

Clinical Article

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Balloon Kyphoplasty through Extrapedicular Approach in the Treatment of Middle Thoracic Osteoporotic Compression Fracture : T5-T8 Level

Objective : Kyphoplasty performed in the middle thoracic spine presents technical challenges that differ from those in the lower thoracic or lumbar region due to small pedicle size and angular severity for thoracic kyphosis. The purpose of this study was to evaluate the efficacy of balloon kyphoplasty through extrapedicular approach for the treatment of intractable osteoporotic compression fractures in the middle thoracic spine.

Methods : The patients who were performed with one level balloon kyphoplasty through extrapedicular approach due to painful osteoporotic compression fractures at T5-T8 from June 2003 to July 2005 were retrospectively analyzed. Imaging and clinical features were analyzed including involved vertebrae level, vertebral height, injected cement volume, clinical outcome and complications.

Results : Eighteen female patients (age ranged from 60 to 77 years old) were included in this study. The average amount of the implanted cement was 4.2 ± 1.5 cc. The mean Cobb angle and compression rate were improved from $12.1 \pm 6.5^\circ$ to $8.5 \pm 7.2^\circ$ and from 30% to 15%, respectively. The mean pain score (visual analogue scale) prior to kyphoplasty was 7.9 and it decreased to 3.0 after the procedure. Cement leakage to the adjacent disc (2 cases) and paravertebral soft tissues (1 case) were seen but there were no major complications such as pneumothorax, segmental artery injury, pulmonary embolism, or epidural leakage.

Conclusion : Balloon kyphoplasty through extrapedicular approach is considered as a safe and effective in treating the middle thoracic regions with low complication rate.

KEY WORDS : Balloon kyphoplasty · Extrapedicular approach · Middle thoracic region · Osteoporotic compression fracture.

INTRODUCTION

Percutaneous vertebroplasty has emerged as an effective treatment of painful osteoporotic compression fracture¹⁾. However, vertebroplasty “freezes” the deformity without correcting the compression, requires cement injection at higher pressures, and incurs a higher risk of cement extravasation compared to kyphoplasty⁶⁻⁹⁾. Despite the benefits of kyphoplasty, osteoporotic compression fractures in the middle thoracic region are technically challenging due to the difficulties in the insertion of large-gauge trocars into a vertebral body compared to vertebroplasty needles. Furthermore, this procedure is more difficult to perform in patients with severe kyphotic deformity and relatively small size of pedicles in the thoracic region. The purpose of this study was to determine the efficacy of balloon kyphoplasty through extrapedicular approach for the treatment of painful osteoporotic compression fracture in the middle thoracic spine.

MATERIALS AND METHODS

Among the patients who underwent the balloon kyphoplasty through extrapedicular approach from June 2003 to July 2005 for one level osteoporotic compression fracture between T5 and T8, 18 patients followed up for longer than 6 months were included in this study. Their age was ranged from 60 to 77 years old, and the mean age was 68.1 years old. We excluded the patients who had the cancer history or who were performed with transpedicular biopsy due to suspicion of spinal metastasis from this study. For all patients, simple radiographs and thoracic spine magnetic resonance imaging (MRI) were taken and bone marrow densitometry

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were performed to assess degrees of osteoporosis. Balloon kyphoplasty was performed on the patients who had acute compression fractures accompanying osteoporosis without neurologic deficit and severe tenderness in the fractured area, which showed the low signal intensity in the T1-weighted MRI. The posterior cortex of vertebral body and diameters of the pedicles were evaluated by thoracic-spine computed

tomography (CT), and the cases with severe cord compression were excluded from this study.

