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Vertebroplasty

A new treatment for vertebral compression fractures

BACKGROUND

The lifetime risk of a vertebral body compression fracture is 16% for women and 5% for men. Vertebroplasty involves the injection of artificial bone cement and an opacifier into the inter-trabecular marrow space of the fractured vertebra.

OBJECTIVE

This article describes vertebroplasty as a treatment of vertebral compression fractures.

DISCUSSION

Treatment for vertebral compression fractures regardless of aetiology has been largely conservative and directed toward pain control. Vertebroplasty has gained popularity since 1987 for treatment of vertebral compression fractures. Vertebroplasty is a safe, effective, and cost effective procedure when performed in an appropriate technical environment by adequately trained interventional radiologists.

The lifetime risk of a vertebral body compression fracture is 16% for women and 5% for men, and the incidence of osteoporotic fractures is expected to increase fourfold worldwide in the next 50 years.¹ In Australia, the median incidence rate of symptomatic osteoporotic vertebral compression fractures has been calculated to be 111 per 100 000 persons per year. The total number of Australians estimated to have osteoporosis in 2001 was 1 871 795.² If these figures remain stable, there should be approximately 2078 symptomatic vertebral fractures per year in Australia.

Other causes of painful compression fracture include malignant involvement of the spinal column (metastasis, myeloma, and lymphoma), haemangioma, and vertebral osteonecrosis. In addition to pain, spinal column instability may also be present. Regardless of aetiology, treatment for compression fractures has been largely conservative and directed toward pain control, usually consisting of narcotic analgesia, bed rest, and back bracing. Current preventive drug regimens for osteoporosis (including hormone therapy, bisphosphonates and calcitonin) are often not prescribed until the disease has been diagnosed by the presence of a fracture.

What is vertebroplasty?

Vertebroplasty was originally developed by Deramond and Galibert, a French radiologist and a French neurosurgeon, who reported their first seven procedures in 1987.³ It is a therapeutic alternative for the treatment of pain associated with vertebral body compression fractures.³⁻⁶

Vertebroplasty involves the injection of artificial bone cement and an opacifier into the inter-trabecular marrow space of the fractured vertebra (*Figure 1a, b*). It is performed with imaging guidance under local anaesthesia and intravenous conscious sedation, or rarely under general anaesthesia. The procedure takes 1–2 hours, depending on the number of vertebrae requiring treatment.

A large calibre needle is placed into the involved vertebral body and radio opaque bone cement (eg. polymethyl methacrylate) is injected. The injected bone cement does not re-expand the collapsed vertebra; it acts as an internal splint to reinforce and stabilise the fracture for pain alleviation.

Indications and contraindications

The major indication for percutaneous vertebroplasty is the treatment of symptomatic osteoporotic or neoplastic vertebral body compression fracture(s) that have been refractory to medical therapy. Failure of medical therapy is

defined by minimal or no pain relief with the administration of prescribed analgesics, or adequate pain relief with narcotic dosages that produce undesirable side effects (eg. excessive and intolerable sedation, confusion, or constipation).

Vertebroplasty is a safe, effective and cost effective procedure when performed in an appropriate technical environment by adequately trained interventional radiologists. Indications and contraindications are summarised in *Table 1*.

Patient selection

It is important to distinguish pain caused by a vertebral compression fracture from other causes of back pain. This requires a careful correlation of the patient's history with clinical examination and available imaging. Most often, vertebral compression fractures are discovered on plain X-ray imaging. Magnetic resonance imaging (MRI) is the subsequent and most sensitive imaging modality with a reported accuracy of 96% in identifying vertebral body fractures.⁷ Magnetic resonance imaging is also the most useful imaging technique for the detection of oedema indicating acute fracture. This is best depicted on sagittal MRI images with short tau inversion recovery (STIR) sequence (*Figure 2*).⁸ If MRI is contraindicated or unavailable, computerised tomography (CT) or bone scans may be useful as alternate imaging techniques.

