Percutaneous vertebroplasty – initial clinical experience in osteoporotic and myelomatous compression fractures

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ABSTRACT

Background To review the clinical impact of vertebroplasty in osteoporotic and myelomatous compression fractures

Methods Eleven compression fractures in eight patients were treated by percutaneous cement vertebroplasty over a three-year period, May 2000 to May 2003.

Results Successful percutaneous stabilisation and cement injection was performed in all compression fractures. In five of eight patients (eight of eleven compression fractures) injection of cement yielded dramatic reduction in pain within 24 hours of the procedure.

Conclusion Preliminary experience suggests that percutaneous cement vertebroplasty is an effective well tolerated method of stabilisation of spinal wedge compression fractures resulting in dramatic reduction in associated pain in most cases.

INTRODUCTION

Percutaneous cement vertebroplasty was first performed in 1984 by French Radiologists (Deramond et al) for treatment of a painful haemangioma in the cervical spine.[1] These authors described percutaneous placement of a wide bore delivery system through the pedicle of a vertebral compression with subsequent installation of methylmethacrylate cement.

Since then the use of vertebroplasty has been extended to successfully treat pathologic vertebral fractures secondary to osteoporosis, painful vertebral metastasis, vertebral haemangioma and multiple myeloma. Although it provides stabilisation, the procedure has since been introduced as a method to reduce pain in affected patients allowing early remobilisation and reduction in the need for analgesics.[2] This paper reviews early experience in a cohort of patients treated over a three-year period in a university-affiliated teaching hospital.

PATIENTS & METHODS

Patients

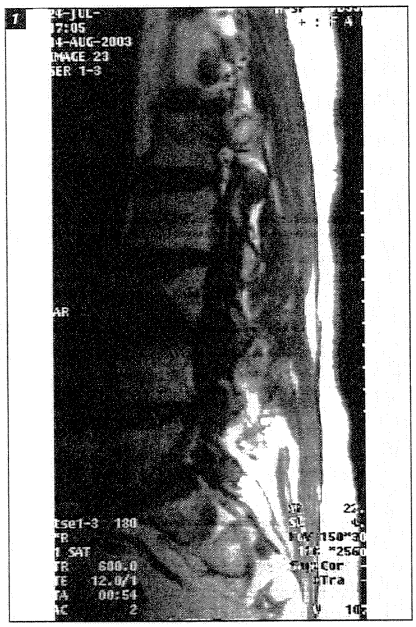
Six patients with proven osteoporosis (DEXA t score less than 2.5) and two patients with proven multiple myeloma were included for study, with a total of 11 spinal wedge compression fractures. Each patient complained of debilitating back pain of at least six weeks duration affecting mobility and sleep. These comprised of seven females (mean age 62 years) and one male (age 64 years). There were eight lumbar and three dorsal compression fractures.

Each patient was referred for radiographic, scintigraphic and or MRI assessment prior to intervention. Patients with imaging features indicating ongoing compression defined by concentration of radiotracer at scintigraphy and bone oedema at MRI were included for treatment.

Methods

Each procedure was performed with conscious sedation (Midazolam and Fentanyl, titrated to patient tolerance) with the patient in the prone position, and under image guidance. C arm fluoroscopy was used in ten procedures and computed tomography on one occasion.

Under fluoroscopic control, aseptic conditions, and using a trans-pedicular approach, an 11-gauge Jamshidi needle was advanced into one of the pedicles of the affected vertebral body.[3] This was placed in the posterior third of the vertebral body to provide a tract to introduce a reamer device to create a channel to the anterior margin of the vertebral body. Having created a channel, a delivery catheter was passed to inject 2-4 mls of cement (methylmethacrylate in eight compressions and Cortoss in three compressions) to each fracture.



