Vertebral Augmentation Procedures for Compression Fractures

A look at one of a number of minimally invasive spinal techniques that have improved healthcare delivery.

BY MICK PEREZ-CRUET, MD, MS

Among the elderly population, compression fractures of the vertebral body are associated with significant morbidity and mortality. These fractures occur when the vertebral body is too weak to support the various loading forces of daily living and are most often attributed to osteoporosis, although neoplastic lesions can also play a role. The consequences of vertebral compression fractures include pain and progressive kyphotic deformity of the spine. Disabling pain from vertebral compression fractures is associated with significant morbidity and has been shown to adversely affect patients' quality of life. The kyphotic deformity, however, has independently been shown to result in reduced physical and social functioning, depression, and malnutrition due to early satiety. These effects are directly related to the severity of the deformity.

For many years, interventional radiologists have been utilizing a transpedicular approach to biopsy lesions found in the thoracic and lumbar vertebral bodies. However, it was not until 1987 that the transpedicular vertebroplasty technique was first reported, by Galibert et al.[1] Since that article, many authors have published their procedure results (see suggested readings). Although initially described to treat spinal pain and instability due to vertebral hemangiomas, the procedure has since been used to treat a variety of neoplastic diseases and, more recently, osteoporotic compression fractures. The existing data have demonstrated that vertebroplasty is a safe and well-tolerated procedure that provides significant and rapid pain relief that lasts.

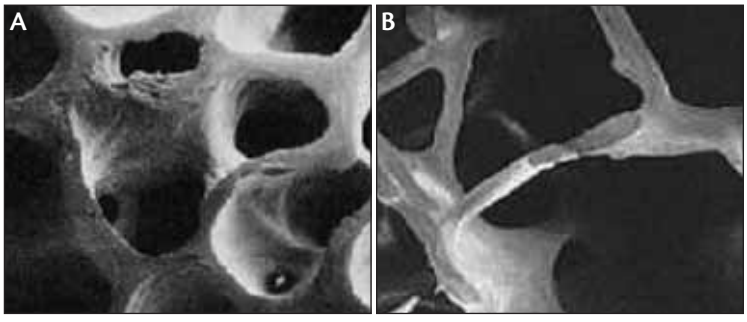

Figure 1. Microscopic image of normal bone (A) versus osteoporotic bone (B). Note the relative lack of bone density in the osteoporotic bone matrix.

EPIDEMIOLOGY

Osteoporosis is defined as a skeletal disorder characterized by compromised bone strength predisposing individuals to an increased risk of fracture (Figure 1). Worldwide, one in three women and one in eight men older than 50 years are affected by osteoporosis. In the US alone, 44 million individuals are at risk for developing osteoporosis, with 1.5 million fractures related to osteoporosis occurring in the US each year. Of these, there is an annual incidence of 700,000 spine fractures per year, with 30% occurring in men. The relative ratio by location in the body of spine:hip:wrist: other fractures occurring secondary to osteoporosis is 5:2:1:2.

The economic impact of compression fractures is significant. In 2001, US hospital and nursing home direct expenditures for treatment of compression fractures was more than $17 billion, with a daily cost of $47 million, and hospital expenditures totaling $1.5 billion. Estimates taken in 1996 predicted 150,000 hospitalizations annually, with an average 8-day stay.