Patients should have a coagulation profile done to exclude any bleeding problems. If there is any doubt or concern regarding a patient's suitability for vertebroplasty, the case must be discussed with the radiologist performing the procedure. Counselling by the radiologist before the procedure is highly recommended.

In September 2005, the Minister for Health and Ageing approved the Medical Services Advisory Committee's recommendation for Medicare Benefits Schedule rebates for vertebroplasty for patients suffering from painful osteoporotic vertebral compression fractures

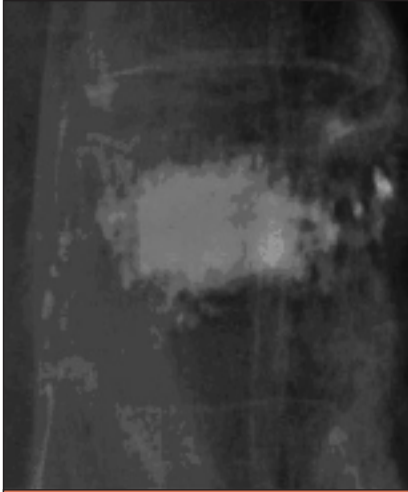


Figure 1a. Vertebroplasty of T8 (AP view)

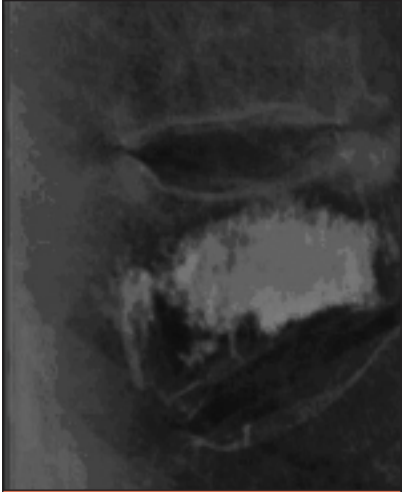


Figure 1b. Vertebroplasty of T8 (lateral view)

not controlled by conservative medical therapy, and for patients with pain from metastatic deposits or multiple myeloma in a vertebral body.

How is vertebroplasty performed?

It is recommended that the vertebroplasty be performed in a hospital setting (either in an interventional radiology room or operating theatre) under sterile conditions. It is commonly performed with the patient under local anaesthesia and intravenous conscious sedation (although it may need to be done under general anaesthesia for certain patients). There must be the option to convert the procedure to an open emergency operation in cases of severe bone cement leak affecting the spinal canal.⁹

The affected vertebral body is usually accessed through the pedicles using an 11 or 13 gauge trochar needle with fluoroscopic or CT guidance. Bone cement (mixture of liquid monomer and powder polymer of PMMA which is mixed with a radio-opaque agent barium +/- broad

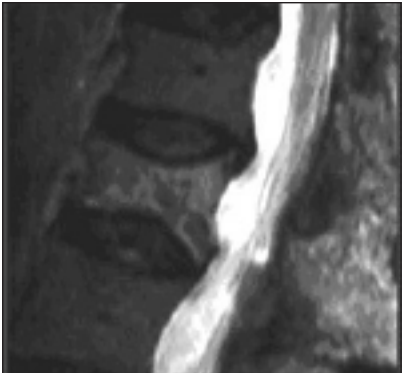


Figure 2. Sagittal STIR image of spine showing wedge compression fracture of L1 associated with marrow oedema

Table 1. Indications and contraindications for vertebroplasty ^{18,19}			
Indications	Contraindications		
	Absolute	Relative	
Osteoporotic vertebral compression fracture(s) causing severe pain and unresponsive to conservative therapy	Fracture that is healed or is responding to conservative management	Fracture >4 months, unless nonunion has occurred	
	Absence of bone oedema or gas cleft on MRI	Loss of integrity of the posterior wall of the vertebral body	
	Presence of untreated coagulopathy		
	Presence of local infection		
Painful vertebral compression fractures(s) caused by metastases or multiple myeloma, may or may not be receiving adjuvant radiation, surgical therapy or chemotherapy			



Figure 3a. Access to T8 vertebral body by uni-pedicular approach (AP view)

