Clinical Study

Complete debridement for treatment of thoracolumbar spinal tuberculosis: a clinical curative effect observation

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Abstract

BACKGROUND CONTEXT: Traditional focal debridement involves clearing of cold abscesses, caseous necrosis, residual intervertebral disc tissue, sinus tracts, bony sequestration, and inflammatory granulation. Reports have demonstrated that approximately 13\% to 26\% of patients were not better or relapsed after traditional focal debridement; these patients required a second surgery or prolonged antituberculous therapy. The presence of retained and diseased focal tissues requiring removal remains poorly understood. The contents of these retained tuberculous foci, improvement of surgical strategies, and improvement in spinal tuberculosis success rate are key subjects for discussion.

PURPOSE: To explain the contents of foci and explore the surgical methods and curative effect of complete debridement.

STUDY DESIGN: Retrospective study of the curative effect of treatment of thoracolumbar spinal tuberculosis by using complete debridement.

PATIENT SAMPLE: A total of 289 patients were included.

OUTCOME MEASUREMENT: The outcomes were evaluated clinically by Frankel grading. The status of the anterior fusion was assessed according to the Moon standard. Eradication of infection was determined by the level of C-reactive protein and erythrocyte sedimentation rate. X-ray, computed tomography, and magnetic resonance imaging were used to evaluate disease localization and morphology.

METHODS: A total of 289 patients with spinal tuberculosis (150 male and 139 female patients, aged 18–82; average age, 41.0±1.4 years) were included in this study. Damage to the vertebrae was as follows: 86 patients had thoracic damage, 49 had thoracolumbar damage, 125 had lumbar damage, and 47 had lumbosacral segment damage. After 2 to 4 weeks of antituberculous therapy, all patients underwent anterior debridement, deformity correction, graft fusion, and internal fixation. In this study, complete debridement was defined as the clearing of any damage or disease, including psoas abscesses, granulomas, residual intervertebral disc tissue, sinus tracts, bony sequestration, and inflammatory granulation. Tuberculosis cavities, sclerotic walls, and bony bridges that had no support and that were eroded by the foci were also removed. A total of 108 patients underwent anterior fixation with the Zephir system (Medtronic Sofamor-Danek, Minneapolis, MN, USA), Z plates (Medtronic Sofamor-Danek), or Ventrifix (China Great Wall Corporation, Beijing, China). A total of 181 patients underwent fixation, posterior correction, and one or two second anterior debridements and graft fusions. Posterior fixation, including TSRH (Medtronic Sofamor-Danek), Cotrell-Dubousset (Medtronic Sofamor-Danek), General Spinal System (WeiGao Orthopaedic Devices Company, Weihai City, China), or UPASS (WeiGao Orthopaedic Devices Company), was performed. All patients underwent structural bone grafting, including autologous iliac bone (251 patients), titanium mesh (32 patients), and rib (6 patients).

RESULTS: The 289 patients were followed for 72.0±2.8 months, with 265 patients (91.69\%) completely treated and 24 incompletely treated, including 3 who suspended chemotherapy because

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Introduction

In the 1930s, Ito et al. [1] performed anterior surgery to treat spinal tuberculosis, and in the 1950s, focal debridement was applied in China [2]. Hodgson and Stock [3] performed “Hong Kong Surgery” to treat spinal tuberculosis, and the curative effect was obviously increased. Sixty years have passed since the use of focal debridement, which remains an elementary but key method for the treatment of spinal tuberculosis. The results of focal debridement determine patient outcomes [1–9]. In 1969, Wilkinson [10] stated that the problem with spinal tuberculosis surgery was how to reach an effective concentration of antituberculous drugs in the disease focus. Traditional focal debridement involves complete clearing of cold abscesses, caseous necrosis, residual intervertebral disc tissue, sinus tracts, bony sequestration, and inflammatory granulation. However, clinical reports have demonstrated that some patients were not cured or experienced relapse after traditional focal debridement; these patients required a second surgery or prolonged antituberculous therapy [10–12]. For this reason, we performed both basic and clinical research involving clinical surgery, histopathology, pharmacokinetics, and bacteriology [13–15]. From this research, we found that sclerotic bone, multiple cavities, and bony bridges were areas of focus in spinal tuberculosis and were the main causes for delayed cure after spinal surgery; thus, they should be completely removed during debridement [13,14,16]. Based on this finding, we retrospectively studied 289 patients who underwent complete debridement in our hospital to explore the effectiveness of this spinal tuberculosis treatment method.

