Int J Clin Exp Med 2015;8(11):20890-20896
www.ijcem.com /ISSN:1940-5901/IJCEM0013140

Original Article

Stage I posterior osteotomy and instrumentation and stage II anterior debridement and bone grafting for lumbar spinal tuberculosis with severe kyphosis

Qiang Deng[1], Yalou Zhang[2], Weibin Sheng[1]

[1]Department of Spinal Surgery, The First Affiliated Hospital of Xinjiang Medical University, Urumqi 830054, Xinjiang, China; [2]Department of Histology & Embryology, Preclinical Institute, Xinjiang Medical University, Urumqi 830011, China

Received July 20, 2015; Accepted November 4, 2015; Epub November 15, 2015; Published November 30, 2015

Abstract: The purpose of this study was to determine the efficacy of stage I posterior osteotomy and instrumentation followed by stage II anterior debridement and bone grafting in patients with lumbar spinal tuberculosis (TB) with severe kyphosis. The records of patients with lumbar spinal TB and severe kyphosis treated with 2-stage surgery at our hospital from 2005 to 2010 were retrospectively reviewed. Outcome measures were kyphosis correction rate, visual analogue scale (VAS) pain scores, and American Spinal Injury Association (ASIA) spinal cord injury and sensation function scores. A total of 53 patients (34 male, 19 female; mean age 32 years) were included. The number of involved kyphosis segments ranged from 7 to 14, and the average preoperative kyphosis angle was 107.3 ± 18.1°. All procedures were performed without serious complications. The average follow-up time was 42 months. Bone fusion occurred at a range of 6 to 9 months after surgery, and none of the patients had internal fixation failure, position change, or pseudoarthrosis. The mean postoperative kyphosis angle was 29.4 ± 12.4°, with a mean improvement of 77.9°, and the correction rate was 72.6% ($P < 0.001$). At final follow-up, average correction loss was 1.35°. The mean postoperative VAS pain score was 2.4 ± 0.8, and the change from the preoperative value was significant ($P < 0.001$). ASIA spinal injury scores were increased postoperatively. Stage I posterior osteotomy and instrumentation followed by stage II anterior debridement and bone grafting can achieve good results in patients with lumbar TB and severe kyphosis.

Keywords: Spinal tuberculosis, kyphosis, osteotomy, bone grafting, clinical efficacy

Introduction

Tuberculosis (TB) is relatively common in underdeveloped countries, and the incidence of spinal TB is increasing [1, 2]. The spine is involved in approximately 50% of cases of bone and joint TB [3], and in 10% there is spinal destruction and severe kyphosis [4]. The anterior column is involved more often than the posterior column, and a single or multiple motion segments can be affected, and the involved segments can be contiguous or non-contiguous [5]. Spinal TB can be treated with anti-tuberculosis (anti-TB) medications with an overall adequate therapeutic effect [1, 2]. Adequate medical treatment, however, does not prevent the progression of the kyphotic deformity [6, 7].

Surgery is generally recommended for spinal TB patients with severe kyphosis (kyphosis angle > 90°) in which heart and lung function may be affect or if there are neurological deficits [8]. Other indications for surgery include a large abscess and large amount of dead and necrotic tissue, uncertain diagnosis, and inadequate response to anti-TB chemotherapy [5]. A large number of surgical strategies for spinal TB have been proposed, including anterior and posterior approaches and staged combined anterior/posterior approaches [5, 6, 9-11]. An anterior-only approach can achieve debridement and clearance of necrotic bones and tissues, but is not suitable for correction of serious kyphosis while a posterior-only approach can provide better deformity correction but it cannot achieve good debridement [12]. Thus, the best surgical method of treating spinal TB with severe kyphosis has yet to be determined.

