws were placed in the standard fashion, and the rods were placed with the aid of a rod guider. These procedures were repeated on the other side of the spine. Plain radiographs were taken immediately after insertion to ensure the accuracy of pedicle screw placement.

The patients were treated after surgery in the intensive care unit according to their general postoperative condition. Even though patients were treated with surgical intervention, the antibiotics still played an important role in treating pyogenic spondylodiscitis. All patients underwent intravenous antibiotic therapy for at least 14 days (range: 15–33 days, including oral and parenteral antibiotics). The treatment plan was discussed with the Department of Infection in our hospital and adjusted according to the culture results, lab data, and clinical symptoms. If symptoms improved and CRP levels returned to normal during hospitalization, patients were allowed to switch to oral antibiotics and were discharged from the hospital. The MRI scans were taken whenever the condition progressed, such as a fever flared up or if the lab data indicated that the condition was worsening. All patients underwent postoperative X-rays of the spinal segment in the lateral and anterior-posterior view 2 days after surgery. Postoperative bony union was defined as intervertebral bony bridges observed on follow-up radiographs taken post-operatively and at 3 months, 9 months, 1 year, and 2 years post-operatively.

## Results

### Study patient demographics and preoperative data

During the study period of 8 years, 10 patients in total were included and underwent MIS procedures for the treatment of spinal infection. The detailed clinical characteristics and preoperative laboratory variables of the enrolled patients are detailed in Table I. There were 7 females and 3 males. The median age was 60 years (58.1 ±12.3). Seven patients only had symptoms of back pain, 1 simultaneously had back pain and bilateral leg pain, and 2 patients had back pain with unilateral leg pain. Nine of the 10 patients were neurologically intact and 1 (10%) patient had a foot drop. The average

**Table I.** Patient demographics, comorbidities and preoperative laboratory variables of the patients who underwent minimally invasive surgery

Characteristic	MIS (n = 10)
Age [years]	58.1 ±12.3
Gender:	
Female	7
Male	3
Preoperative VAS score	9.0 ±1.1
Symptoms:	
BP	7 (70%)
BP and bilateral leg pain	1 (10%)
BP and unilateral leg pain	2 (20%)
Neurologically symptoms:	
None	9 (90%)
Foot drop	1 (10%)
Bacterial culture (positive)	10 (100%)
Infections spine:	
Lumbar spine	7
Thoracic spine	3
Preoperative laboratory variables:	
WBC count [ $\times 10^3$ cells/l]	12.0 ±4.8
CRP [mg/l]	62.2 ±78.3

Data are expressed as number (%) or mean ± standard deviation. MIS – minimally invasive surgery, BP – back pain, WBC – white blood cells, CRP – C-reactive protein.

**Table II.** Results of surgical variables for the included patients

Variables	MIS (n = 10)
OT [min]	111.5 ±46.0
EBL [ml]	40 ±32.5
BT	0 (0%)
Hospital stay [day]	21.7 ±17.0
Perioperative complications:	
Incidental durotomy	0 (0%)
Urinary tract infection	0 (0%)
Screw malposition	0 (0%)
Screw site wound problem	1 (10%)

Data are expressed as number (%) or mean ± standard deviation. MIS – minimally invasive surgery, OT – operation time, EBL – estimated blood loss, BT – blood transfusion.

**Table III.** Results of BOC and antibiotic treatment

Variables	MIS (n = 10)
BOC:	
MSSA	3 (30%)
MRSA	2 (20%)
<i>S. epidermidis</i>	1 (10%)
<i>P. aeruginosa</i>	1 (10%)
<i>K. pneumoniae</i>	2 (20%)
<i>E. coli</i>	1 (10%)
Laboratory variables after antibiotic treatment 2 weeks:	
WBC count [ $\times 10^3$ cells/l]	4.3 ±2.1
CRP [mg/l]	1.2 ±0.5

Data are expressed as number (%) or mean ± standard deviation. MIS – minimally invasive surgery, BOC – bacterial organism cultured, MRSA – methicillin-resistant *Staphylococcus aureus*, MSSA – methicillin-sensitive *Staphylococcus aureus*.

