Treatment of Thoracolumbar Fractures With Vertebroplasty in Combination With Posterior Instrumentation

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Abstract: The surgical treatment of thoracolumbar fracture remains controversial. The anterior approach provides good decompression and solid fusion, but the operative risk is relatively higher than that associated with the posterior approach. The posterior approach, which often involves treatment with short rigid posterior fusion, is simple to perform and less traumatic for the patient. The surgical treatment of deformities such as kyphosis and scoliosis can be challenging, however, given the associated poor bone quality and propensity for instrumentation cutout. This report describes 3 patients with thoracic and lumbar fractures who were successfully treated with vertebroplasty in combination with posterior fixation using pedicle screws or hooks. Vertebroplasty with polymethylmethacrylate offers immediate spinal stability in patients with thoracolumbar fractures and may decrease the instrument failure rate compared with not using vertebroplasty.

Key Words: vertebroplasty, instrumentation, vertebral fracture

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Several treatment options for thoracolumbar spine fractures have been reported, such as anterior decompression and stabilization, posterior decompression, and a combination of the anterior and posterior procedures.[1–9] The ideal surgical procedure remains controversial, however. Percutaneous vertebroplasty should be viewed not only as a pain-relieving procedure but as an effective method for providing anterior load sharing in accordance with basic biomechanical principles.[10] Vertebroplasty offers the capability of providing anterior treatment, and there exists the possibility of reinforcing posterior instrumentation.[11–14] This report describes 3 patients, 2 with osteoporotic compression fractures and 1 with traumatic fractures with anterolisthesis, who were successfully treated with vertebroplasty in combination with posterior fixation using pedicle screws or hooks.

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CASE REPORTS

Case 1

A 78-year-old woman could not stand because of back pain without palsy in her lower limbs. Plain radiographs revealed an old compression fracture in the L1 vertebra, and functional imaging showed movement of the compressed vertebra (Fig. 1). Corset fixation and bed rest were not effective, and her disuse dementia symptoms were aggravated. During surgery, laminectomy of L1 and polymethylmethacrylate (PMMA) vertebroplasty of L1 with pedicle screw fixation of T11, T12, and L2 were performed. The patient was allowed to walk with an orthosis attachment 2 weeks after surgery. Good alignment was maintained for 4 months after the operation (Fig. 2).

Case 2

A 66-year-old woman suffered a fall from a height. Imaging of her spine revealed a wedged compression fracture of L1 with anterolisthesis of T12 on L1 and minimal compromise of the spinal canal (Fig. 3, left). She also required evacuation of her cranial epidural hematoma. She underwent craniotomy in the prone position and posterior reduction and fixation by vertebroplasty combined with short fusion by pedicle screw fixation at the same time. After surgery, she had no back pain, and good alignment was maintained for 3 months after the operation (Fig. 3, right).

Case 3

A 48-year-old man suffered from severe back pain attributable to steroid-induced osteoporotic thoracic fracture and severe kyphotic deformity. He was unable to assume the supine position because of back pain for 1 year. Imaging studies revealed T6 and T7 vertebral compression fractures associated with significant kyphosis (Fig. 4A, B). There was no significant compression of the spinal canal at the level of the fracture. Hook fixation from T4 to T9 in combination with vertebroplasty for T6 and T7 ablated his back pain, and kyphosis correction was achieved (Fig. 4C).

DISCUSSION

Compression fractures of the vertebral body are common injuries in elderly osteoporotic patients.[1,2,15] Osteoporotic compression fractures have been described as stable spinal injuries, and in most cases, they are well-managed with nonoperative treatment. Progressive collapse of the vertebral body and late kyphosis may be associated with these fractures, however. In such cases, neurologic deficit occurs insidiously and gradually worsens. Neural compression by displaced bone fragments and late kyphosis can produce neurologic deficit.[16,17] Surgical treatment is usually required in cases with posttraumatic

FIGURE 1. Case 1. A 78-year-old woman was treated with combined L1 vertebroplasty and pedicle screw fixation. A preoperative plain radiograph of the lumbar spine is shown. A lateral radiograph reveals the old L1 vertebral fracture with instability,

kyphosis and neurologic compromise secondary to osteoporotic fracture because nonoperative treatment is generally ineffective.