The aim of this study was to report our results of a 2-stage correction of severe kyphosis in lumbar TB patients consisting of stage I poste-

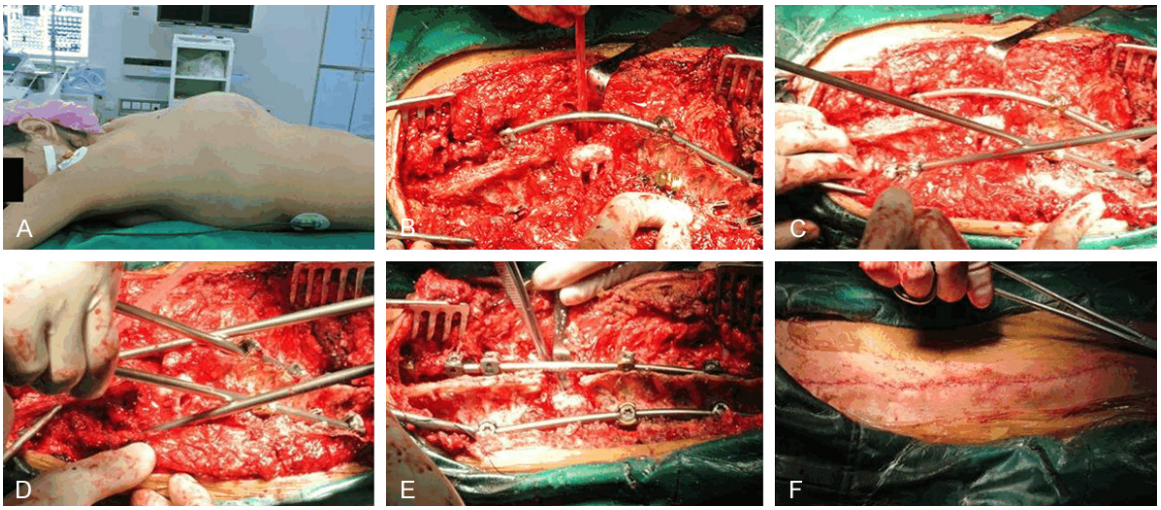

Figure 1. Intraoperative images of a 32-year-old female. A. Patient in the prone position under general anesthesia. B. Single rod fixation before osteotomy. C, D. Installation of double rods and orthopedic. E, F. Complete correction of kyphosis.

rior osteotomy and instrumentation followed by stage II anterior debridement and bone grafting.

Materials and methods

Patients

The medical records of patients diagnosed with lumbar spinal TB complicated by severe kyphosis who were diagnosed and received surgery at our hospital from 2005 to 2010 were retrospectively reviewed. Inclusion criteria were patients who had lumbar spinal TB complicated by severe kyphosis together with and spinal Cobb angle (kyphosis angle) ≥ 90°. Exclusion criteria were patients who could not tolerate surgery, and those with a kyphosis angle < 90°. All patients were underwent stage I posterior osteotomy and instrumentation and 2 weeks later received stage II anterior debridement and bone grafting. This study was conducted in accordance with the Declaration of Helsinki and with approval from the Ethics Committee of Xinjiang Medical University. Written informed consent was obtained from all participants.

Operative technique

All the operations were done by the same team of senior spine surgeons with more than 20 year's experiences. Surgery was performed under general anesthesia and endotracheal intubation, and somatosensory evoked potential (SEP) and motor evoked potential (MEP) were monitored in all cases. For stage I posterior osteotomy and instrumentation, patients were placed in a prone position with a pad on both sides of trunk to avoid thoracic and abdominal compression. With the Spinal tuberculosis lesion as a center, a posterior median incision was made. After routine exposure, pedicle screws for internal fixation were inserted, respectively, at the proximal end and distal end of the vertebral bodies around the lesion. Each pair of screws were placed at a 1-2 vertebrae intervals to increase the holding force of the orthopedic rod. After achieving an optimal view, with the top vertebrae as the center, a V-shaped vertebral column resection (VCR) osteotomy was performed. X-ray was performed to confirm the position of the deformity correction and the pedicle screws with two rods were fixed. The surgical site was washed with a large amount of normal saline and streptomycin was placed in the surgical site. After autologous bone was grafted, a closed drain was placed in the incision, and the incision was closed in layers. Wake-up tests were also performed to observe if good lower limbs movement was present.

One to 2 weeks later, stage II anterior debridement and bone grafting was performed. Patients were placed in the lateral decubitus position, usually on their right. After making an incision at the left side of the rib margin, the distraction of retroperitoneum was carried out.