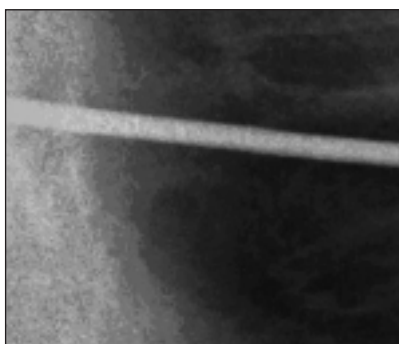


Figure 3b. Access to T8 vertebral body by uni-pedicular approach (lateral view)

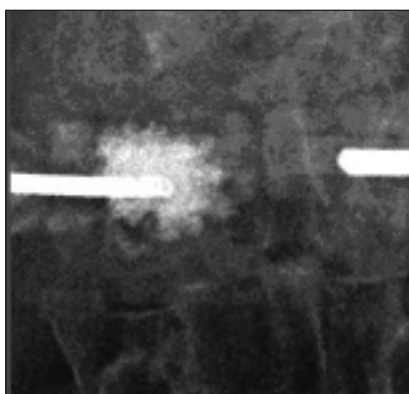


Figure 4a. Access to L1 vertebral body by bi-pedicular approach (AP view)

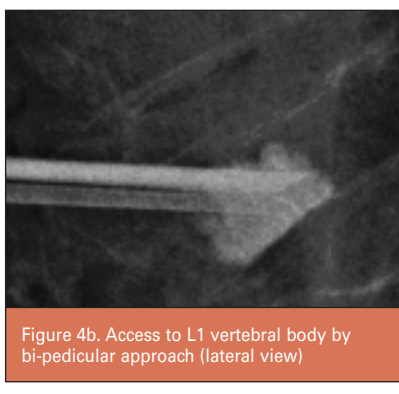


Figure 4b. Access to L1 vertebral body by bi-pedicular approach (lateral view)

spectrum antibiotic such as gentamycin) is injected into the vertebral body, again under image control. The anticipated

result can be achieved either by uni- or bi-pedicular approach (Figure 3a, b; 4a, b).

Following the procedure, the patient is monitored in the recovery area where they lie supine for 3–4 hours. This allows both time for the cement to set and recovery from sedation. If there is someone at home who can help, most patients are sent home on the same day. Otherwise, the patient is admitted to hospital for an overnight stay.

What are the success rates?

When percutaneous vertebroplasty is performed for osteoporosis, success is defined as achievement of significant pain relief and/or improved mobility as measured by validated measurement tools with a threshold of 80%. When performed for neoplastic involvement, the threshold is 50–60%.

Vertebroplasty has been shown to be highly effective in reducing pain from both compression fractures and osteolytic tumours. Most fractures treated are subacute and less than 1 year old. Although better results can be expected with more recent fractures, quite satisfactory results have been reported in chronic cases.¹⁰ Regarding the long term effect of vertebroplasty on pain, Grados et al¹¹ reported good or excellent results

in 96% of patients with a mean follow up of 48 months (range 12–84 months).

Complications

Major complications occur in less than 1% of patients treated for compression fractures secondary to osteoporosis and in less than 5% of treated patients with neoplastic involvement.¹² These complications include:

- cement leakage into disc, epidural space or vena cava
- cement embolisation to lungs
- pulmonary oedema
- myocardial infarction
- rib fractures
- spondylitis
- paraesthesia resulting from cement leak in epidural space.^{13–17}

The Australian Government's Medical Services Advisory Committee's review¹⁸ examined 72 studies that reported on safety outcomes associated with vertebroplasty. They identified one death out of 1292 vertebroplasties; this was directly related to sequelae of decompressive surgery undertaken to correct cement leak into the spinal canal. Cement leak causing spinal canal compression should not happen in patients having vertebroplasty under appropriate conditions with proper imaging.

Conclusion

Vertebroplasty is a safe, effective and cost effective for the treatment of vertebral compression fractures when performed in an appropriate technical environment by adequately trained interventional radiologists. Medicare Benefits Schedule rebates are now available for certain patients.