Materials and methods

General data

A total of 324 patients with spinal tuberculosis who underwent complete debridement from January 2000 to January 2010 were selected. Because of failed follow-up in 17 patients, refusal of chemotherapy by 15 patients, and death during follow-up in 3 patients, a total of 289 patients were followed. The cohort comprised 150 male and 139 female patients aged 18 to 82 (average age, 41.0 ± 1.4 years). Vertebral damage was as follows: 86 patients had thoracic damage, 49 had thoracolumbar damage, 125 had lumbar damage, and 47 had lumbosacral segment damage; 9 patients had one affected vertebra, 204 had five single affected segments, 49 had two affected segments, 10 had three affected segments, 10 had four affected segments, and 7 had five or more affected segments; 37 patients had active tuberculosis and 24 had other tuberculosis; 75 patients had paraspinal abscesses, 136 had psoas abscesses, 26 had iliac abscesses, 5 had lumbar triangle abscesses, 11 had gluteal abscesses, and 14 had sinus tract formation; 35 patients had paraplegia, and preoperative Frankel grading showed that 2 patients were grade A, 5 were grade B, 27 were grade C, and 1 was grade D. A total of 204 patients had low-grade fever, night sweats, hypodynamia, and pain associated with diseased regions on admission to the hospital. All patients were confirmed to have spinal tuberculosis based on clinical manifestations, imaging, and histopathology. Seventeen patients who relapsed or were not cured after surgery were from other hospitals.

Preoperative preparation

All patients required bed rest and underwent antituberculous therapy for 2 to 8 weeks (average duration, 3.1 ± 1.2 weeks). Complete debridement was performed when patients had no surgical contraindications.

Imaging examination

Radiographs, computed tomography (CT), non–contrast-enhanced scan, and three-dimensional reconstruction, and plain and enhanced magnetic resonance imaging (MRI) scans were performed for all patients. Radiographs showed that 237 patients had kyphosis. Based on CT scanning, vertebral damage was divided into osteolytic and sclerotic...
types: 70 patients (24.22%) had osteolytic damage and 219 patients (75.78%) had sclerotic damage, 201 (91.78%) of whom had disease in multiple cavities and 18 (8.22%) of whom had disease in single cavities; 29 had affected bony bridges, and 72 (24.91%) had vertebral canal involvement (Table).

Surgical strategy

The indications for surgery were as follows: spinal cord or cauda equine nerve or root compression causing neurological dysfunction; destroyed spinal stability; serious or progressive kyphosis; large abscess formation, bone sequestration, cavitation, or sinus tract formation; and drug or multidrug resistance.

All patients underwent anterior debridement, focal graft implantation, anterior or posterior deformity correction, and internal fixation. A total of 108 patients underwent anterior fixation with the Zephir plate system (Medtronic Sofamor-Danek, Minneapolis, MN, USA), Z-plates (Medtronic Sofamor-Danek), or Ventrifix (China Great Wall Corporation, Beijing, China). A total of 181 patients underwent fixation, posterior correction, and one or two anterior debridements and graft fusions. Posterior fixation, including TSRH (Medtronic Sofamor-Danek), Cotrell-Dubousset (Medtronic Sofamor-Danek), General Spinal System (Weigao Orthopaedic Devices Company, Weihai City, China), or UPASS (Weigao Orthopaedic Devices Company), was performed. Focal body support bone grafts were performed, including autologous iliac bone (251 patients), titanium mesh (32 patients), and rib (6 patients).

Complete debridement

Elementary method

Traditional debridement involves complete removal of abscesses, caseous necrosis, residual intervertebral disc tissue, sinus tracts, bony sequestration, and inflammatory granulation. The fiber envelopes of osteolytic foci are also removed.