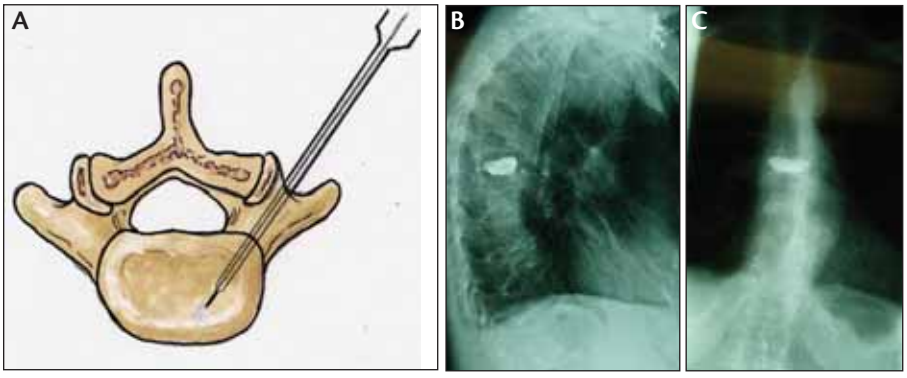

Figure 2. Cannulation of the pedicle with Jamshidi needle (MedSurge Inc., Rochester, MN) (A) with lateral (B) and anteroposterior (C) x-ray views after vertebroplasty for a thoracic compression fracture.

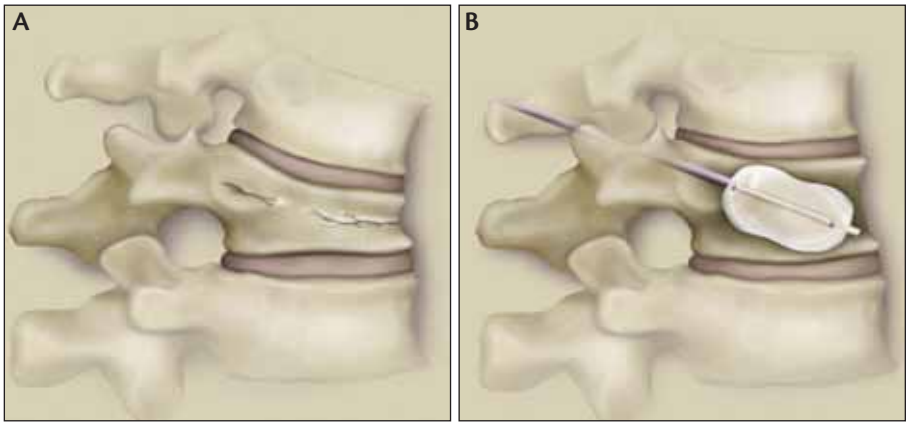

Figure 3. Placement of the balloon tap into a compression fracture (A) and reduction of the fracture with insufflation of the balloon (B).

BIOMECHANICS OF COMPRESSION FRACTURES

A number of biomechanical factors occur in the spine as a result of compression fractures. The center of gravity of the spine moves forward resulting in a large bending moment. To counteract this, there is increased strain placed on the posterior musculature and ligamentous structures of the spine, causing the anterior structures of the spine to maintain higher compressive forces. This results in decreased gait velocity, changes in balance, increased muscle fatigue, and increased risks of falls and additional compression fractures. It is estimated that there is a fivefold increase in risk of additional compression fractures after the initial fracture. Therefore, a cycle of compression fractures can ensue.

The clinical sequelae of compression fractures are significant. Spinal deformity results in pain, impaired function, and decreased mobility. This decreased activity leads to further bone mineral loss and increased risk of additional fractures. The compressed thoracic cavity and abdominal cavity results in decreased pulmonary function and appetite. Sleep disorders and depression ensue, often robbing the elderly of their quality of life during the retirement "golden" years.

TREATMENT

Before vertebral augmentation techniques were developed, many individuals who experienced compression fractures were treated with bracing and bed rest. Unfortunately, this often worsened the condition of their spines due to decreased load bearing of the spine and increased overall bone mineral loss. If surgery was performed to reconstruct the spine, the morbidity rate was extremely high because the "soft" bone could not adequately support spinal instrumentation and often resulted in fusion failures.

Perhaps the greatest contribution to the surgical management of osteoporotic compression fractures has been vertebral augmentation with the use of methylmethacrylate cement. This procedure is performed using percutaneous techniques, can be done efficiently, and has shown excellent clinical outcomes (Figure 2). More recently, techniques have been developed to restore the compressed vertebrae using an expandable balloon (Kyphoplasty, Kyphon Inc., Sunnyvale, CA) (Figure 3), or a mesh bag filled with bone (Optimesh, Spineology, St. Paul, MN) (Figure 4). There are advantages and disadvantages to vertebroplasty, Kyphoplasty, and Optimeshplasty. It is beyond the scope of this article to discuss the advantages and disadvantages, indications, and techniques of these three different procedures. These procedures can be performed using a biplanar fluoroscopic unit or in the operating room using two C-arm units positioned for anteroposterior and lateral views.

