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One-stage posterior grade 4 osteotomy and bone graft fusion at pseudarthrosis for the treatment of kyphotic deformity with Andersson lesions in ankylosing spondylitis

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ABSTRACT

Objectives: The optimal surgical procedure for treating kyphotic deformity with Andersson lesions (ALs) in ankylosing spondylitis (AS) patients is controversial. The one-stage posterior osteotomy and bone graft fusion approach is rarely reported. The aim of the present study was to report a new surgical procedure involving one-stage posterior grade 4 osteotomy and bone graft fusion for the treatment of kyphotic deformity with ALs in AS.

Patients and methods: Eleven patients with ALs in AS were enrolled. One-stage posterior grade 4 osteotomy and bone graft fusion was performed in all patients. Frankel classification and visual analog scale (VAS) were used to evaluate neurologic deficit and the level of back pain pre- and postoperatively, respectively. Radiographic and clinical outcomes were assessed with a mean of 31.5 months follow-up.

Results: Local kyphosis was corrected from 19.1° to 0.5° after surgery with a mean correction rate of 95%. One Frankel C and 5 Frankel D patients changed to Frankel D and Frankel E, respectively. VAS was reduced from 6.7 to 0.27 at final follow-up. Bone graft fusion was observed at an average of 4.3 months and solid bony fusion was achieved at final follow-up. Average operation time and blood loss were 268.6 min and 1009 ml, respectively. Three patients developed dural tear complications. There were no neurological or instrumentation complications reported or observed at final follow-up.

Conclusion: One-stage posterior grade 4 osteotomy and bone graft fusion is an optional surgical procedure to treat ALs in AS patients. This approach results in reduced blood loss and operation time, satisfactory correction of local kyphosis, and good safety. Successful fusion and good clinical outcomes can also be achieved.

1. Introduction

Ankylosing spondylitis (AS) is a chronic inflammatory disease, characterized by ossification of the ligaments of the spinal column, annulus fibrosis, endplates, and apophyseal joints, resulting in the formation of a “bamboo spine” [1–3]. Ankylosis of the spine also causes vertebral osteoporosis and biomechanical alterations [4,5]. Spinal pseudarthrosis is a well-known complication in AS patients [3,6]. This pseudarthrosis often progresses to destructive lesions of the intervertebral disc and vertebral body at the site of pseudarthrosis [6,7], known as Andersson lesions (ALs) [3]; ALs lead to persistent back pain, progressive kyphotic deformity at the site of the apex of pseudarthrosis, and neurologic symptoms in AS patients [8,9].

Acute fractures in AS have been successfully treated using conservative treatments such as plaster immobilization or Halo-jacket immobilization [10]. However, there is no evidence that conservative treatment is successful in AS patients with ALs, even after a long treatment course. Surgical procedures for ALs patients are associated with considerable adverse effects, including unbearable pain, progressive kyphotic deformity, and neurologic deficits [2,11], and the optimal surgical strategy is controversial. Successive surgical approaches used have included the anterior approach [8], one-stage posterior osteotomy with anterior bone graft fusion [2], one-stage posterior osteotomy, two-stage anterior bone graft fusion [12], and posterior osteotomy correction without anterior fusion [13]. Each surgical procedure has its advantages and disadvantages.

The aim of surgery in AS patients with ALs is to decompress the spinal canal and restore spinal stability, facilitating healing and fusion of the spinal lesion with adequate safety and with reduced pain and cost [3]. To our knowledge, few studies have reported outcomes of one-stage posterior grade 4 osteotomy and bone graft fusion for the treatment of kyphotic deformity with ALs in AS. The current study

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aimed to evaluate the effectiveness and safety of this method.

2. Materials and methods

2.1. Patient information

This study was approved by the institutional review board at our Hospital, and written informed consent was obtained from all patients. From March 2009 to December 2013, 11 patients with AS with a progressive kyphotic deformity or potential instability at the site of pseudarthrosis underwent surgical treatment via one-stage posterior grade 4 osteotomy and intervertebral fusion to simultaneously debride the ALs and correct the kyphotic deformity. The study population comprised 10 males and 1 female with an average age of 53.1 years (range: 37–75 years). Of these 11 patients, 5 had a definite history of mild trauma that involved falling down with the hip contacting the ground, or had experienced a minor strike on the back; the remaining 6 patients had no history of trauma. Eight of these 11 patients showed significant kyphotic deformity at the site of the ALs. Although the remaining 3 patients had no significant kyphotic deformity, there were severe destructive lesions of the intervertebral disc or vertebral body that could lead to instability of the spine.