Table 1. Patient clinical data

	Preoperative	Postoperative	*P*
Coronal Cobb angle (°)	11.5 ± 5.1	0.5 ± 1.4	< 0.001
Sagittal Cobb angle (°)	107.3 ± 18.1	29.4 ± 12.4	< 0.001
ASIA sensation	118 ± 14	151 ± 8	< 0.001
ASIA motor	33 ± 4	53 ± 3	< 0.001
VAS pain score	5.3 ± 1.3	2.4 ± 0.8	< 0.001
ESR	51.7 ± 15.6	7.9 ± 3.2	< 0.001
CRP	37.2 ± 21.2	5.7 ± 1.5	< 0.001

ASIA, American Spinal Injury Association; CRP, C-reactive protein; ESR, erythrocyte sedimentation rate; VAS, visual analogue scale.

Table 2. American Spinal Injury Association (ASIA) scores

ASIA score	Preoperative	Preoperative%	Postoperative	Postoperative%
A	0	0	0	0
B	2	4	0	0
C	20	38	1	2
D	25	47	13	25
E	6	11	39	74

Data are presented as number of patients, and the percentage of total patients.

Paravertebral tissues were identified, and purulent and the necrotic tissues were debrided. The area of the lumbar lesion was exposed through retraction of the psoas major, and a bone knife was used to debride necrotic bone and granulation tissue. Allograft bone was placed between the upper and lower healthy vertebrae. X-ray was performed to confirm the position of the vertebrae. A closed drain was placed in the pleural cavity and the incision was closed in layers. Intraoperative images showing the surgical techniques are shown in **Figure 1**.

Pre- and postoperative management

Preoperatively, all patients received routine laboratory tests as well as erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP). X-ray, magnetic resonance imaging (MRI), computed tomography (CT), and three dimensional (3D) reconstruction imaging of the spine was performed before surgery. Patients were placed on the anti-TB drugs after their diagnosis with 2 week, and were for 12-18 months. Postoperatively, patients were followed-up every 3 months for the first year, and then every 6 months. Follow-up visits included physical examination, laboratory testing including measures of liver function, ESR, and CRP and spine radiographs.

Outcome measures

Kyphosis angle was determined before and after surgery and at all follow-up visits by X-ray or other imaging examinations [5]. Correction rates and the loss of kyphosis correction were also recorded and compared. Bone fusion and position of the internal fixation were checked by imaging at follow-up visits to determine instrumentation failure and the presence of pseudoarthrosis. Visual analogy scale (VAS) [13] pain scores and American Spinal Injury Association (ASIA) spinal cord injury and sensation function scores [14] were used to evaluate function after surgery.

Statistical analysis

Data of continuous variables were presented as mean ± standard deviation. Differences between preoperative and postoperative measurements were compared using the paired t tests. Statistical analyses were performed with SPSS (IBM statistics software) for Windows. Version (13.0 SPSS inc., Chicago, IL, USA). All statistical analyses were 2-sided, and values of $P < 0.05$ were considered to be statistically significant.

Results

A total of 53 patients (34 male, 19 female) with a mean age of 32 year (range, 10-62 years) were included in the study. Patient clinical data are summarized in **Table 1**, and ASIA data in **Table 2**. The number of involved kyphosis segments ranged from 7 to 14, and the average preoperative kyphosis angle was 107.3 ± 18.1°. Preoperative ESR, CRP, and VAS pain scores were 51.7 ± 15.6, 37.2 ± 21.2, and 5.3 ± 1.3, respectively. The mean preoperative ASIA sensation function score was 118 ± 14 and motor function score was 33 ± 3. The posterior ASIA sensation score and motor function score were improved (151 ± 8 and 53 ± 3, respectively; both P < 0.001) (**Table 1**). The ASIA spinal injury scores increased postoperatively (**Table 2**). Preoperative neurological deficit ASIA scores were B in 2 cases, C in 20 cases, D in 25 cases, and E in 6 cases. Patients had ASIA scores of E (74%), D (25%), and C (2%) postoperatively.

