Posterior mono-segmental fixation, combined with anterior debridement and strut graft, for treatment of the mono-segmental lumbar spine tuberculosis

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Abstract

Purpose A retrospective study was conducted to determine the beneficial effect of posterior mono-segmental fixation, combined with anterior debridement and strut graft for the treatment of mono-segmental lumbar spine tuberculosis.

Methods From February 2002 to February 2008, a total of 34 cases with mono-segmental lumbar spine tuberculosis were treated by posterior mono-segmental fixation, combined with anterior debridement and strut graft. The degree of damage to the patients' vertebral bodies was 1/3–2/3 height. Antituberculous therapy was performed both before and after surgery.

Results None of the patients suffered from spinal cord, nerve, great vessel or organ damage, with all patients passing through the peri-operative period successfully. Graft union was observed four to six months after surgery, with a mean of five months. In addition, no fracture or prolapsed internal fixation was found. The Cobb's angle prior to and after surgery, and at the final follow-up were $22.70 \pm 9.8^\circ$, $4.5 \pm 8.4^\circ$ and $5.30 \pm 7.10^\circ$, respectively, with a mean correction of $18.20 \pm 5.8^\circ$ after surgery; however, $1.70 \pm 1.0^\circ$ loss was observed at the final follow-up. Four cases with neurological lesions recovered to 'E' grade. At the final follow-up, all patients could live and work normally.

Conclusions The results demonstrated that for cases with 1/3–2/3 height of vertebral body damaged in mono-segmental lumbar spine tuberculosis, treatment with posterior mono-segmental fixation, combined with anterior debridement and strut graft, can cure foci, rebuild spinal stability, reduce fused segments, and retain maximal function of the motion units.

Introduction

More than 50 years have passed since surgeons utilized the “Hong Kong operation” to treat spinal tuberculosis. Autologous iliac bone grafting can shorten the duration to obtain a fusion of the focus. However, instability of graft in the “Hong Kong operation” leads to graft movement, absorption and breakage; these complications pose problems for the use of graft fusion and have been shown to cause a high incidence of kyphosis deformity [1–3]. To solve this problem, anterior or posterior internal fixation is commonly selected in combination with “Hong Kong operation” to prevent and correct the deformity, stabilize the spinal cord, promote graft fusion and facilitate quick patient recovery [4–9]. Nowadays, debridement, deformity correction, graft fusion, as well as internal fixation are routine methods for the treatment of spinal tuberculosis [10–13].

An anterior approach is the conventional treatment strategy for spinal tuberculosis debridement. As for the range of internal fixation, authors have differing views. At present, focus size is ignored by most authors, and the range of fixation and/or fusion comprises one or multiple normal motion units above and below the lesion(s) in the anterior approach or posterior approach [14–18]. While this type of fixation provides strong support, it sacrifices the motion and function of the fixed segment, and may lead to degeneration of neighbouring segments [19, 20]; this is particularly a concern for the lumbar portion of the vertebral column, as it requires a larger range of motion than the rest of the column. In fact, the remaining 1/3–2/3 vertebral height is enough to accommodate the conventional transpedicular screw after debridement, and it can avoid fixing across the normal intervertebral space. In this study, posterior mono-segmental fixation, combined with anterior debridement and a strut graft, was used to treat mono-segmental lumbar spine tuberculosis.

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Material and methods

Case inclusive and exclusive criteria

A total of 34 cases with mono-segmental lumbar spine tuberculosis were selected. These patients had been admitted to the Department of Orthopedics, Affiliated Hospital of Ningxia Medical University between February 2002 and February 2008, were treated by surgery, and had a follow-up appointments more than three years later. Patients were selected if they had damage to one motion unit, and showed a range of vertebral destruction between 1/3–2/3 of the original vertebral body height, as determined by three-dimensional CT. Patients were excluded if they showed serious active tuberculosis and could not undergo vertebral fixation or if the spinal tuberculosis was present with kyphosis deformity. The cohort comprised 19 males and 15 females, aged 20–56 years, with an average age of 37.8 years. Damage to the vertebra was as follows: eight cases with L1–2 damage, nine cases with L2–3 damage, six cases with L3–4 damage, seven cases with L4–5 damage, and four cases with L5–S1 damage. The pre-operative Frankel grading showed that two cases were grade B, one was grade C, one was grade D, and 30 were grade E (Table 1). The pre-operative CT examination showed irregular cavitation of the vertebral bodies in 34 cases, with bony sequestration surrounded by a high-density shadow. MRI examination showed vertebral body damage, as follows: 18 cases with a psoas abscess, six cases with a deep abscess in the vertebral canal and a compressed dural sac, and two cases with sinus tract formation in addition to abscess formation.