Summary of important points

- Vertebroplasty provides significant reduction in analgesia use and offers long term pain relief.
- Vertebroplasty increases patient mobility.
- Vertebroplasty is a minimally invasive day stay procedure with a low incidence of complications.

Conflict of interest: none declared.

References

1. Riggs B, Melton III L. The worldwide problem of osteoporosis: insights afforded by epidemiology. *Bone* 1995;17(Suppl):50S–11.
2. Access Economics Pty Ltd. The burden of brittle bones: costing osteoporosis in Australia. Access Economics Pty Ltd 2001;1–36.
3. Jensen M, Dion J. Percutaneous vertebroplasty in the treatment of osteoporotic compression fractures. *Neuroimaging Clin N Am* 2000;10:547–68.
4. Grados F, Depriester C, Cayrolle G, et al. Long term observations of vertebral osteoporotic fractures treated by percutaneous vertebroplasty.

- Rheumatology 2000;39:1410–4.
5. Peh W, Gilula L, Peck D. Percutaneous vertebroplasty for severe osteoporotic vertebral body compression fractures. *Radiology* 2002;223:121–6.
 6. McGraw J, Lippert J, Minkus K, et al. Prospective evaluation of pain relief in 100 patients undergoing percutaneous vertebroplasty: results and follow up. *J Vasc Interv Radiol* 2002;13:883–6.
 7. McKiernan F, Faciszewski T. Intravertebral clefts in osteoporotic vertebral compression fractures. *Arthritis Rheum* 2003;48:1414–9.
 8. Meyers S, Wiener S. Magnetic resonance imaging features of fractures using the short tau inversion recovery (STIR) sequence: correlation with radiographic findings. *Skeletal Radiol* 1991;20:499–501.
 9. Lin EP, Ekholm S, Hiwatashi A, Westesson PL. Vertebroplasty: cement leakage into the disc increases the risk of new fracture of adjacent vertebral body. *Am J Neuroradiol* 2004;25:175–80.
 10. Crandall D, Slaughter D, Hankins P, Moore C, Jerman J. Acute versus chronic vertebral compression fractures treated with kyphoplasty: early results. *Spine J* 2004;4:418–24.
 11. Grados F, Depriester C, Cayrolle G, et al. Long term observations of vertebral osteoporotic fractures treated by percutaneous vertebroplasty. *Rheumatology* 2000;2000:1410–4.
 12. McGraw J, Cardella J, Barr J, et al. Society of Interventional Radiology. Quality improvement guidelines for percutaneous vertebroplasty. *J Vasc Interv Radiol* 2003;14:827–31.
 13. Padovani B, Kasriel O, Brunner P, Peretti-Viton P. Pulmonary embolism caused by acrylic cement: a rare complication of percutaneous vertebroplasty. *Am J Neuroradiol* 1999;20:375–7.
 14. Lee BJ, Lee SR, Yoo TY. Paraplegia as a complication of percutaneous vertebroplasty with polymethylmethacrylate: a case report. *Spine* 2002;27:E419–22.
 15. Rauschmann MA, von Stechow D, Thomann KD, Scale D. Complications of vertebroplasty. *Orthopade* 2004;33:40–7.
 16. Yoo KY, Jeong SW, Yoon W, Lee J. Acute respiratory distress syndrome associated with pulmonary cement embolism following percutaneous vertebroplasty with polymethylmethacrylate. *Spine* 2004;29:E294–7.
 17. Yu SW, Chen WJ, Lin WC, Chen YJ, Tu YK. Serious pyogenic spondylitis following vertebroplasty. A case report. *Spine* 2004;29:E209–11.
 18. Vertebroplasty and kyphoplasty for the treatment of vertebral compression fracture. MSAC reference 27, August 2005.
 19. Predey TA, Sewall LE, Smith SJ. Percutaneous vertebroplasty: new treatment for vertebral compression fractures. *Am Fam Physician* 2002;66:611–5.