Int J Clin Exp Med 2016;9(7):14383-14389
www.ijcem.com /ISSN:1940-5901/IJCEM0024838

Original Article

Clinical efficacy of single-stage posterior radical debridement, bone grafting and internal fixation in lumbar spinal tuberculosis with kyphotic deformity

Jian-Jun Chang[1], Xun Ma[1], Hao-Yu Feng[1], Jian-Zhong Huo[1], Chen Chen[1], Yan-Nan Zhang[1], Yu-Fei Wang[2], Ya-Ning Zhang[2], Jian Liu[2]

[1]Department of Orthopedics, Shanxi Academy of Medical Sciences Shanxi Dayi Hospital, Taiyuan 030032, Shanxi Province, China; [2]Department of Orthopedics, The People's Hospital of Linfen City, Linfen 041000, Shanxi Province, China

Received January 24, 2016; Accepted April 29, 2016; Epub July 15, 2016; Published July 30, 2016

Abstract: Purpose: The purpose of this study was to validate the efficacy and safety of single-stage posterior debridement bone grafting for treatment of lumbar spinal tuberculosis with kyphotic deformity (LSTKD). Methods: From June 2010 to June 2013, 48 patients were enrolled in this study. Total 27 and 21 patients underwent single-stage posterior and anterior instrumentation and fusion respectively, combined with radical debridement and bone grafting. Clinical and radiographic results were analyzed. Results: The post-operative and follow-up Cobb's angle for LSTKD with posterior debridement were of statistically significantly differences ($P < 0.05$), compared with that with anterior debridement. Grades or scale of healing of focus and bone grafting with posterior debridement were better than that of anterior debridement. No recurrence of tuberculosis or instrumentation failure occurred. Conclusions: Single-stage posterior instrumentation debridement with fusion was demonstrated to be a more safe and effective method to achieve spinal decompression and kyphosis correction in patients of LSTKD, compared with anterior treatment.

Keywords: Lumbar spinal tuberculosis, kyphotic deformity, single-stage posterior, bone grafting

Introduction

Tuberculosis of the thoracic and lumbar spine causing gross destruction of the anterior and middle columns often leads to kyphotic deformity [1]. It has been reported that, among children treated conservatively, only 44% experienced improvement of the deformity, while in the remaining patients there was no change (17%) or deterioration (39%); in particular, kyphosis of more than 60° developed in 3%-5% of cases [2-4]. Thus, even after tuberculosis was cured, the deformity could progress. Moreover, if the destruction involves more than two vertebral bodies, severe kyphosis is frequently inevitable [5].

Patients of lumbar spinal tuberculosis with kyphotic deformity (LSTKD) will result in pain, spinal cord compression, cardiopulmonary dysfunction, cosmetic concerns and costopelvic impingement [3, 6]. In addition, surgical management of tuberculous spondylitic kyphosis is indicated if there is a lack of response to antibiotics, severe and/or progressive kyphosis, or a developing neurological deficit [7]. Therefore, intervention for prevention of deformity must be done early because surgery in the early stages is relatively simple, produces good results, and prevents additional deformity [8].

Debridement is generally performed anteriorly as the pathology is typically located in the vertebral bodies [3, 9, 10]. To our knowledge, there are few studies to correct LSTKD utilizing posterior debridement. The purpose of this study was to validate the efficacy and safety of single-stage posterior debridement bone grafting for treatment of LSTKD.

Materials and methods

Patient population

From June 2010 to June 2013, 48 patients diagnosed as early LSTKD were collected in the

Table 1. Characteristics of patients in observation group and control group

Group	Observation	Control
Sex		
Male	16	11
Female	11	10
Age, year		
Max.	63	74
Min.	22	20
Average	43.6±5.1	43.9±6.3
Disease course, month		
Max.	36	48
Min.	1/3	19/30
Average	8.6±1.2	8.7±1.1
Cobb's, °		
Max.	27.4	23.5
Min.	4.5	6.5
Average	12.5±2.8	11.5±2.5
Accumulated		
T12~L1	13	10
L1~L2	14	11
ASIA classification		
A	1	1
B	2	1
C	5	3
D	16	12
E	5	4