The surgical goals parallel those of unstable spine trauma and include the improvement of neurologic deficit through neural decompression, the correction of deformity, and stabilization of the spinal column by arthrodesis.[18] Conversely, in the treatment of traumatic burst fracture, the major goals include correction of the deformity, reduction of neurologic deficit, and limiting progression of the deformity and neurologic deficit by stabilization of the fracture.

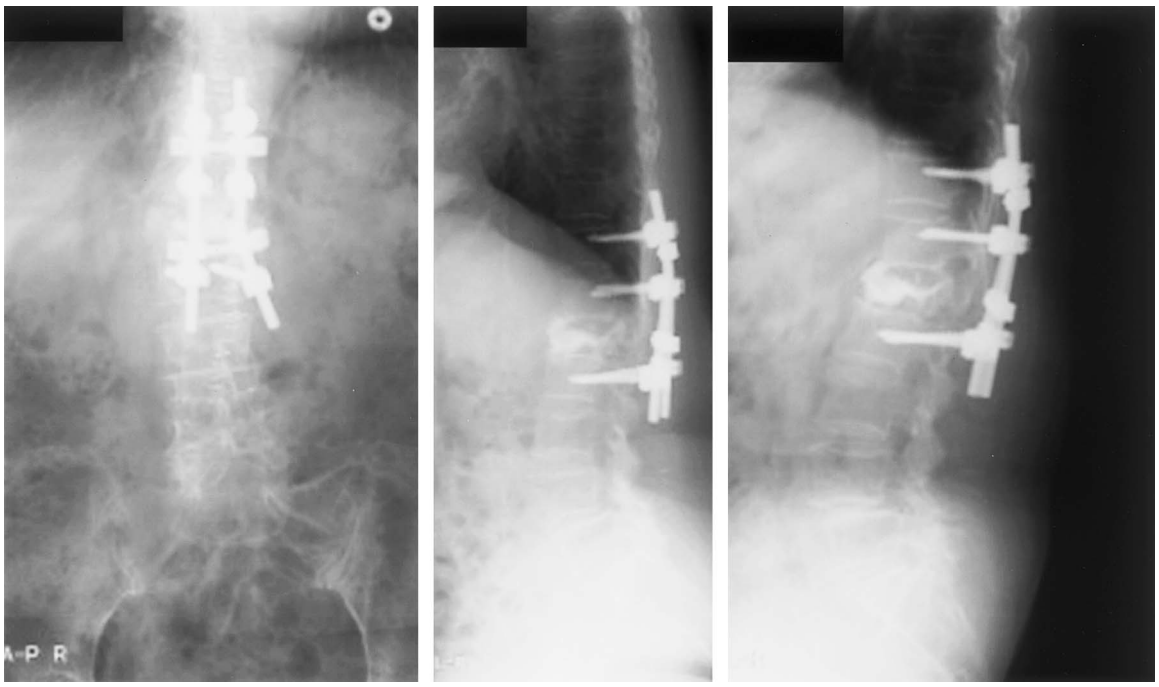

FIGURE 2. Case 1. A postoperative plain radiograph shows good realignment of the thoracolumbar spine.

FIGURE 3. Case 2. A 66-year-old woman was treated with a combined L1 vertebroplasty and pedicle fixation procedure. A preoperative computed tomography scan with 3-dimensional reconstruction of the lumbar spine shows a wedged compression fracture of L1 with anterolisthesis of T12 on L1. A postoperative lateral thoracic radiograph confirms good positioning of the instrumentation with realignment of the thoracolumbar spine.