All patients presented at the Department of Spine Surgery because of persistent back pain, progressive kyphotic deformity, or neurological symptoms. Neurologic deficit was evaluated preoperatively and at final follow-up according to the Frankel classification [15]. Preoperatively, 1 patient was graded as Frankel C, 5 were Frankel D, and 5 were Frankel E. The level of pain was assessed preoperatively and at final follow-up using a visual analog scale (VAS). The average preoperative VAS value was 6.7 (Table 1). General laboratory markers of erythrocyte sedimentation rate (ESR), C-reactive protein (CRP), and human leukocyte antigen (HLA)-B27 were tested preoperatively. All patients were HLA-B27-positive and had elevated CRP and ESR levels.

2.2. Radiographic assessment

Preoperative radiography, computed tomography (CT), and magnetic resonance imaging (MRI) were performed to determine the degree of ALs in AS patients (Figs. 1 and 2). All patients were found to have extensive discovertebral or transvertebral destructive lesions that were classified as type E according to the classification system by Cawley et al. [6]. The lesions often involved a single segment and the spine above and below the ALs had advanced ankylosis. There was irregular destruction of the discovertebral site, with extensive resorption and sclerosis extending into the adjacent vertebral body. The ALs affected the posterior structure of the spine, causing 3-column fracture in all patients and kyphotic deformity in 9 patients. The ALs site was the thoracic vertebrae in 6 patients, the thoracolumbar junction in 3 patients, and the lumbar vertebrae in 2 patients.

Standing lateral radiographs were obtained preoperatively, postoperatively and at final follow-up to evaluate sagittal alignment change by measuring the parameters of thoracic kyphosis (TK), lumbar lordosis (LL), global kyphosis (GK), local kyphosis (LK), sagittal vertical axis (SVA), pelvic incidence (PI), and pelvic tilt (PT) (Figs. 1 and 2). TK was defined as the angle between the upper endplate of T5 and the lower endplate of T12; LL was measured between the superior endplate of T12 and S1; GK was measured from the superior endplate of the maximally tilted upper end vertebra to the inferior endplate of the maximally tilted lower end vertebra; LK was assessed by the angle between the upper endplate of the vertebra one cephalad to the pseudarthrosis and the lower endplate of the vertebra one caudal to the pseudarthrosis; SVA was defined as the distance between the C7 plumb line and the posterior superior corner of S1; PT was measured as the angle between the vertical line and the line connecting the midpoint of the sacral plate to the femoral head axis; PI was measured as the angle between the line perpendicular to the sacral plate at its midpoint and the line connecting this point to the femoral head axis.

Postoperative bone union was evaluated by radiography or CT during regular follow-up. If the fracture line was blurred on the radiograph, or bony trabeculae grew across the fusion site on the CT, we concluded that bone union was achieved. All measurements were performed by two spine surgeons. All data were obtained by the average values of two measurements.

2.3. Surgical technique

Grade 4 osteotomy is defined as resection of a substantial portion of the posterior vertebral body, posterior elements with pedicles, and at least a portion of one endplate with the adjacent intervertebral disc [14]. Grade 4 osteotomy via the posterior approach can provide wider debridement of lesions than pedicle subtraction osteotomy at the site of ALs. It is not necessary to use an additional anterior approach to debride these lesions, and the surgeon can conduct osteotomy and bone graft fusion in the same procedure. Under general endotracheal anesthesia, the patient was placed in prone position on a special folding frame to accommodate the kyphotic spine and avoid new injury of the spinal cord from postural changes. The affected section of spine was exposed through a standard posterior midline approach with subperiosteal dissection. Pedicle screws were inserted into several vertebrae above and below the site of pseudarthrosis. After the temporary rod was fixed on the side of the pedicle screws, the laminae, articular processes, and transverse processes at the level of the pseudarthrosis were resected. The dura and nerve roots were then carefully exposed and protected by a sponge. A transpedicular wedge osteotomy was performed at the site of the pseudarthrosis. Sclerotic bone around the pseudarthrosis was also resected. Simultaneously, the fibrous tissue, residuary disc tissue, and fibrocartilage were debrided by bone curettes. The resected specimens were examined histopathologically. Adequate bone grafts were placed in the anterior wedge defect. Compressive forces were applied on the pedicle screws above and below the

Table 1
Patients information.

Case no.	Age (year)	Gender	Pseudart-hrosis site	Trauma history	Neurologic function (Pre/FFU)[a]	VAS (Pre/FFU)	Follow-up (month)
1	75	M	T11	Y	E/E	7/1	43
2	42	M	T8-9	Y	D/E	6/0	35
3	37	M	L2-3	N	E/E	7/0	30
4	51	F	L1-L2	N	D/E	5/0	23
5	49	M	T10-11	Y	E/E	7/0	21
6	38	M	T9-T10	N	C/D	7/1	39
7	68	M	T11	Y	D/E	7/1	25
8	63	M	T12-L1	Y	D/E	6/0	45
9	76	M	T12-L1	N	E/E	6/0	30
10	41	M	T10-11	N	E/E	7/0	22
11	45	M	T12-L1	N	D/E	7/0	33

[a]Pre: pre-operation; FFU: Final follow-up.