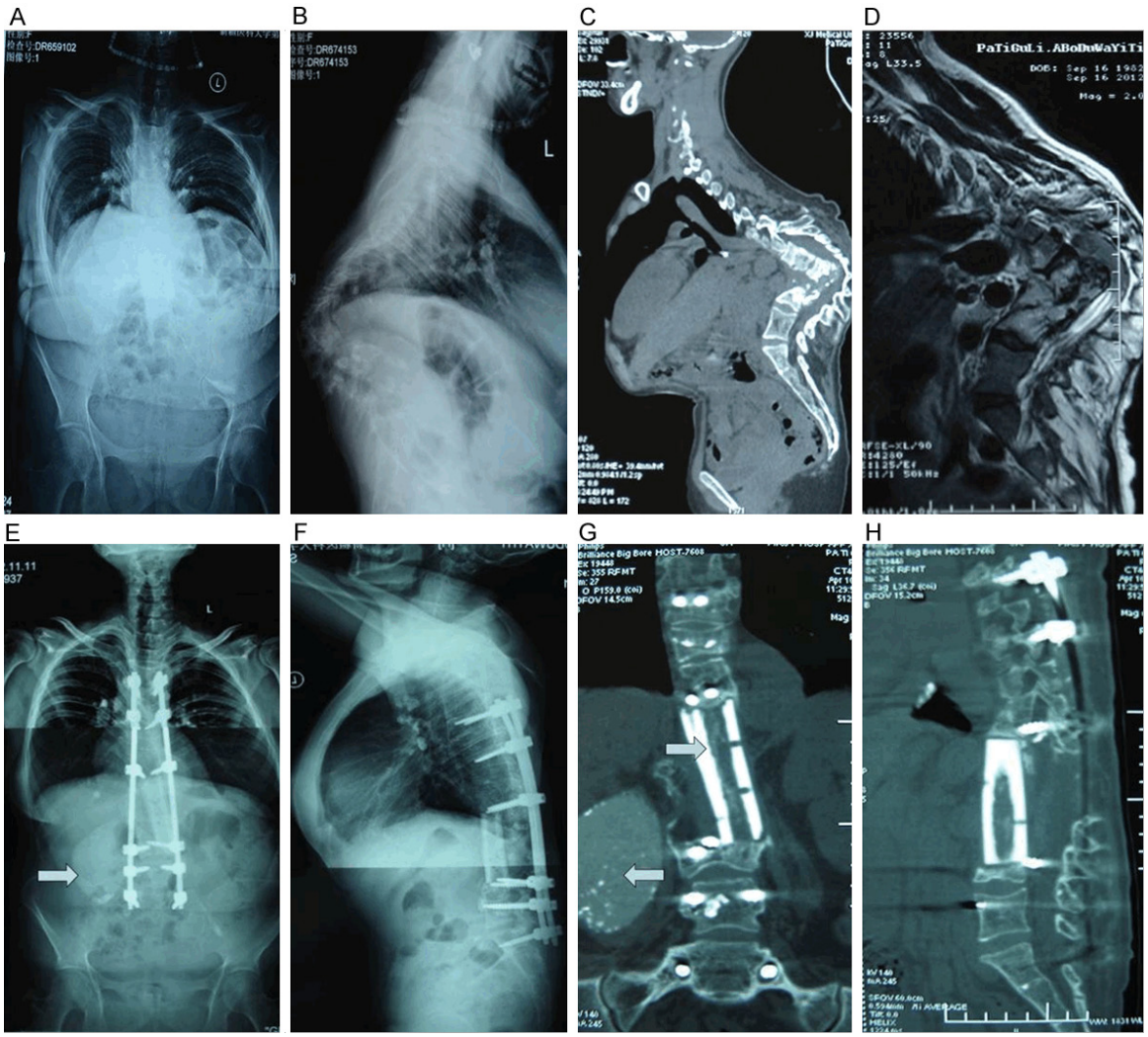

Figure 2. Pre- and postoperative imaging of the patient shown in **Figure 1**. A, B. Preoperative anteroposterior and lateral, respectively, computed tomography (CT). C, D. Preoperative anteroposterior and lateral, respectively, magnetic resonance imaging (MRI). E, F. Postoperative anteroposterior and lateral, respectively, CT showed a complete correction of kyphosis. Arrow in E indicates a huge abscess around the right psoas. G. At the 1-year follow-up, CT showed the bone cage with a continuous bone callus as indicated by the top arrow and the right psoas abscess was not fully absorbed as indicated by the lower arrow. H. Perfect positioning of the bone grafts was noted at 1-year.