There are 3 major approaches (anterior, posterior, and combined) used in the treatment of patients with thoracolumbar fracture. Because the anterior approach offers good visualization of the fracture and allows direct restoration of the defect, it consequently provides good decompression and solid fusion. Also, angular correction is better achieved and maintained through an anterior approach. Disadvantages compared with the posterior approach include a longer duration for the procedure, greater blood loss, and an increase in postoperative morbidity. In addition, anterior approaches often require the involvement of an approach surgeon, and lateral extracavitary approaches are tedious with poor exposure for anterior graft placement.

The posterior approach is simple to perform and less traumatic for the patient and is familiar to most spine surgeons. For the posterior approach, the pedicle screw instrumentation system has become the device of choice.[19–21] Recently developed pedicle screw devices allow the surgeon to apply translation and angulation to the spine independently, and this is accomplished by applying appropriate device adjustments. Because the holding power of the implant is not sufficient for an osteoporotic spine without vertebral body reconstruction, however, it has a high instrument failure rate.

Whether the anterior approach or posterior approach is used, the failure rate with either approach alone may be unacceptably high in patients such as those with kyphotic deformities and loss of integrity of the posterior column. The combination of the anterior and posterior approaches is an ideal method, but the operative time is longer and the surgical trauma is higher. Similar to case 2, patients with complications associated with multiple major traumas are not suitable candidates for this major operation.

In recent years, percutaneous vertebroplasty has been viewed not only as a pain-relieving procedure but also as an effective method for improving vertebral body height, kyphosis angle, and wedge angle and for providing anterior load sharing in accordance with basic biomechanical principles.

Lu et al[10] reported that spinal stiffness after burst fracture was significantly decreased by 47.5% of the intact condition with the use of this procedure. These investigators also mentioned that instant spinal stiffness was recovered by 107.8% of the intact condition with PMMA vertebroplasty. Cement vertebroplasty offers the capability of providing anterior treatment with a posterior approach when performing pedicle screw fixation.[10] This treatment may improve outcomes in most patients with fractures without the need for a second anterior approach and has the advantage of allowing vertebral body treatment with less trauma for the patient.

Cho et al[12] proposed an insightful strategy for overcoming the pitfalls of conventional burst fracture treatment by supplementing their posterior approach with PMMA vertebroplasty. They reported that PMMA vertebroplasty in this setting conceptually helps to provide anterior column support and provides superior correction and long-term internal