Complete debridement

Based on the elementary method, the following tissues are removed. First, the focal walls, especially the sclerotic walls, must be cut down. The focal walls comprise fiber envelopes of osteolytic foci and sclerotic walls surrounding affected vertebrae. The former are easy to clear by scraping, but the latter should be slowly cleared in a series of steps (cutting, grinding, and chipping). Because of the hard surface of the bone walls, it is better to remove several millimeters of affected bone structure. The extension of removal can be larger than the focus to ensure good graft implantation. Second, multiple cavities should be excised. The multiple cavities should be completely removed in patients with sclerotic tuberculosis. Third, all affected bony bridges should be excised. Bony bridges comprise two types. The first type, which has a bone fistulous opening, with a wrapped tuberculous focus and an uneven surface, no blood supply or a poor blood supply, and has no effect on the supporting spine, must be cut (Fig. 1). The second type, which is thick and has a good blood supply, fuses well with the vertebrae. In the present study, although there was a small tuberculous focus, it was easily cleared. The sign of complete removal is a well-distributed broken bone end; sand gravel; and no sclerotic walls, cavities, or residual tuberculosis.

Postoperative treatment and chemotherapy

The drainage tube was removed when the volume decreased to 50 mL, 24 hours after surgery. Drainage tubes could be maintained for 10 days for abscess cavities. The SHRZ (S: streptomycin, H: isoniazid, R: rifampicin, and Z: pyrazinamide) scheme was continued postoperatively, and direct observation was performed for a short time. Following 1 month of bed rest, off-bed activity with a brace was permitted. Spinal flexion, lateral flexion, and rotation were prevented in the first 3 to 4 months postoperatively, and the patients returned to daily life after 4 to 5 months.

Main outcome measures

Preoperative and postoperative case histories were collected by a specially assigned person. Observations comprised (1) clinical manifestations, including toxic symptoms, local pain, spinal function, and recovery of daily life and work; (2) laboratory examination, including erythrocyte sedimentation rate (ESR), C-reactive protein (CRP) level, and liver and renal functions; and (3) imaging, including radiographs, CT scan and three-dimensional reconstruction, plain and enhanced MRI scans, and B-ultrasonic wave. The Cobb angle was measured according to Cengiz et al. [17], and graft union was assessed by the Moon standard [18].

Table

Vertebral body damage in 289 patients with spinal tuberculosis

<table>
<thead>
<tr>
<th>Focus type</th>
<th>Sclerotic type</th>
<th>Osteolytic type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Damage type</td>
<td>219</td>
<td>75.78</td>
</tr>
<tr>
<td>Sequester</td>
<td>175</td>
<td>79.91</td>
</tr>
<tr>
<td>Cavity</td>
<td>219</td>
<td>100.00</td>
</tr>
<tr>
<td>Single</td>
<td>18</td>
<td>8.22</td>
</tr>
<tr>
<td>Multiple</td>
<td>201</td>
<td>91.78</td>
</tr>
<tr>
<td>Sclerotic wall</td>
<td>219</td>
<td>100.00</td>
</tr>
<tr>
<td>Circumferential sclerosis</td>
<td>47</td>
<td>21.46</td>
</tr>
<tr>
<td>Bony bridge</td>
<td>38</td>
<td>17.35</td>
</tr>
<tr>
<td>Affected</td>
<td>29</td>
<td>76.32</td>
</tr>
<tr>
<td>Nonaffected</td>
<td>9</td>
<td>23.68</td>
</tr>
<tr>
<td>Abscess</td>
<td>211</td>
<td>98.60</td>
</tr>
<tr>
<td>Single</td>
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<td>28.91</td>
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<tr>
<td>Double</td>
<td>150</td>
<td>71.09</td>
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<tr>
<td>Vertebral canal involved</td>
<td>69</td>
<td>31.51</td>
</tr>
</tbody>
</table>
Statistical analysis

Experimental data were expressed as mean±standard deviation, and statistical analysis was conducted by using SPSS 11.5 statistical software (SPSS, Chicago, IL, USA).