**Table IV.** Results of visual analogue scale score for the included patients

Schedule	VAS score (n = 10)
Preoperative	9.0 ±1.1
Next day after operation	5 ±1.3*
Seven day after operation	2.9 ±1.1*

Data are expressed as mean ± standard deviation. VAS – visual analogue scale, \* $p < 0.01$ .

preoperative VAS was 9.0 ±1.1. All 10 patients had positive cultures (blood) before surgical intervention. Nine of the 10 patients were started on antibiotics before neurosurgical symptoms. Of the 10 patients, 3 patients had infections of the thoracic spine, and 7 patients had lumbar spine infections. The preoperative WBC counts of all the patients was  $12.0 \pm 4.8 \times 10^3$  cells/l and the CRP was 62.2 ±78.3 mg/l.

### Surgical results in detail

The surgical outcomes of the included patients are described in Table II. The average EBL was 40 ±32.5 ml, the average operative time was 111.5 ±46.0 min. No patients (0%) underwent blood transfusion during the operation. The overall hospital stay was 21.7 ±17.0 days. In the 10 included patients, only 1 (10%) patient had a screw site wound and persistent bleeding. After intensive hemostatic treatment for 30 min, these symptoms were relieved. No patient experienced incidental durotomy, screw malposition or urinary tract infection perioperatively.

### Bacterial organism cultured (BOC) and antibiotic treatment

These laboratory variables 2 weeks after antibiotic treatment are shown in Table III. The positive culture rate from deep tissue biopsy was above 100% (10/10 for the included patients). The most common organism encountered was methicillin-sensitive *Staphylococcus aureus* (MSSA). Three patients had positive MSSA culture. Two patients had positive methicillin-resistant *S. aureus* (MRSA) culture. Two patients had positive *Klebsiella pneumoniae* culture. Single patients had positive *Staphylococcus epidermidis*, *Pseudomonas aeruginosa* and *Escherichia coli* culture. Two weeks after antibiotic treatment, the average WBC counts of all the 10 patients was  $4.3 \pm 2.1 \times 10^3$  cells/l and the average CRP was 1.2 ±0.5 mg/l.

### The VAS score in follow-up

The VAS score data of all the included patients are summarized in Table IV. The average preoperative VAS was 9.0 ±1.1. The VAS score (respectively on postoperative day 1 and day 7) suggested the patients in this study had significantly less pain than preoperatively (day 1 : 5 vs. 9,  $p < 0.001$ ; day 7 : 2.9 vs. 9,  $p < 0.001$ ). During the follow-up for 5 to 13 months, neither recurrent infection nor intraopera-

tive complications (such as wound infection or screw loosening) were found in this study.

## Discussion

Many spinal surgeons have started to adopt minimally invasive strategies to minimize the access-related morbidity [17–19]. However, to be considered as a viable alternative, MIS must be equivalent to traditional open techniques in terms of safety, pain reduction and neurological outcomes. Pyogenic spondylodiscitis can be treated nonsurgically with antibiotics and immobilization. Spinal infections infrequently require operative treatment, especially when the patients have neurologic deficits, epidural abscess or kyphotic deformity [20]. Whether this is the case for the surgical treatment of spinal infections has not yet been examined thoroughly. This study was performed to determine whether MIS is a safe and effective approach for patients with thoracic or lumbar pyogenic spondylodiscitis.

The diagnosis of a spinal infection is made based on clinical histological evidence and appropriate cultures. However, the pathogen identification rate varies among different studies [15, 21, 22]. Computed tomography-guided cultures are often negative, especially when patients have empirical preprocedural antibiotic treatment for a suspected infection. A negative culture result may challenge the presence of infection and may require treatment with broad spectrum antibiotics which are not optimized to the actual pathogen. In this study the positive culture rate from deep tissue biopsy was above 100% despite almost all of them being on antibiotics before surgery. The most common organism encountered was MSSA. This result was in accordance with a previous study [22], suggesting that the MIS techniques yield higher diagnostic efficacy.