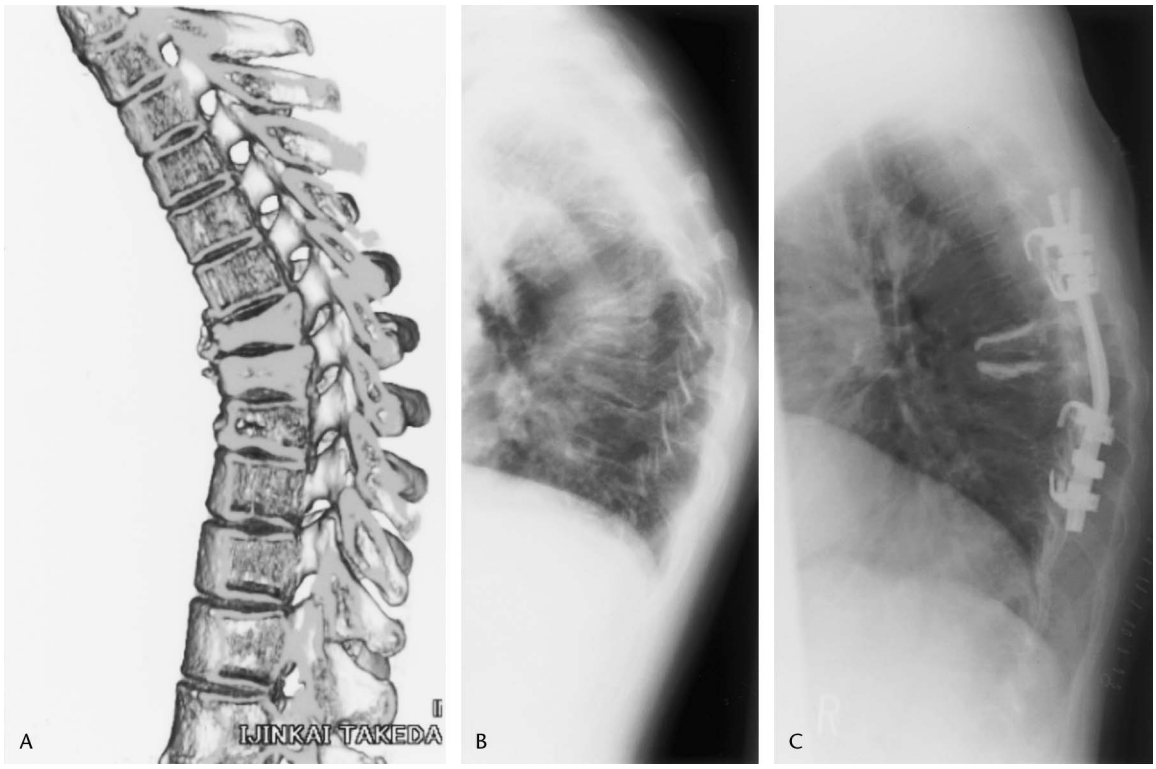

FIGURE 4. Case 3. A 48-year-old man was treated with combined vertebroplasty and posterior hook fixation. A, B, Preoperative lateral radiographs show an osteoporotic compression fracture at T6 and T7 and 35° of kyphosis. C, Postoperative lateral radiographs. Kyphosis was corrected to 8°.

fixation compared with their initial experience with these types of injuries without using PMMA vertebroplasty.[12] Matsuyama et al[13] reported that vertebral reconstruction with calcium phosphate cement using instrumentation was a safe and useful surgical treatment of osteoporotic vertebral compression fracture. Verlaan et al[14] also reported that transpedicular balloon vertebroplasty for the direct restoration of burst fractures is feasible in combination with posterior instrumentation. These reported that the improvement in angular deformity and reconstitution of body height was better achieved in those patients undergoing vertebroplasty and that the instrumentation failure rate may decrease than without vertebroplasty.

This approach has some disadvantages, however. The injection of PMMA into a fractured vertebral body may lead to significant cement extrusion into the spinal canal, particularly if the posterior longitudinal ligament is torn. Although we found no such cases in our other percutaneous vertebroplasty series, this could easily occur in less experienced hands.

Furthermore, it is unknown what the long-term fate of the PMMA in the traumatized vertebral body is and how it affects fracture healing. Clinical studies on long bone fractures augmented with PMMA indicate that this is a feasible application; however, ultimately, this question can only be answered after longer follow-up is obtained for patients treated in this manner.

Ultimately, the use of osteobiologic agents combined with hydroxyapatite cement for structural integrity could replace the use of PMMA, making this approach more attractive. Perhaps the use of an osteoconductive cement such as hydroxyapatite may eventually achieve the same ends.

CONCLUSION

Posterior instrumentation reinforced with PMMA vertebroplasty involves using a posterior approach to administer anterior and posterior surgical treatment. Posterior instrumentation reinforced with PMMA vertebroplasty may be safe and less invasive. For certain patients, this technique is an insightful option for overcoming the pitfalls of conventional thoracolumbar fracture treatment.

