1

History and Early Development of Percutaneous Vertebroplasty

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For several decades, vertebroplasty has been performed as an open procedure to augment the purchase of pedicle screws for spinal instrumentation (1) and to fill voids resulting from tumor resection (2–5). The procedure introduces bone graft or acrylic cement into vertebral bodies to mechanically augment their structural integrity (2–4,6–12). In some cases, however, the risk of an open procedure is not indicated. It was one such case that served as the impetus for the development of percutaneous vertebroplasty (PV). Percutaneous vertebroplasty achieves the benefits of surgical vertebroplasty without the morbidity associated with an open procedure. Vertebral augmentation is accomplished by injecting polymethylmethacrylate (PMMA) cement into a vertebral body via a percutaneously placed cannula.

The procedure was first performed in 1984 by Galibert and Deramond in the Department of Radiology of the University Hospital of Amiens, France (13), on a woman, aged 54, who had complained of severe cervical pain for several years. In 1979, plain radiographs of her cervical spine indicated normal findings, but in 1984, when she presented with unbearable pain associated with a severe radiculopathy localized to the C2 nerve root, plain radiographs showed a large vertebral hemangioma (VH) involving the entire C2 vertebra. An axial computed tomography (CT) scan confirmed epidural extension of the disease. A C2 laminectomy was first performed, and the epidural component was excised. To obtain structural reinforcement of the C2 vertebral body, it was decided that cement would be injected percutaneously. A 15-gauge needle was inserted into the C2 vertebral body via an anterolateral approach (Figure 1.1A). The amount of PMMA injected was estimated to be 3 mL (Figure 1.1B). The patient experienced complete pain relief. The results of the procedure were so impressive that the procedure was subsequently used for six other patients. A report describing the outcomes was published in 1987 (13).

The experience gained from these patients, and from some experimental work conducted on fresh cadaveric vertebral bodies, helped establish the main technical points of the procedure (13–15). These technical points include the use of large-bore (10–13 gauge) needles in the

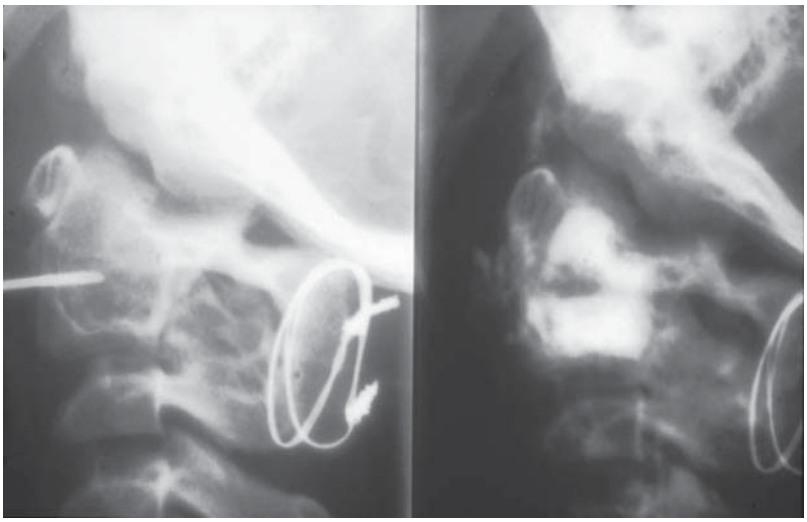

Figure 1.1. The first PV case. **(A)** Lateral view of C2 with a cannula in place in the VH cavity. **(B)** Lateral view of C2 after PMMA injection (white arrows). This resulted in complete pain resolution for this patient. (From JM Mathis, H Deramond, SM Belkoff [eds], Percutaneous Vertebroplasty. New York: Springer, 2002, with permission.)

thoracic and lumbar spine and smaller bore (13–15 gauge) needles in the cervical spine. An opacification agent was added to the PMMA cement to facilitate fluoroscopic visualization of the distribution of the cement during injection. Early in the clinical experience, a posterolateral approach for the needles was used in the thoracic spine, but after cement leakage along the track of the needle induced a case of intercostal radiculopathy, a transpedicular needle approach was developed. With the transpedicular approach, the needle passes through the pedicle into the vertebral body, resulting in a lower risk of cement discharging posteriorly along the needle track.

Inspired by the success of the initial PV cases, clinicians from the neuroradiologic and neurosurgical teams of the University Hospital in Lyons (France) (16,17) used a slightly modified technique (18-gauge needles) to inject PMMA into the weakened vertebral bodies of seven patients: four with osteoporotic vertebral compression fracture (VCFs), two with VHs, and one with spinal metastasis. These clinicians reported good (one patient) to excellent (six patients) pain relief in these seven initial patients (16).

In the early 1990s, PV (performed with Deramond's technique) was introduced into clinical practice in the United States at the University of Virginia (18). Since that time, PV has become a more commonly used method for treating painful vertebral lesions. The European experience has predominantly focused on treating pain related to tumor involvement (both benign and malignant) (13,19–22), whereas the U.S. experience focused on treating painful osteoporotic VCFs. This distinction has become blurred as clinicians on both continents have responded to changing patient demographics (e.g., increased longevity, increased

incidence of osteoporosis, and increased numbers of patients surviving cancer—all of whom have higher risks of VCFs). Severe pain associated with VCF is a very common medical problem; it affects between 700,000 and 1,000,000 patients every year in the United States alone (23–25). The disease demographics are similar in Europe. Most of these fractures are the result of bone mineral loss due to primary osteoporosis (occurring progressively with age). However, an increasing number of fractures also result from secondary osteoporosis caused by therapeutic drugs such as catabolic steroids, anticonvulsants, cancer chemotherapy, and heparin (26).

Until the introduction of PV, there were few treatment options other than bed rest and pain management for osteoporotic VCFs. The immediate and lasting pain relief attained with PV is quickly making the procedure an accepted treatment for osteoporotic VCFs and is challenging the standard medical treatment of bed rest and analgesics. Similarly, because patients with metastatic lesions are surviving longer, there is an increased demand to improve their quality of life and provide mobility during the end stages of their disease. In cases of spinal metastases, PV reportedly relieves pain and structurally augments vertebral bodies compromised by osteolytic lesions, providing some palliation and allowing the patient to continue with weight-bearing activities of daily living.

Since the first edition of this book was published, substantial progress has been made in our understanding of the requirements for providing an adequate percutaneous augmentation of a vertebra following VCF. Numerous companies are producing devices and materials to aid in the performance of PV. Bone cements for percutaneous vertebroplasty and kyphoplasty now have Food and Drug Administration approval (in the United States) or have obtained the Conformitè Europèene mark (in Europe). In the United States, reimbursement for PV is available through Medicare and numerous independent insurance carriers. This coverage is now being expanded to allow the procedure to be performed in outpatient offices.

The second edition of this book contains the most current information available on both patient selection and the techniques of the procedures used for percutaneous augmentation of the vertebra and other areas of the skeleton. The book also contains new information on the materials used in the procedures. We have added a section with case reports to show the reader interesting clinical problems and the methods used to solve them. These cases provide practical information to enhance the core didactic chapters, and the result is a complete body of information on how to perform each of these procedures with maximal effectiveness and safety.

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