Technique of balloon kyphoplasty

All procedures were done under, local anesthesia. The biopsy needles were placed percutaneously into the posterior vertebral body through extrapedicular approach. The entry point is immediately superior and lateral to the pedicle, just medial to the rib head (Fig. 1). The biopsy needles were exchanged over a guide wire for a working cannula. KyphX Inflatable Bone Tamps (Kyphon, Inc., Sunnhvale, CA) were placed bilaterally into the vertebral body through a working cannula. Inflation was continued until the balloon contacted a vertebral body cortical wall, and the maximal balloon volume was reached or when the inflatable balloon tamp (IBT) reached 300 psi. The IBTs were then withdrawn, and polymethylmethacrylate (PMMA) cement (KyphX, Kyphon, Inc.) was placed into the cavity within the fractured vertebral body. The degrees of compression fractures were measured by the shortening of the anterior vertebral height based on the posterior side of the identical vertebra. The improvement of the degree of pain was assessed by the visual analogue scale (VAS) score (without pain was 0 point, and the worst imaginable pain was 10 points). Statistical analysis of pre- and postoperative scores for the severity of pain and

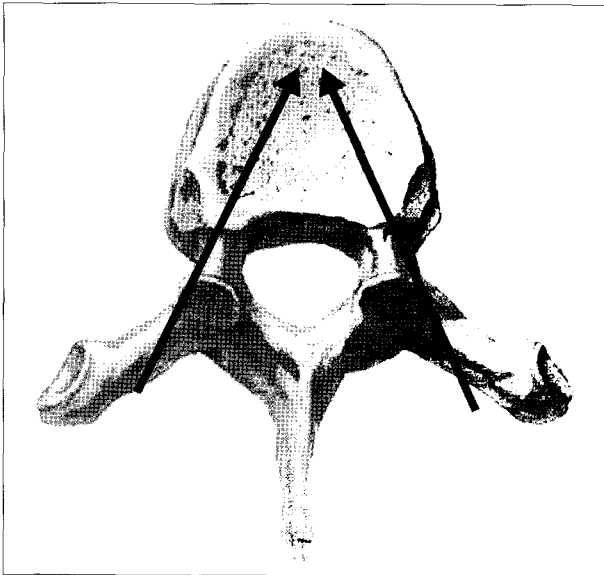


Fig. 1. The extrapedicular entry point (black arrow).

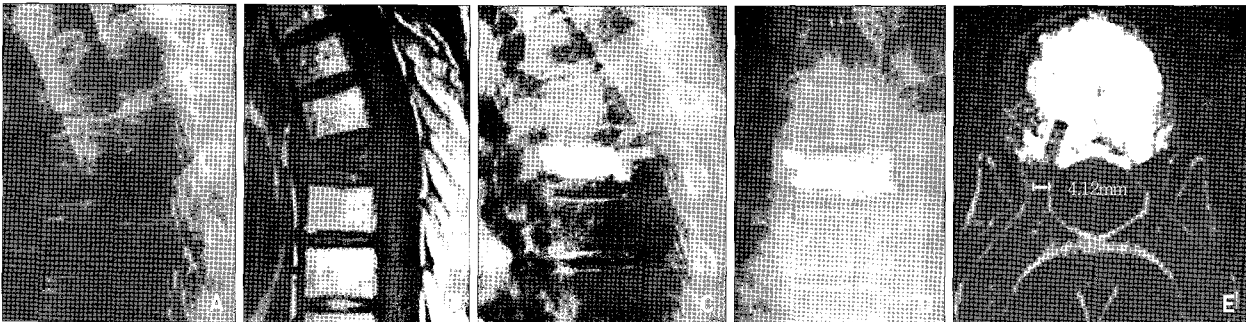


Fig. 2. A, B : Lateral plain film and magnetic resonance image of a 64-year-old woman revealing T7 compression fracture. C, D : Simple plain films show the vertebra that has been consolidated after balloon kyphoplasty. E : Computed tomography scan shows well consolidated vertebra. The size of pedicle is 4.12 mm that indicates less than the working cannula size.



Fig. 3. A, B : Magnetic resonance image and computed tomography scan of a 68-year-old woman with T6 compression fracture. C, D : Re-expanded vertebra has been consolidated after balloon kyphoplasty. E : Computed tomography scan shows well consolidated vertebra. The size of pedicle is 4.05 mm that indicates less than the working cannula size.

Table 1. Complications observed on radiographs

Pattern of bone cement leakage	Number of cases (%)
Paravertebral	1 (5.6)
Adjacent discal	2 (11.2)
Venous (pulmonary embolism)	0 (0)
Epidural	0 (0)

mean injected cement volume for each level were performed using Chi-square & paired t-test. *p*-value less than 0.05 was considered as statistically significant.