REFERENCES

1. Kostuik JP, Matsusaki H. Anterior stabilization, instrumentation, and decompression for post-traumatic kyphosis. *Spine*. 1989;14:379–386.
2. Roberson JR, Whitesides TE Jr. Surgical reconstruction of late post-traumatic thoracolumbar kyphosis. *Spine*. 1985;10:307–312.
3. Gertzbein SD, Harris MB. Wedge osteotomy for the correction of post-traumatic kyphosis. *Spine*. 1992;17:374–379.
4. Kaneda K, Asano S, Hashimoto T, et al. The treatment of osteoporotic-posttraumatic vertebral collapse using the Kaneda device and a bioactive ceramic vertebral prosthesis. *Spine*. 1992;17:295–303.
5. Kempinsky WH, Morgan PP, Boniface WR. Osteoporotic kyphosis with paraplegia. *Neurology*. 1958;8:181–186.
6. Malcolm BW, Bradford DS, Winter RB, et al. Post-traumatic kyphosis. A review of forty-eight surgically treated patients. *J Bone Joint Surg Am*. 1981;63:891–899.
7. McAfee PC, Bohlman HH, Yuan HA. Anterior decompression of traumatic thoracolumbar fractures with incomplete neurological deficit using a retroperitoneal approach. *J Bone Joint Surg Am*. 1985;67:89–104.

8. Mochida J, Toh E, Chiba M, et al. Treatment of osteoporotic late collapse of a vertebral body of thoracic and lumbar spine. *J Spinal Disord*. 2001; 14:393–398.
9. Shikata J, Yamamuro T, Iida H, et al. Surgical treatment for paraplegia resulting from vertebral fractures in senile osteoporosis. *Spine*. 1990;15: 485–489.
10. Lu WW, Cheung KM, Li YW, et al. Bioactive bone cement as a principal fixture for spinal burst fracture: an in vitro biomechanical and morphologic study. *Spine*. 2001;26:2684–2690.
11. Mermelstein LE, McLain RF, Yerby SA. Reinforcement of thoracolumbar burst fractures with calcium phosphate cement. A biomechanical study. *Spine*. 1998;23:664–671.
12. Cho DY, Lee WY, Sheu PC. Treatment of thoracolumbar burst fractures with polymethyl methacrylate vertebroplasty and short-segment pedicle screw fixation. *Neurosurgery.* 2003;53:1354–1360.
13. Matsuyama Y, Goto M, Yoshihara H, et al. Vertebral reconstruction with biogradable calcium phosphate Cement in the treatment of osteoporotic vertebral compression fracture using instrumentation. *J Spinal Disord Tech*. 2004;17:291–296.
14. Verlaan JJ, Dhert WJ, Verbout AJ, et al. Balloon vertebroplasty in combination with pedicle screw instrumentation: a novel technique to treat thoracic and lumbar burst fractures. *Spine*. 2005;30(Suppl):E73–E79.
15. Suk SI, Kim JH, Lee SM, et al. Anterior-posterior surgery versus posterior wedge osteotomy in posttraumatic kyphosis with neurologic compromised osteoporotic fracture. *Spine*. 28:2170–2175.
16. Sutherland CJ, Miller F, Wang GJ. Early progressive kyphosis following compression fractures. Two case reports from a series of stable thoracolumbar compression fractures. *Clin Orthop*. 1983;173:216–220.
17. Tanaka S, Kubota M, Fujimoto Y, et al. Conus medullaris syndrome secondary to an L1 burst fracture in osteoporosis. *Spine*. 1993;18:2131–2134.
18. Connelly PJ, Abitbol JJ, Martin RJ, et al. Spine: trauma. In: Garfin SR, Vaccaro AR, eds. *Orthopaedic Knowledge Update: Spine*. Rosemont, IL: American Academy of Orthopaedic Surgeons; 1997:197–217.
19. Aebi M, Etter C, Kehl T, et al. Stabilization of the lower thoracic and lumbar spine with the internal spinal skeletal fixation system: indications, techniques, and first results of treatment. *Spine*. 1987;12:544–551.
20. Lindsey RW, Dick W. The fixator interne in the reduction and stabilization of thoracolumbar spine fractures in patients with neuralgic deficit. *Spine*. 1991;16(Suppl): 140–145.
21. Vaccaro AR, Garfin SR. Internal fixation (pedicle screw fixation) for fusions of the lumbar spine. *Spine*. 1995;20(Suppl):157–165.