All patients tolerated the surgical procedures well. The surgical time ranged from 195 min to 420 min. The average number of corrected segments was 11.8 (range, 9 to 16). No spinal cord injuries or intraoperative complications were observed. Postoperative pleural effusions occurred in 6 patients, and all resolved with chest tube drainage within 5 days. ESR and CRP values at 3 months after surgery were 10.9 ± 4.5 mm/h and 9.3 ± 7.2 mg/l, and the differences from preoperative values were statistically significant (both, $P < 0.001$). At the last follow-up, ESR and CRP levels had returned to the normal range (7.9 ± 3.2 mm/h and 5.7 ± 1.5 mg/l, respectively).

The average follow-up time was 42 months, and all patients experienced multilevel pain relief after surgery. Bone fusion occurred at a range of 6 to 9 months after surgery, and none of the patients had internal fixation failure, position change, or pseudoarthrosis. The mean postoperative kyphosis angle was 29.4 ± 12.4°, with a mean improvement of 77.9°, and the correction rate was 74.6% ($P < 0.001$). At the final follow-up, correction loss was an average of 1.35°. The mean postoperative VAS pain

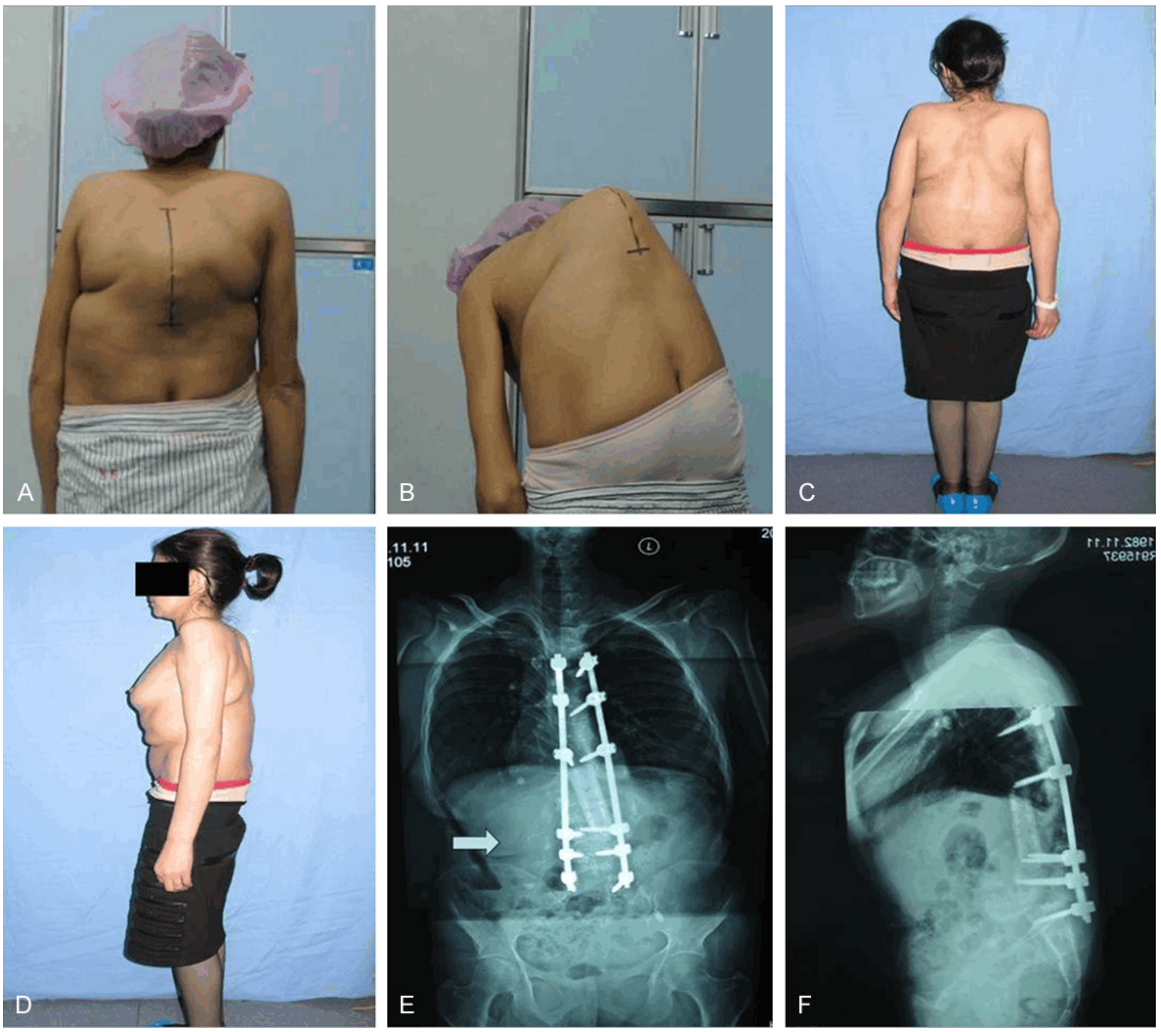

Figure 3. Images of the patient shown in **Figure 1**. A, B. Preoperatively a severe kyphotic deformity was noted. C, D. Kyphosis correction at 2 years after surgery. E. Arrow indicates the right psoas muscle abscess after anterior debridement at the 2-year follow-up. F. At the 2-year follow-up, the correction of kyphosis almost completed.

score was 2.4 ± 0.8, and the change from the preoperative value was significant ($P < 0.001$). Pre- and postoperative images of representative case are shown in **Figures 2** and **3**, respectively.

Discussion

The results of this study showed that stage I posterior osteotomy and instrumentation followed by stage II anterior debridement and bone grafting approximately 2 weeks later can achieve good results in patients with lumbar TB and severe kyphosis deformity. The mean improvement of kyphosis angle was 77.9°, mean correction rate was 74.6%, and at final follow-up the average loss of correction was 1.35°. There were no serious intraoperative complications, and there were improvements in VAS pain scores and ASIA spinal injury scores.

Kyphosis deformity is the most common manifestation of spinal TB, and affects the anterior column approximately 90% of cases and the posterior column in 5% to 10% [8]. While anti-TB chemotherapy can result in good outcomes in the majority of patients, it will not correct a severe kyphosis deformity. Anti-TB chemotherapy is associated with a mean increase of the kyphosis angle of 15° [15] in 3% to 5% of patients in whom the kyphosis angle has reached 60° or more [16]. In children, the kyphosis increases to a greater degree due to incomplete fusion and continued growth [4, 17]. As severe kyphosis is not only a cosmetic concern, but can be associated with progressive pain, neurological deficits, and loss of function, surgical treatment is necessary.