Simply, vertebroplasty is the direct injection of methylmethacrylate cement into the compression fracture (Figure 2). It is the fastest and easiest option of the three techniques because it only requires cannulation of the

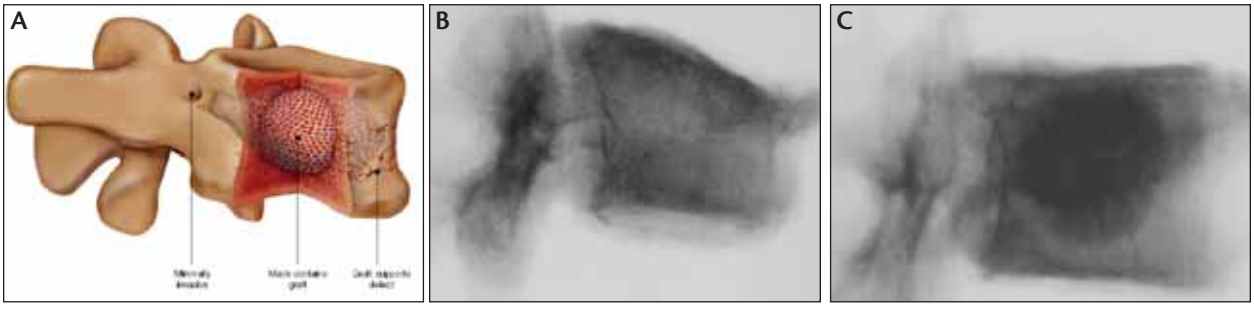

Figure 4. The Optimesh inside the vertebral body (A) with pre- (B) and post-Optimesh (C) filling to restore a compression fracture.

> "Techniques for spine augmentation offer safe and effective means for treating compression fractures while improving the quality of life. . . "

pedicles and proper placement of the Jamshidi needle into the compressed vertebrae (Figure 2). Because vertebroplasty requires a minimal amount of tools, it is also relatively inexpensive. The kyphoplasty technique involves placing an expandable balloon within the vertebral body. Once the balloon is placed, it is then insufflated to reduce the compressed vertebrae (Figure 3). This is best suited for relatively recent compression fractures (ie, fewer than 10 weeks from the date of the incident) to allow for movement and reduction of the compressed vertebrae. It may also be more difficult to reduce compression fractures in relatively young patients in whom the bone density is much greater. The balloon is then removed, and the remaining cavity is filled with cement.

One advantage of this technique is reduced risk of cement extravasations because the cavity created by the balloon allows cement to be injected at relatively lower pressures compared to vertebroplasty. The Optimesh technique employs a unilateral transpedicular approach to the spine. Once in the compression fracture, a mesh bag is deployed via a working cannula (Figure 4). The mesh bag is then filled with bone allograft. As the bag fills, the compression fracture can be reduced by a method called *fluid mechanics*. The reduced compression fracture is held in place and, with time, new bone integrates through the porosities of the mesh bag. This technique might be advantageous for relatively young patients having osteoporotic compression fractures, in whom osseous integration of bone can occur. Nevertheless, we ask that the reader refer to the manufacturer's printed material on each technique for indications and contraindications.

CONCLUSION

Techniques for spine augmentation offer safe and effective means for treating compression fractures while improving the quality of life for individuals with this condition in a cost-effective manner. Vertebral augmentation for the treatment of osteoporotic compression fractures is just one of a number of minimally invasive spinal techniques that has improved healthcare delivery. ■

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1. Galibert P, Deramond H, Rosat, et al. Preliminary note on the treatment of vertebral angioma by percutaneous acrylic vertebroplasty. Neurochirurgie. 1987;33:166-168.

SUGGESTED READING

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