RESULTS

Fractured vertebral bodies were involved from level T5 to T8. Kyphoplasty was performed in 18 patients (one at T5, three at T6, six at T7, and eight at T8). For all levels, the mean volume of injected cement was 4.2 ± 1.5 cc. The mean volume of injected cement at T5, T6 was less than that of T7, T8 (3.8 ± 1.4 versus 4.5 ± 1.5 cc, respectively), but there was no statistical significance ($p=0.0654$). The mean VAS score prior to the procedure was 7.9 which it improved to 3.0 within 48 hours later, and the VAS score after 6 months later was 3.0, which was statistically significantly decreased ($p=0.001$). With regards to the improvement of pain, all patients were improved mainly within 48 hours. The compression rate and kyphotic angle were slightly improved after procedure from 30% to 15% and from $12.1 \pm 6.5^\circ$ to $8.5 \pm 7.2^\circ$ respectively (Fig. 2, 3). The improved alignment was maintained on a true lateral radiograph after 6 months follow-up. Complications observed on radiographs were cement leakage to the adjacent disc (2 cases) and paravertebral soft tissues (1 case) (Table 1). But, pulmonary embolism, epidural leakage, segmental artery injury, other new neurological deficits, and pneumothorax were not seen.

DISCUSSION

With the increased rate of aging populations, patients with osteoporotic compression fractures in the vertebral body are increased as well, and thus, quality of life is lowered^{3,4}. Balloon kyphoplasty is a recently developed, minimally invasive surgical treatment for osteoporotic vertebral compression fractures (VCFs). It is designed to address the fracture-related pain and the associated spinal deformity. Less frequent cement leakage as well as restoration of vertebral body height have been reported with kyphoplasty compared to vertebroplasty^{2,5}. Despite these benefits, it is difficult to perform balloon kyphoplasty in middle thoracic region. Most cases of osteoporotic compression fracture have occurred in the lower thoracic region and thoraco-lumbar spine. Middle thoracic kyphoplasty may pose special challenges considering the relatively small pedicle

size, risk of pneumothorax and segmental artery injury, and severe angulation from kyphosis that are not present in thoracolumbar and lumbar procedures. The biggest problem encountered in these patients is the issue of needle placement due to the thoracic kyphotic angle and relatively small pedicle size⁴. Limitations in using the transpedicular approach include inadequate pedicle width, usually above T9, and lateral angulation of the pedicle with respect to the vertebral body. In thoracic vertebral bodies from T9 and above, pedicles are narrow and laterally directed. In these vertebra a transpedicular approach results in suboptimal balloon placement, against the lateral cortex instead of near the center of a vertebral body. At these levels, an extrapedicular approach must be considered. Moreover the diameter of the working cannula used in kyphoplasty is about 4.5 mm, transpedicular approach must be performed in patients whose pedicle diameter is bigger than 4.5 mm. With the extrapedicular approach, the pedicle is entered as it connects to the vertebral body slightly laterally. The tools can then be directed to a point just lateral to the center of the vertebral body. But, we must keep in mind that the approach is too lateral, the pulmonary cavity may be entered and it is too inferior, the segmental artery can be violated.

This study confirmed the safety and feasibility of balloon kyphoplasty in the middle thoracic regions to extrapedicular route. The vertebral height was restored substantially and significant pain relief achieved. The improved alignment was also maintained. Although needle placement was challenging in case of severe thoracic kyphosis, strict adherence to craniocaudal angulation with the lateral side and slight obliquity to the anteroposterior side was facilitated by rapid treatments in every case. There were no pneumothorax or segmental artery injury. Our study demonstrates that PMMA leakage into the adjacent disc or paravertebral soft tissue may happen. But, the patients did not have side effects from such leakage of the small amounts of PMMA into disc or paravertebral soft tissues.

Although our study demonstrates successful results, the management of the middle thoracic lesion still poses the technical difficulty compared with thoracolumbar or lumbar junction, and it should be kept in mind that serious complications may occur.

CONCLUSION

Balloon kyphoplasty is becoming a standard care for palliative pain control associated with osteoporotic compression fracture. Balloon kyphoplasty through extrapedicular approach provides pain relief and vertebral stabilization for the compression fracture of middle thoracic region with low complication rate.

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