present study. Patients with any of the following conditions were excluded: traumatic or pathological lumbar fracture; cervical and thoracic tuberculosis with intolerance routine anti-tuberculosis drugs; previously undergone surgery for tuberculosis of the lumbar spine; and those who had serious viscera dysfunction, autoimmune disease and refuse to this study. Diagnosis of LSTKD was made based on clinical symptoms, laboratory findings and radiographic evidence. They comprised: (1) typical symptoms such as lower back pain with or without lower limbs radiating pain, morning stiffness, low grade fever, decreased myodynamia, and spinal kyphosis deformity; (2) significantly high erythrocyte sedimentation rate (ESR), C reactive protein (CRP) and N/med tuberculosis specific antibody (T-Spot); and (3) production of sequestra and abscesses confirmed by imaging X-ray, magnetic resonance imaging (MRI) and computed tomography (CT) scanning, or intervertebral space narrowed or even disappear, vertebral body damage or collapse, abnormal signal intensity of the involved vertebrae, paravertebral abscesses or psoas abscesses. Patients confirmed to diagnostic criteria of lumbar spine tuberculosis and kyphotic deformity and had operative indication were defined as LSTKD in the current study. Indications for surgery were therapeutically refractory disease, panvertebral lesions, an expanding cold abscess, severe kyphosis or kyphosis likely to progress, and neurological deficit [11]. Written informed consent was obtained from all patients and their families, and the study protocol was approved by the Ethics Committee of our hospital.

The 48 patients were randomly divided into two groups, observation group (n = 27) which performed single-stage posterior debridement bone grafting treatment and control group (n = 21) which carried out anterior debridement. For observation group, there were 16 males and 11 females, their ages ranged from 22 to 63 years old, on average (43.6±5.1) years; a mend disease course of 8.6±1.2 months (ranged, 1/3~36 months); the kyphosis level was denoted as Cobb's angle [12], the average degree was (12.5±2.8)° which ranged from 4.5° to 27.4°; 13 accumulated T12~L1 and 14 L1~L2, while according to the American Spinal Injury Association (ASIA) Classification, there were 1, 2, 5, 16 and 5 cases classified to A, B, C, D and E grade, respectively. The detailed characteristics for observation group and control group were displayed in **Table 1**. Complementally, for control for control group, 10 T12~L1 and 11 L1~L2 were presented. When classifying controls based on ASIA, 1, 1, 3, 12 and 4 patients were evaluated on A, B, C, D and E grade separately.

Pre-operative preparation

After a clinical diagnosis of LSTKD was made, patients in two groups were treated with the quadruple anti-tuberculosis treatment, consisting of isoniazid (300 mg po qd), rifampicin (450 mg po qd), pyrazinamide (500 mg po tid) and ethambutol (750 mg po qd), for two to four weeks before surgery, until body temperature < 37.5°C, ESR < (40~60) mm/h, mycobacterium tuberculosis cultivated into feminine. The other clinical symptoms (anemia, hepatorenal function, electrolyte and low protein) were corrected. Besides, risk assessment of operation and anesthesia must meet to the standard.

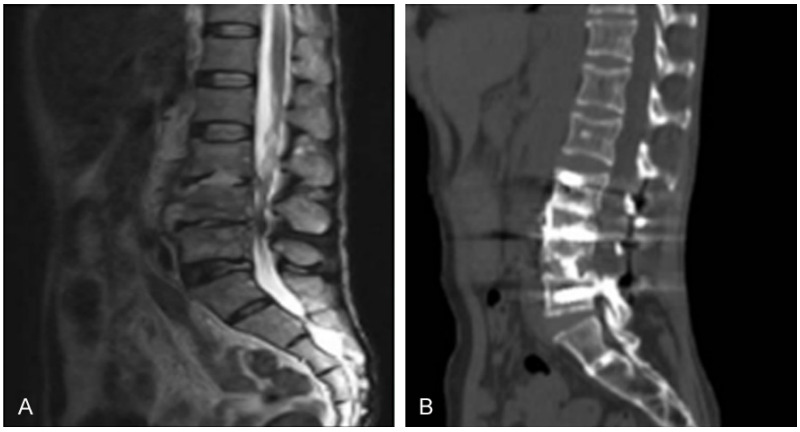

Figure 1. A: Pre-operative X-ray of lumbar spinal tuberculosis with kyphotic deformity. B: Post-operative X-ray of lumbar spinal tuberculosis with kyphotic deformity.