The surgical objective in patients with kyphosis secondary to spinal TB is complete lesion clear-

ance and kyphosis correction. The anterior-only approach can achieve debridement and clearance of necrotic bones and tissues, but does not allow deformity correction, while the posterior-only approach can provide better deformity correction but no adequate debridement [12]. For this reason, we perform a staged procedure: stage I posterior osteotomy and instrumentation and stage II anterior debridement and bone grafting. The staged procedure allows total clearance of the lesion, kyphosis correction, and obtains stability of vertebral column.

Hirakawa et al. [9] evaluated the clinical outcomes of a 2-stage surgery (first stage posterior instrumentation and second stage anterior debridement and bone grafting) in 10 patients with spinal TB with follow-up ranging from 24 to 101 months. The mean VAS pain score was 4.2 ± 0.9 before the surgery, 2.6 ± 1.0 after the first surgery, and 1.5 ± 0.7 after the second surgery. Frankel grades before surgery were B in 1 case, C in 1 case, D in 6 cases, and E in 2 cases and after surgery were E in 7 cases, D in 2 cases, and C in one case. On the other hand, Fukuta et al. [18] used the same surgical treatment but did not report good clinical results. The reason may be that the patients in Fukuta's study had no or only a small kyphosis angle. Qureshi et al. [5] compared the results of an anterior-only approach and combined anterior and posterior surgery and found no significant difference in neurological improvement, ESR, CRP, pain relief, and bone fusion time between the 2 approaches. However, the combined approach resulted in better correction of the kyphotic deformity with an angle correction rate of 48% vs. 24% with the anterior only approach. Wang et al. [10] performed stage I anterior debridement and interbody fusion followed by posterior instrumentation in 37 patients with thoracic and lumbar TB. The mean preoperative kyphosis angle of 53.5° was reduced to 11.0° postoperatively with a correction loss of 1.6° at the final follow-up. While there are different views on whether posterior fixation should be performed before or after anterior debridement, studies in which stage I anterior debridement and bone grafting were performed before stage II (or stage I) posterior osteotomy have not reported good results [19, 20]. Of note, the average correction loss of 1.35° in our study is better than that of 4.64° reported by Sundararau et al. [21], 3.3° reported by Louw et al. [19], and 3° reported by Moon et al. [22].