Surgery strategy

The surgical indications for the cases were as follows: cases with spinal cord or cauda equina nerve or root compression causing neural functional disorders; cases where the stability of spine had been destroyed; cases with serious or progressive kyphosis deformity; and cases accompanied by large abscess formation, bone sequestration, cavitation or sinus tract formation.

Table 1 Pre-operative and postoperative neurological status of 34 patients

Frankel scale on admission	Frankel scale at final follow-up				
	A	B	C	D	E
A					
B					2
C					1
D					1
E					30

Patients were confined to bed rest to prevent disease aggravation. Patients were administered with 0.3 g Isoniazid, 0.45 g Rifampicin, and 0.75 g Pyrazinamide, as well as daily intramuscular injections of 0.75 g streptomycin. Anti-tuberculosis therapy was carried out for two to four weeks, with an average of 2.5 weeks. All therapy was continued after surgery. The overall treatment period was five to 24 months (mean of seven months). Nutritional support was provided to correct for hypoproteinemia, and liver and renal functions were monitored.

Single segment fixation was first conducted via a posterior approach. The affected segment was located by C-arm radiography. During transpedicular screw insertion, the site should be situated at a distance from the foci, but close to the end-plate to avoid exposing the screw after debridement. The apparatus was then used to manipulate body posture to correct kyphosis deformity, as required. After fixation, secondary operations were performed on specific cases depending on their physical status. Overall, 26 cases underwent a one-stage operation; eight cases underwent secondary operations.

Next, the most damaged side of the vertebral body was exposed; 20 cases underwent a left approach, whereas 14 cases underwent a right approach. Only two adjacent affected vertebral bodies were exposed, and any damage or disease was cleared, including psoas abscess, caseous tissue, residual intervertebral disc tissue, sinus tract formation, bony sequestration and inflammatory granulation. The tuberculosis cavity and sclerotic wall, as well as bony bridges that had no support and were eroded by a focus, were also removed. Anterior decompression was used, and autologous iliac bone graft was implanted into the defect (Fig. 1).

The drainage tube was removed when the drainage volume reached 20–50 mL, 24 hours after surgery. Following four weeks of bed rest, patients were permitted ambulant activity using a brace. Informed content was obtained from each patient and the experiment was approved by the Ethics Committee of the hospital.

Clinical and imaging evaluations

All cases were required to have a follow-up once per month in the first six months after surgery, which was then extended to annual check-ups. Examination by X-ray, CT and/or MRI was performed at each follow-up. The Cobb's angle was measured using a lateral projection X-ray, and any loss in the corrected angle was calculated as Cobb's angle in the follow-up minus that after surgery. Patients were followed-up for various changes, including physical symptoms and signs, degree of rehabilitation of neurological function assessed by the Frankel scale, recovery of daily life, or other complications. Graft union was assessed according to Moon [7], based on CT and X-ray. Laboratory examinations comprised erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP), as well as liver and renal functions.

Fig. 1 **a** Three-dimensional reconstruction CT shows tuberculosis at L1–2 segment. **b** MRI shows tuberculosis at L1–2 segment and abscess formation around the vertebrae. **c, d** The graft has united, without fixation loosening at four months following treatment with posterior

mono-segmental fixation, combined with anterior debridement and strut graft. **e, f** X-ray film shows graft union and no obvious correction angle loss four years after surgery

Statistical analysis

Experimental data were expressed as mean±standard deviation (SD), and statistical analysis was conducted using SPSS 18.0 statistical software (SPSS, Chicago, IL, USA).

Results

No case suffered from spinal cord, nerve, great vessel or organ injury during surgery. All cases passed through the peri-operative period successfully. There was a mean follow-up time of 5.2 years, ranging from three to nine years.

All patients had recovered from tuberculosis at the final follow-up. ESR and CRP levels were normal, and no abscess or sinus tract formation could be found. Imaging examinations showed that the graft had united without cavitation or bony sequestration. Graft union was identified within four to six months after surgery, with an average of five months. No fracture or prolapsed internal fixation was found. The Cobb's angle prior to and after surgery, as well as at the final follow-up, was $22.70 \pm 9.8^\circ$, $4.5 \pm 8.4^\circ$ and $5.30 \pm 7.10^\circ$, respectively, with a mean correction of $18.20 \pm 5.8^\circ$ after surgery. However, $1.70 \pm 1.0^\circ$ was lost in the final follow-up. Four patients with neurological lesions recovered to a grade of E (Table 1). At the final follow-up, all patients reported a normal return to their life and work.