Table 2. Comparison of operation between observation group and control group

Group	Incision length, cm	Operation time, min	Blood loss, mL
Observation	7.5±1.2	154.6±22.5	450.2±30.8
Control	8.6±1.3	203.8±35.7	706.8±45.6
P	0.037	0.024	0.021

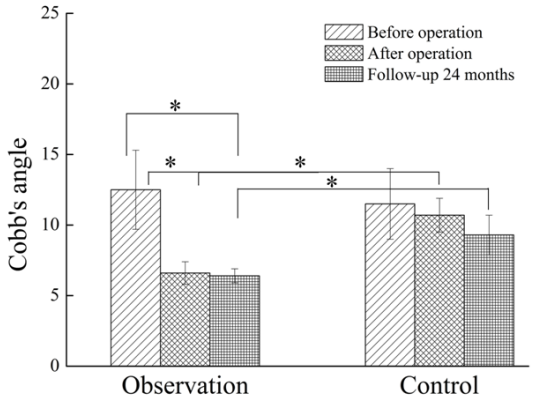

Figure 2. Kyphosis correction of patients in observation group and control group pre-operative, after operation and follow-up 24 months. *indicated that the comparison of two groups were different with $P < 0.05$.

Operative technique

Briefly, for the posterior approach, patients were first placed in a prone position under general anaesthesia. With the muscles adjacent to the spine on the symptomatic side retraced laterally to minimise damage, the area lateral to the lamina and the posterior joint was exposed. Dividing the inter-vertebral nutrient vessels, let centrums posterior focus was exposed. Next, the tuberculous lesion, including paravertebral or psoas abscesses, collapsed vertebrae, and inter-vertebral discs, was thoroughly debrided until healthy bleeding margins were obtained. Subsequently, a pedicle screw system was placed on the symptomatic side on the guide of the cantilever X-ray technique. Accordingly, a single titanium mesh cage filled with bone graft material was inserted into the disc space. The choice of bone graft was made based on the involved levels and in consideration of the patient's preference. Eventually, the surgery was performed by compressing the inter-vertebral space slightly with pedicle screw fixation to secure stability and improve the bony union immediately post-operation. Before placing drainage tube and suturing the incision by layers, we injected 1.0 g streptomycin and 0.2 g isoniazid in the original diseased region. In this procedure, tuberculosis of lumbar spine before and after operation was shown in **Figure 1**.

For control group, patients were performed anterior debridement. Under general anaesthesia, patients were first placed in a right or left lateral position on the basis of vertebrae site. We selected the 12th ribs made cut, and implemented thorax extraperitoneal approach to peel off tissues layer by layer, and finally exposed anterior vertebral. The following steps were the same as they done in the posterior method.

Post-operative care

After surgery, patients resumed the oral chemotherapy (treatment course 12~18 months). When post-operative 7 to 9 days with drainage flow < 50 mL per 24 hours, we pulled up the drainage tube. Comparison and analysis of incision length, operation time, and bleeding amount were conducted. The kyphotic angle was measured on the upright lateral view with

Table 3. ASIA classification for patients post-operation and follow-up 24 months

	Pre-operation		Post-operation		Follow-up 24 months	
	D grade	E grade	D grade	E grade	D grade	E grade
Observation	16	5	8	17	5	21
Control	12	4	9	8	8	10

the Cobb technique. Followup heals of focus and bone grafting in observation and control group were performed, further, internal fixation related complications were also detected. Focus healing effectiveness evaluation was carried out employing modified Kirkaldy-Willis evaluation criterion [13]. Bone grafting heal was estimated by Bridwell classification criterion [14].

Statistic analysis

Each test was carried out in triplicate at least and the results were dealt with statistics process by Statistical Product and Service Solutions (SPSS, Chicago, IL, USA) [15]. The Data were expressed as mean ± standard deviation. We implemented *t* test and X^2 test to compare differences between groups. $P < 0.05$ was considered to be statistically significant difference.

Results

Operation properties

Spinal tuberculosis was confirmed in all 48 cases post-operatively, and patients were followed-up for at least 24 months, with an average of 31.5 months (range, 24-60 months). No recurrence was observed. The mean operation time for observation group was (154.6±22.5) min with an average blood loss of (450.2±30.8) mL and incision length (7.5±1.2) cm. As for control group, mean operate time (203.8±35.7 min), blood loss (706.8±45.6 mL) and incision length (8.6±1.3 cm) were higher than that of observation group. Further, the three properties were statistically significant with $P < 0.05$ between observation and control group (**Table 2**).

Kyphosis angle

Pre-operative kyphosis was (12.5±2.8)° on average and became (6.6±0.8)° after single-stage posterior debridement bone grafting for 27 LSTKD patients, with a correction rate of 62.1%. All the patients demonstrated solid fusion at six- to nine-month follow-up. The average kyphosis angle at the last followed-up was (6.4±0.5)°, increased of correction was 0.2° on average. **Figure 2** illustrated the kyphosis correction in patients according to pathological regions and bone graft materials. We found that there was a great difference before and after operation in observation group, this condition also suited for before operation and follow-up 24 months after operation. When comparing with control group, the correction of kyphosis angle after operation and follow-up 24 month were both statistically significant differences for observation group with $P < 0.05$. For follow-up 24 months in control group, the angle was slightly decreased from (10.7±1.2)° to (9.3±1.4)°.