Single-stage anterior or posterior procedures have provided reasonable outcomes in various groups of patients. Cavuşoğlu et al. [23] treated 22 patients with multilevel spinal TB with anterior radical debridement, decompression, and fusion using anterior spinal instrumentation and tibial allograft replacement. With a mean follow-up time of 84 months, mean postoperative kyphosis correction was 74% (range 63-91%) and on average 2° of loss of correction occurred. ASIA and VAS pain scores were improved. Zhang et al. [11] used 1-stage posterior fixation, anterior debridement, bone grafting and anterior fixation for patients with kyphosis and multiple-segment cervicothoracic spinal TB and reported significant improvement in kyphosis angle and no obvious loss at last follow-up (follow-up range 18-46 months). Wang et al. [6] compared single-stage posterior debridement, interbody fusion and instrumentation with 1-stage anterior debridement, interbody fusion and posterior instrumentation in patients with thoracic and lumbar spinal TB and reported that the single-stage posterior procedure produced better overall results with less complications.

Overall, we believe that an anterior and posterior combined approach would be the best choice in the case of: 1) Spinal TB complicated by severe kyphosis (kyphosis angle > 90°) with or without neurological deficits; 2) The presence of long bone defects that require vertebral resection and bone grafting.

There are limitations to this study. First is the retrospective nature of the analysis. Secondly, the number of patients was relatively small and there was no control group. While the combined procedure we have described has comparatively low operational risks, it requires advanced surgical skills, and detailed diagnostic and preoperative planning for good outcomes. In addition, all procedures were performed by the same team of surgeons and thus the results may not be duplicable at other institutions.

Conclusions

In summary, stage I posterior osteotomy and instrumentation followed by stage II anterior debridement and bone grafting approximately 2 weeks later can achieve good results in patients with lumbar TB and severe kyphosis deformity.

Disclosure of conflict of interest

None.

Address correspondence to: Dr. Weibin Sheng, Department of Spinal Surgery, First Affiliated Hospital of Xinjiang Medical University, 137 Liyushan South Rd., Urumqi 830054, Xinjiang, China. Tel: 0086-09914365316; Fax: 008609914365444; E-mail: 1714250017@qq.com

References

[1] Pola E, Rossi B, Nasto LA, Colangelo D, Logroscino CA. Surgical treatment of tuberculous spondylodiscitis. Eur Rev Med Pharmacol Sci 2012; 16 Suppl 2: 79-85.

[2] Bakhsh A. Medical management of spinal tuberculosis: an experience from Pakistan. Spine 2010; 35: E787-E791.

[3] Rivas-Garcia A, Sarria-Estrada S, Torrents-Odin C, Casas-Gomila L, Franquet E. Imaging findings of Pott's disease. Eur Spine J 2013; 22 Suppl 4: 567-578.

[4] Rajasekaran S. Buckling collapse of the spine in childhood spinal tuberculosis. Clin Orthop Relat Res 2007; 460: 86-92.

[5] Qureshi MA, Khalique AB, Afzal W, Pasha IF, Aebi M. Surgical management of contiguous multilevel thoracolumbar tuberculous spondylitis. Eur Spine J 2013; 22 Suppl 4: 618-623.

[6] Wang X, Pang X, Wu P, Luo C, Shen X. One-stage anterior debridement, bone grafting and posterior instrumentation vs. single posterior debridement, bone grafting, and instrumentation for the treatment of thoracic and lumbar spinal tuberculosis. Eur Spine J 2014; 23: 830-837.

[7] Rajasekaran S. Kyphotic deformity in spinal tuberculosis and its management. Int Orthop 2012; 36: 359-365.