There were five patients with complications after surgery: one case suffered from wound infection, which was cured after the local dressings were changed; one case had intercostal neuralgia; two cases had pain at the graft harvesting site; one case presented with psoas major abscess formation after three months on the contralateral side to where the surgery was performed, and was cured by incision and drainage; and one case accepted a secondary surgery because of incomplete debridement, and was cured after the second surgery.

Discussion

The results of clinical and imaging examination demonstrated that, for cases with 1/3–2/3 height of vertebral body damaged in mono-segmental lumbar spine tuberculosis, treatment using posterior mono-segmental fixation, combined with anterior debridement and strut graft, can cure foci and effectively decrease the incidence of kyphosis deformity. Furthermore, the results also demonstrate that the insertion of transpedicular screws into the affected vertebrae does not lead to the recurrence of tuberculosis. In our department, cases whose residual height of the adjacent vertebral body is greater than 2/3 after debridement, centrum screws should be used via an anterior approach to fix the vertebral body. However, if the residual height is less than 1/3, space is limited for the use of centrum screws, and the short-screw fixation was used. These cases were excluded and not discussed in this paper.

In 1995, Moon et al. [7] reported that a posterior approach to fixation achieved good results in the treatment of spinal tuberculosis; however, the Harrington system was used in their study, which required a large range for fixation and fusion. At present, most surgeons adopt a pedicle screw system in posterior fixation, but the range of fixation and fusion is still greater. In similar cases, Talu et al. [16] used pedicle screw-rod or hook-rod combinations for two levels above and below the lesion at the thoracic region and pedicle screw-rod combination for one level above and below the lesion at the lumbar region in 127 patients who

were operated on for TB of the spine. Lee et al. [21] suggested the next option, that at least two of the normal vertebral body were fused at the thoracic and thoracolumbar region. For the lumbosacral region, Bezer et al. [22] recommended that the fixation included a normal vertebral body above and below the affected vertebra. Besides providing strong fixation, these fixation and/or fusion modes which included only one or a few normal motion units affect the spine in both structure and motor function because excess normal segments are involved in the fixation. Unlike other fixation procedures, in this paper, only the affected motion unit was fused and fixed, and the procedure was performed with limited surgical access, thus causing little damage to the structure and physiological function of the spine.

Over the past few years, there is documented evidence to suggest that satisfactory mid- and short-term results can be achieved if the spinal motion units remain during mono-segmental pedicle screw fixation in spinal fracture [23, 24]. Here, all patients with mono-segmental lumbar spine tuberculosis underwent anterior debridement and strut graft in addition to posterior mono-segmental fixation; this is different from previous studies in spinal fracture. Compared with other single segment fixation for spinal fracture, the surgery in this paper shows a more favourable result in maintaining spinal stability because of reconstructing the anterior and middle column of spine. The correction rate of kyphosis deformity is greater than previously documented, which may result first from using a posterior fixation, followed by anterior debridement and graft implantation. Using this surgery scheme, the patient undergoes deformity correction before graft implantation. However, most surgeons employ anterior debridement and interbody grafting, followed by a posterior fixation to correct deformity [7, 9, 14–16]. We think this would weaken the role of correction of posterior fixation. It would lead to graft shifting or shedding and affect its fusion rate if there is a larger correction required.

Although, internal fixation for spinal tuberculosis is safe [8, 14, 18, 25]. For cases with 1/3–2/3 height of vertebral body damaged in mono-segmental lumbar spine tuberculosis, if anterior internal fixation is selected after debridement, there will not be enough space in the damaged lumbar body for graft implantation; this, in turn, will prolong fixation and/or require fusion of the segment to the consecutive segment, which may lead to multi segmental surgery. These circumstances increase the operative scope and can potentially lead to more complications. The main aim of the surgery scheme presented here is to reduce segment fusion and provide the advantage of maintaining normal motion of the spine.

Another benefit of the method presented here is that it increases the graft union site as well as the stability of the spine. Furthermore, it can reduce graft deformation or breakage. The surgery field is small and causes minor trauma to the patients. The main point of our surgery is to ensure there is no

focal zone at the front of the screw fixation; otherwise, the screw would be exposed during anterior debridement.

Our surgery method also has some deficiencies. Because of the weak posterior approach to mono-segmental fixation, this method is not suitable for: (1) patients with severe kyphosis deformity, (2) aged or osteoporotic patients and (3) patients with tuberculosis with bone healing or bone silent oscillation, accompanied by kyphosis deformity; these patients require osteotomy or internal fixation.

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