Vertebroplasty in oncology: a novel approach to pain relief in the cancer patient

Glen P Schlaphoff
Department of Radiology, Liverpool Hospital, Sydney
Email: glen.schlaphoff@swsahs.nsw.gov.au

Abstract
The mechanism by which vertebroplasty is effective in providing pain relief is unclear, but may involve destruction of nerve endings consequent upon the injection of bone cement into the vertebral body. Vertebroplasty is now employed to treat osteoporotic compression fractures and spinal metastases which are the most common vertebral body tumours. Patients likely to benefit are those having relative spinal canal compromise with epidural involvement and vertebra plana related to osteoporosis and secondary to metastatic disease. Application of the procedure is critically dependent upon appropriate imaging. While evaluation by prospective randomised controlled trials is not available thus far, a range of reports have consistently documented efficacy.

Percutaneous Vertebroplasty (PVP) by definition is a procedure which augments the strength of a weakened and or fractured vertebra by injecting bone cement, usually Polymethylmethacrylate (PMMA) into the vertebral body. This augmentation restores some of the mechanical properties of the vertebra, stabilising the fractured vertebral body, thus relieving pain. The technique, using a fluoroscopically guided, percutaneously placed needle, was pioneered in France in 1987 to treat benign aggressive haemangioma.

Currently the two most commonly treated conditions are osteoporotic compression fractures and spinal metastases, which are the most common vertebral body tumours.8 Spinal metastases are most frequently related to breast lung or prostate carcinomas. Multiple myeloma and lymphoma are also frequent causes of disseminated spinal lesions. The lumbar spine is most frequently involved.7 The associated back pain in many lesions leads to impaired functioning and significant reduced QOL. This often results in chronic pain syndromes with loss of sleep, decreased mobility and depression.

Why it works
Various theories on the procedure’s ability to provide pain relief have been suggested. In cases of vertebral metastases, local pain is thought to be secondary to bone fractures and the reaction of the remaining nerve structures to the tumour’s mass effect.7 It is likely that a component of the vertebroplasty-related analgesia is secondary to immobilisation of microfractures and reduction of mechanical forces. The destruction of nerve endings caused by the cytotoxic, mechanical and vascular effects of PMMA, as well as the thermal effects of polymerization, however, may also play a role in pain relief. Furthermore, it has been proposed that PMMA has an antitumoural effect, which may explain the rarity of local recurrence after vertebroplasty. This effect may be the result of the cytotoxicity, thermal effects and ischemia produced by PMMA. Analysis of pathological findings in patients in whom PMMA has been injected has demonstrated a macro and microscopic rim of tumour necrosis six months after vertebroplasty/tumour injection, which seems to extend outside the limits of the cement.

Relevant literature has consistently identified uncorrected coagulopathy, spinal canal compromise with epidural involvement and severe vertebral body compression (vertebra plana) as contra-indication for percutaneous vertebroplasty.9,11 More recent studies have demonstrated the safe and highly effective use of percutaneous vertebroplasty in patients with relative spinal canal compromise with epidural involvement and in vertebra plana related to osteoporosis and secondary to metastatic disease.1,12,13 Interventional radiologists have also begun treating destructive pedicle lesions by cement injection with excellent results.

Technique
Careful patient selection must be undertaken when pain relief is the goal, as in patients with advanced disease, the source of pain may not be limited to a given vertebra.7,8 Diagnostic MR and CT scanning are required to accurately define the infiltrated vertebra. The procedure is performed by an interventional radiologist familiar with high quality imaging, either under fluoroscopy or CT guidance. The patient is placed prone and local anaesthesia is provided at the appropriate level. An 11G or 13G PVP (percutaneous vertebroplasty) needle is used to gain access to the involved vertebral body.

A bipedicular or unipedicular approach is used. The choice of approach depends on the different access geometry in, for example, the L-spine compared to the T-spine and also depends on the degree of cement distribution across the vertebral body. The degree of pedicular involvement and intention to treat or avoid the pedicle is also taken into account.10

A biopsy sample should be obtained if the primary cancer is unknown and if the fracture is suspicious for metastasis.7,14 The barium impregnated PMMA (polymethylmethacrylate) bone cement is prepared and injected once the proper consistency of the compound has been reached. From a technical point of view both the osteolytic part of the lesion and the part of the vertebra that appears architecturally normal should ideally be injected with cement. A cement distribution limited to the boundaries of a lytic cavity is however, often observed and generally results in excellent pain relief.

The entire lesion does not need to be filled because there is no relationship between the amount of the lesion that is filled and subsequent pain relief. On the contrary, complete or over enthusiastic filling of the lesion leads to an increased risk of cement leakage. The total duration of the procedure is 0.5 to 1.5 hours. The procedure can be performed on an out-patient basis with 3-4 hours post procedure observations recommended.

Figure 1a:
Pathological fracture d/t Renal cell cancer. Axial CT demonstrates gross destruction of the vertebral body with associated destruction of the posterior wall.
Figure 1b:

Pathological fracture d/t Renal cell cancer. PVP needle is placed into the osteolytic lesion. Ba. PMMA is injected stabilising the fracture. Myelographic contrast confirms no retropulsion into the compromised spinal canal

Prognosis following vertebroplasty

There are no prospective randomised controlled studies on vertebroplasty published to date, however numerous other studies have all documented the efficacy of vertebroplasty in providing pain relief and improving mobility in patients with metastatic spinal disease.

These studies have documented improvement of pain in 80 to 97% of patients within 48 hours of the procedure. At six-month follow up, 65 to 76% of patients in all studies experienced persistent pain relief.

Unlike the delayed effects of radiotherapy, vertebroplasty provides immediate strengthening of the anterior column, which may limit painful vertebra body collapse. Furthermore, vertebroplasty provides early mobility, which limits complications related to inactivity. Increased mobility and pain relief lead to improvement in quality of life for these patients.

The published complication frequency is 1.3% in osteoporotic fractures and 10% in metastatic disease. The higher frequency probably reflects increased vertebral body destruction and or the poor general condition of the cancer patient, as well as the progressive destructive nature of the disease. Note however, the long-term complication rate in patients with metastatic disease is 1.7%.

Percutaneous vertebroplasty and radiotherapy are complementary procedures with radiation preferred after percutaneous vertebroplasty when possible.

Conclusion

Percutaneous vertebroplasty is becoming a standard of care for palliative pain control associated with neoplastic pathological compression fractures. Severe compression fractures and fractures with epidural involvement should not contra-indicate this procedure in selected patients with cancer, intractable pain, few treatment options and reduced life expectancy.

Vertebroplasty is complementary to both surgery and radiotherapy and should be considered as a treatment modality in patients with metastatic spinal disease.

References