[8] Jain AK. Tuberculosis of the spine: a fresh look at an old disease. J Bone Joint Surg Br 2010; 92: 905-913.

[9] Hirakawa A, Miyamoto K, Masuda T, Fukuta S, Hosoe H, Iinuma N, Iwai C, Nishimoto H, Shimizu K. Surgical outcome of 2-stage (posterior and anterior) surgical treatment using spinal instrumentation for tuberculous spondylitis. J Spinal Disord Tech 2010; 23: 133-138.

[10] Wang XB, Li J, Lu GH, Wang B, Lu C, Kang YJ. Single-stage posterior instrumentation and anterior debridement for active tuberculosis of the thoracic and lumbar spine with kyphotic deformity. Int Orthop 2012; 36: 373-380.

[11] Zhang HQ, Hu X, Yin X, Chen Y. One-stage combined anterior-posterior approach treatment of multiple cervicothoracic spinal tuberculosis with kyphosis. Int Orthop 2015; 39: 1605-1610.

[12] Lu G, Wang B, Li J, Liu W, Cheng I. Anterior debridement and reconstruction via thoracoscopy-assisted mini-open approach for the treatment of thoracic spinal tuberculosis: minimum 5-year follow-up. Eur Spine J 2012; 21: 463-469.

[13] He M, Xu H, Zhao J, Wang Z. Anterior debridement, decompression, bone grafting, and instrumentation for lower cervical spine tuberculosis. Spine J 2014; 14: 619-627.

[14] Waring WP 3rd, Biering-Sorensen F, Burns S, Donovan W, Graves D, Jha A, Jones L, Kirshblum S, Marino R, Mulcahey MJ, Reeves R, Scelza WM, Schmidt-Read M, Stein A. 2009 review and revisions of the international standards for the neurological classification of spinal cord injury. J Spinal Cord Med 2010; 33: 346-352.

[15] Parthasarathy R, Sriram K, Santha T, Prabhakar R, Somasundaram PR, Sivasubramanian S. Short-course chemotherapy for tuberculosis of the spine. A comparison between ambulant treatment and radical surgery--ten-year report. J Bone Joint Surg Br 1999; 81: 464-471.

[16] Rajasekaran S, Vijay K, Shetty AP. Single-stage closing-opening wedge osteotomy of spine to correct severe post-tubercular kyphotic deformities of the spine: a 3-year follow-up of 17 patients. Eur Spine J 2010; 19: 583-592.

[17] Rajasekaran S. The problem of deformity in spinal tuberculosis. Clin Ortop Relat Res 2002; 398: 85-92.

[18] Fukuta S, Miyamoto K, Masuda T, Hosoe H, Kodama H, Nishimoto H, Sakaeda H, Shimizu K. Two-stage (posterior and anterior) surgical treatment using posterior spinal instrumentation for pyogenic and tuberculotic spondylitis. Spine 2003; 28: E302-E308.

[19] Louw JA. Spinal tuberculosis with neurological deficit. Treatment with anterior vascularised rib grafts, posterior osteotomies and fusion. J Bone Joint Surg Br 1990; 72: 686-693.

[20] Huang QS, Zheng C, Hu Y, Yin X, Xu H, Zhang G, Wang Q. One-stage surgical management for children with spinal tuberculosis by anterior decompression and posterior instrumentation. Int Orthop 2009; 33: 1385-1390.

[21] Sundararaj GD, Behera S, Ravi V, Venkatesh K, Cherian VM, Lee V. Role of posterior stabilisation in the management of tuberculosis of the dorsal and lumbar spine. J Bone Joint Surg Br 2003; 85: 100-106.

[22] Moon MS, Woo YK, Lee KS, Ha KY, Kim SS, Sun DH. Posterior instrumentation and anterior interbody fusion for tuberculous kyphosis of dorsal and lumbar spines. Spine (Phila Pa 1976) 1995; 20: 1910-1916.

[23] Cavuşoğlu H, Kaya RA, Turkmenoglu ON, Tuncer C, Colak I, Aydin Y. A long-term follow-up study of anterior tibial allografting and instrumentation in the management of thoracolumbar tuberculous spondylitis. J Neurosurg Spine 2008; 8: 30-38.