ASIA classification

In the present work, we studied ASIA classification for patients of observation group and control group post-operation and follow-up 24 months, the results for the major grades were displayed in **Table 3**. In observation group, patients of E grade were increased with time increase after operation. Before operation, there were 21 patients of D grade and E grade, when follow-up 24 month after operation, they increased to 26 patients (5 D grade and 21 E grade) which accounting for 26/27 of all patients. This phenomenon was not discovered in control group.

Focus and bone grafting heals

Focus heals were detected by Kirkaldy-Willis standards, an excellent and good rate of 92.6% of observation group was obtained, which was higher than that of control group with 85.7%. In detailed, 16 were excellent heals of focus, and 9 belonged to good heals in observation group. Meanwhile, for control group, 8 had excellent heal extent and 10 were good. Proportion of I and II grades for bone grafting healing was 88.9% in observation group and significantly higher than that in control group with 81.0%. A total of 5 (18.5%) and 6 (28.6%) patients had complications in observation and control group,

respectively. Hence, focus and bone grafting heals and complications were significantly different ($P < 0.05$) between observation group and control group.

Discussion

Anterior debridement, strut grafting fusion and fixation, had become the standard for surgical treatment of LSTKD [16, 17]. The disadvantages of the anterior approach used alone include insufficient kyphosis correction and post-operative loss of correction [5]. For mild kyphosis, it has been associated with long-term loss of deformity correction, although the problem can be alleviated by anterior instrumentation [18, 19]. Most reports paid attention on application of anterior surgery, but it is not suitable for patients with multiple-level involvement. Thus, other surgeons attempted to address this challenge with single-stage posterior debridement and fixation [20, 21]. Additionally, posterior debridement bears the potential risk of tuberculosis spread to the posterior healthy regions, infection, and fistulas.

Therefore, in this paper, we utilized single-stage posterior debridement bone grafting for correction of LSTKD. And the results of our work demonstrated that posterior debridement was better than anterior approach to correct deformity of spinal tuberculosis. The post-operative and follow-up Cobb's angle for LSTKD with posterior debridement were of statistically significant differences ($P < 0.001$), compared with that of anterior debridement. Sundararaj et al. [22] claimed that for short-term active tuberculosis, posterior correction was relatively easy to achieve and hence could be done first. A correction of 9.4° was achieved, which was similar to the result (9°) of Huang et al. [23].

Patients with a history longer than six months tend to have facet fusion leading to rigid deformity that cannot be reduced by fixation alone and sometimes even causes the pull-out of screws [24, 25]. Thus, bone grafting should be performed to facilitate correction. And our results showed that the healing of focus and bone grafting were better than anterior debridement. It has been believed that the advantages of posterior pedicle screw instrumentation are multifold: for instance, sufficient kyphosis correction can be accomplished, exposure of tuberculosis foci posteriorly is avoided, three-column spinal fusion can prevent the imbalanced spinal growth of children, and long-term correction can be maintained [26-28].

Although Jain et al. [20] considered that posterior fixation without prior anterior debridement was a risk for increased neurologic injury, it might be reasoned that when posterior correction was performed first, further spinal shortening was prevented; the anterior compression caused by the tuberculosis focus (including abscess, caseous tissue and ruptured discs) should not pose instant threats neurologically. Moreover, with a one-stage procedure, decompression can be done immediately, thereby eliminating risk factors for spinal injury [29, 30]. Wang et al. revealed that no incidence of neurologic exacerbation occurred and all patients experienced improvement of their neurologic function, proving the safety of this strategy [5]. What was more, we found that complication of posterior approach was lower than that of anterior debridement.

In conclusion, single-stage posterior instrumentation debridement with fusion was demonstrated to be a more safe and effective method to achieve spinal decompression and kyphosis correction in patients of LSTKD, compared with anterior approach.

Acknowledgements

This research received no specific grants from any funding agency in public, commercial, or not-for-profit sectors.

Disclosure of conflict of interest

None.

Address correspondence to: Jian-Jun Chang, Department of Orthopedics, Shanxi Academy of Medical Sciences Shanxi Dayi Hospital, Taiyuan 030032, Shanxi Province, China. E-mail: jianjunchang2015@yeah.net

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