With the guidance of culture results, we gave antibiotic treatment to the included patients, and all the WBC counts improved. MIS adequate tissue for histopathology and cultures not only determines the correct bacteria but also helps us to rule out tuberculosis, sterile discitis, and fungal or parasitic spinal infections [23].

Localized back pain is the most common presentation of pyogenic spine infections. In this study, all the 10 patients had symptoms of back pain, 1 had additional bilateral leg pain, and 2 had extra unilateral leg pain. Previous studies suggested that spine

surgery might improve pain in patients with discitis. Nasto *et al.* [24] found that patients with single-level noncomplicated spondylodiscitis, surgical stabilization with percutaneous screw, and rod stabilization had faster recovery, lower pain scores, and improved quality of life compared to patients with thoracolumbar bracing. Our results showed that the average preoperative VAS was  $9.0 \pm 1.1$ . The VAS score on postoperative day 1 and day 7 suggested that patients in this study had significantly less pain. Our study found quick pain relief from a VAS of 9.0 to 2.9 after MIS surgery and antibiotic treatment. MIS obviously improved localized back pain in patients with pyogenic spine infections. On one hand, MIS could increase the sensitivity of organism culture. This would enable the patients to receive antibiotic treatment as soon as possible. On the other hand, MIS techniques enable drainage of infected material, prompt relief of pain, and early patient mobilization. Reduction of pain allows for early patient mobilization [25].

Previous studies suggested that promoted MIS surgery was indicated in patients with pyogenic infection with an epidural abscess [20]. Our study showed that even in the presence of spondylodiscitis without an epidural abscess, it is possible to use MIS techniques to drain infected material and result in immediate improved functional recovery [26]. The MIS techniques allow for a less invasive approach that may be appropriate for patients with extensive comorbidities that exclude a larger surgical approach [27]. Previous studies have also discussed the use of MIS to treat pyogenic spondylodiscitis. While percutaneous endoscopic techniques are not suitable for all surgeons, we do believe that MIS techniques and surgery through a tubular retractor are a familiar technique to many spine surgeons. The same MIS techniques can be applied to drain and obtain tissues for patients with lumbar and thoracic discitis. The combined effect of antibiotics and percutaneous fixation achieved quick pain relief and rapid mobilization. However, patients receiving posterior instrumentation without interbody fusion can still incur anterior bony defects and may require additional long segment instrumentation. In cases of discitis which are often managed with a biopsy and antibiotics, early debridement of these infections by percutaneous discectomy can accelerate the natural process of healing and prevent progression to bone destruction and epidural abscess. The

delayed treatment may result in serious neurologic complications [28, 29]. This study demonstrates that MIS techniques do not result in an increased rate of secondary surgery. If the infectious process were arrested, further bone destruction and subsequent surgery would be avoided.

Although this study provides encouraging results for minimal invasive spine surgery, it has several limitations. It was designed as a retrospective non-randomized cohort study. The relatively small sample size may affect the outcomes available for analysis. In addition, the approach used in the second-staged posterior fixation procedure depended upon each patient's individual preference, which may have incurred some bias. However, this study provides important information regarding MIS fixation in patients with spondylodiscitis who need surgical intervention. Particularly, MIS is suggested in patients with multiple comorbidities who are at high risk of perioperative complications [30].

## Conclusions

This series suggests that MIS surgical techniques are safe and efficacious, to relieve pain dramatically. This surgery provides a high yield culture to guide appropriate antibiotic therapy in patients with thoracic and lumbar spondylodiscitis. A larger sample, prospective, randomized trial should be carried out to validate these findings.

## Conflict of interest

The authors declare no conflict of interest.

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