Results

A total of 289 patients were followed (range, 18–120 months; average, 72±2.8 months). A total of 265 patients were cured, 24 were incompletely cured, and 9 underwent a second surgery.

Clinical manifestations

The toxic symptoms and local pain of 216 patients (74.74%) were relieved or disappeared 1 to 2 months after surgery. A total of 244 patients (84.43%) returned to normal life and work after 4 to 6 months (average, 4.5±1.2 months).

Recovery of neurological functions

Postoperative Frankel grading showed that 35 patients, including 2 with grade A (postoperative one was grade C and another was grade D), were improved; 1 was grade C, 3 were grade D, and 31 were grade E.

Laboratory examination

The preoperative ESR and CRP levels were (39.26±11.53) mm/1H and (27.38±9.67) mg/L, respectively. These levels decreased quickly in 69 patients (23.88%) after 4 weeks and returned to normal at the final follow-up in 96% of patients.

Chemotherapy and duration

SHRZ chemotherapy was continued after surgery, including 161 patients who received ultra short-course chemotherapy (<6 months), 44 who received short-course chemotherapy (6–9 months), and 84 who received standard chemotherapy (9–12 months). A total of 108 patients experienced side effects, such as gastrointestinal reaction, liver impairment, damage to the nervus statoacusticus, and vision impairment, and all completed chemotherapy after appropriate treatment. Three patients suspended chemotherapy because of renal failure (one patient) and liver failure (two patients), and they were not cured.

Imaging examination results

Bone graft healing was observed 4.3±1.2 months after surgery. The Cobb angle before and after surgery and at the final follow-up was 22.16±11.51°, 8.11±4.83°, and 9.96±3.49°, respectively, with a mean correction of 63.40% after surgery; however, a 1.85±1.34° loss was observed at the final follow-up, with a loss rate of 8.35%.

Focal impaired cure and complications

Twenty-four patients were incompletely treated. Twenty-one patients (7.27%) failed to attain complete debridement: 16 with incomplete bone debridement and 5 with incomplete abscess debridement. The reason was the lack of knowledge of what constituted complete debridement in the early cases, so that in the surgery presently accepted methods had not completely been performed. Four patients underwent the traditional debridement because of difficult exposure with severe adhesions resulting in indistinct anatomy and bleeding, and also underwent delayed chemotherapy. In the 21 patients with residual disease, 9 underwent a second surgery and 2 received percutaneous aspiration of abscess under CT guidance and were cured. The 10 patients who underwent delayed chemotherapy also were cured at the final follow-up.

A total of 22 patients experienced surgery complications, including 3 with graft shifting, 5 with wound infection and fat liquefaction, 4 with pleural effusion, 6 with pain at the graft harvesting site, and 4 with incisional hernia. No damage to major blood vessels, nerves, or organs, or other serious complications were observed in any of the 289 patients. There were also no cases of postoperative fixation loosening, or breakage. Seventeen patients who experienced...
relapse or who were still infected after surgery were from other hospitals and were successfully treated after undergoing complete debridement (Fig. 2).

Discussion

Incomplete debridement is a key cause of recurrence or lack of cure after spinal surgery [19–22]. The recurrence rate after spinal surgery reportedly reached 13% to 26% [2,19,23–25], with second surgery rates of 6% to 23% [2,19,22–27]. An increasing number of surgeons understand the importance of complete debridement [18,28–32], and many new methods, such as “margin dissection” of Hao et al. [33], propose complete removal of all affected foci. Parthasarathy et al. [34] and Ruan et al. [20] emphasized the importance of “radical surgery” or...
“excision” and attempted to decrease the second surgery rate. “Complete debridement” has been proposed because focal debridement fails at times. Ito [1], Fang [2], and Hodgson and Stock [3] proposed that focal debridement be performed to completely clear cold abscesses, caseous necrosis, residual intervertebral disc tissue, sinus tracts, bony sequestration, and inflammatory granulation, and termed this traditional focal debridement. However, a retrospective study by van Loenhout-Rooyackers et al. [35] showed that “Hong Kong Surgery” (focal debridement) had a 2% to 17% recurrence rate. In contrast, we believe that the goal should be defined as complete debridement. Traditional focal debridement may leave infected tissue that allows for persistence or recurrence of disease. In our 10-year study, we found that besides the traditional focus, such as cold abscesses, caseous necrosis, residual intervertebral disc tissue, sinus tracts, bony sequestration, and inflammatory granulation, other affected tissues should be included.

Sclerotic walls

Sclerotic walls are sclerotic bone shells that exist at the margin of single or multiple cavities as well as at the anterior aspect and two lateral planes of the vertebrae. Sclerotic bone reportedly occurs in 19.8% to 69.2% [36,37] (75.78% in our study). Each patient with sclerotic spinal tuberculosis formed sclerotic walls. The sclerotic walls were considered to be foci for the following reasons. First, a histopathological study [14] found that the sclerotic walls were from the margin of the sclerotic focus to the margin of the vertebrae. The sclerotic walls were thickened at 2 to 8 mm, with a smooth but hard surface and without a blood supply. The bone trabeculae were thickened and the structure was connected similar to lamellar bone without a Haversian system. The occurrence of small tubercular foci was identified in 95% of cases, with 2.5 to 4.0 mm surrounding sclerotic walls [14]. This is the key part of foci in sclerotic walls. Second, antituberculous therapy showed that only the lowest minimum inhibitory concentration of rifampin, isoniazid, and pyrazinamide can be detected; however, no antituberculous drugs were found in sclerotic tissue, which acted as a barrier to these medications [13]. Third, a bacteriological study showed that the positive rate of Mycobacterium tuberculosis DNA in the sclerotic wall was 86.7%, 16.0% of which comprised outside walls [15]. Accordingly, we considered sclerotic walls to be foci.

Affected bony bridges

In our study, 10% of patients presented with affected bony bridges that incompletely fused with upper and lower damaged vertebrae and were characterized by thinness, crispness, and a free blood supply and were wrapped by plenty of focal tissue.

Key points

1. Our study highlights the differences between complete debridement and traditional focal debridement.
2. Appropriate treatment of sclerotic bone, multiple cavities, and bony bridges is the key to complete debridement.
3. Combined with the results of our basic research, we herein emphasize that complete debridement is an effective surgical approach for treating spinal tuberculosis.

Multiple cavities

Multiple cavities are common in spinal tuberculosis. In the present study, 231 patients (79.94%) had multiple cavities; single cavities were rare. It is detrimental to the patient’s outcome if multiple cavities are missed. In all, the three (sclerotic bone, multiple cavities, bone bridges) of these tuberculosis findings have the following common characteristics: a solid surface, no blood supply or poor blood supply, small foci that can be seen with the naked eye, a shell that prevents antituberculous drugs from having a full effect, and a surface that deters graft incorporation and promotes sequestration. These foci can at times be ignored. Sixteen patients with incomplete debridement and 17 patients who experienced relapse or who were not improved after surgery were from other hospitals, but were better after a more complete debridement. The authors used iliac bone grafts, titanium mesh, and rib to achieve reconstruction of the spine after complete debridement. At the same time, anterior fixation or posterior fixation with instrumentation was performed, which satisfactorily maintained correction.

It is important to distinguish between “complete and incomplete debridement.” Under the premise of complete debridement, the reactive affected vertebrae outside the sclerotic walls (also called normal bone or subnormal osseous tissues) should be retained. For patients with normal or fundamentally normal intervertebral discs, the end plate should be maintained even though it may be only several millimeters in depth or is exposed because of a more deeply seated bony defect. On the other hand, it is not wise to neglect focal tissues to maintain more bone tissue. The best choice is to completely clear all foci and maintain nonfocal tissues.

Conclusion

Our results demonstrate that sclerotic bone, multiple cavities, and bony bridges are foci in spinal tuberculosis. Clearing traditional tuberculous foci combined with sclerotic bone, multiple cavities, and bony bridges so as to increase the curative effect is an effective treatment method.
References