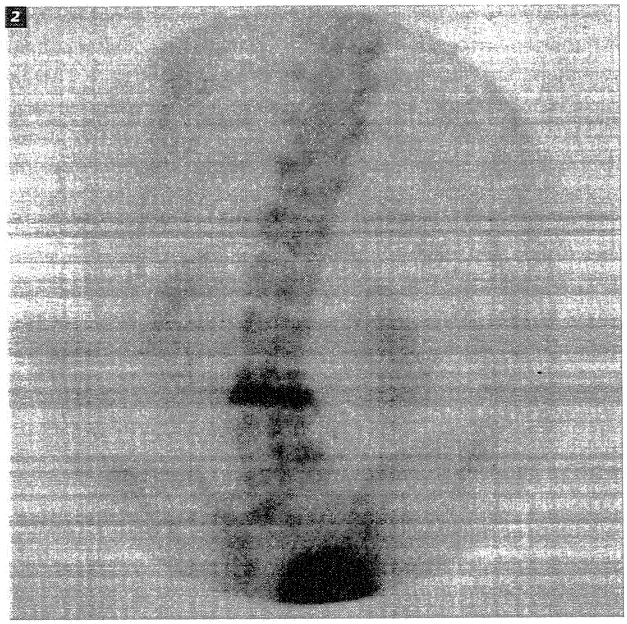
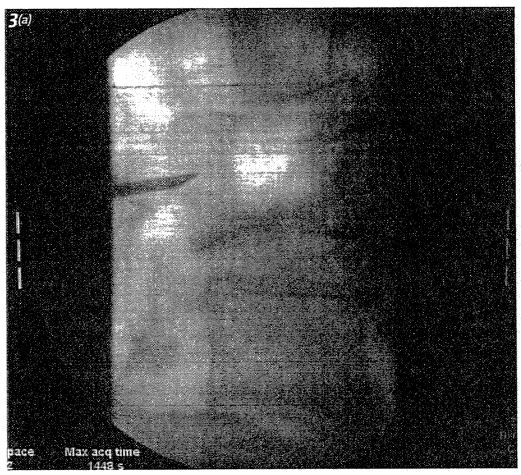
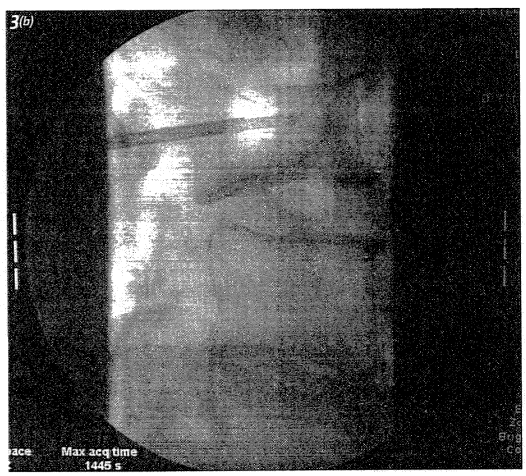
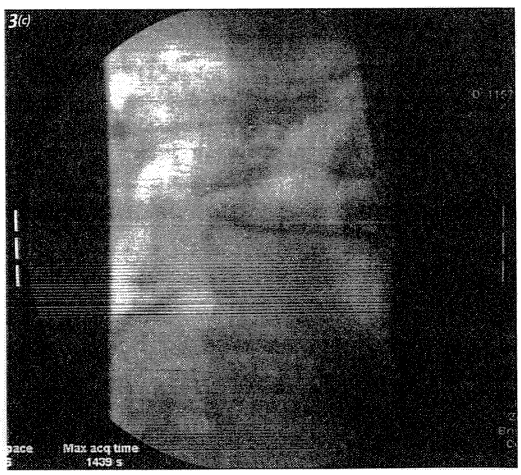


Figure 1 — SAGITTAL T1 WEIGHTED MRI SHOWS ACUTE INFERIOR END PLATE COMPRESSION OF L3 SECONDARY TO OSTEOPOROSIS

Figure 2 — ISOTOPE BONE SCAN ON THE SAME PATIENT SHOWS CONCENTRATION OF RADIOTRACER AT THE SITE OF INFERIOR END PLATE COMPRESSION







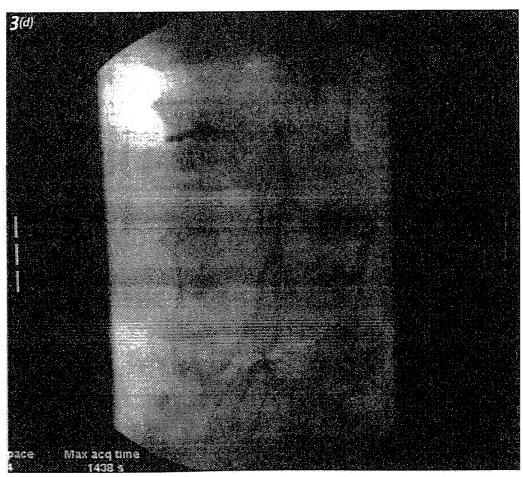


Figure 3 (a) — LATERAL C ARM IMAGE SHOWS TRANSPEDICULAR CORE NEEDLE IN SITU

Figure 3 (b) — LATERAL C ARM IMAGE SHOWS REEMING DEVICE EXTENDING TO THE ANTERIOR THIRD OF THE VERTEBRAL BODY

Figure 3 (c) — LATERAL IMAGE SHOWS CEMENT IN SITU THROUGHOUT THE MID BODY OF THE L3 COMPRESSION FRACTURE

Figure 3 (d) — FRONTAL IMAGE OF THE L3 COMPRESSION SHOWS CEMENT WITHIN THE L3 VERTEBRAL BODY.

In each of eight cases methylmethacrylate cement was admixed with tobramycin and iodinated contrast. Cortoss cement is radiopaque and obviates the need for admixed contrast. Unipedicular injection was performed in each case over a mean procedure time of 25 minutes. Following the procedure the patient was instructed to remain supine for an hour to allow fixation. Patients were subsequently mobilised and then discharged following 24 hours of bed rest. Patients were subsequently assessed at four weeks and at six months post procedure (four of eight patients).

RESULTS

Physical stabilisation of the fracture was achieved in each case. In a single patient with osteoporotic compression at T12, cement was noted to extravasate to the end plate above the compression, the T11/T12 disc space. No leakage of cement to either the anterior or posterior spinal soft tissues was documented. In five of eight patients (eight of eleven compression fractures) injection of cement yielded dramatic reduction in pain within 24 hours of the procedure.

In five of eight patients, successful remobilisation was documented the day following the procedure. There was no significant reduction in pain documented in the other three patients. In two of the three, fractures were in the dorsal spine, in the other patient, the fracture was in the lumbar spine. There was no significant restoration of vertebral body height. C arm injection was favoured as it allowed continuous visualisation of cement during injection as opposed to CT where needle localisation was precise but contrast injection was poorly followed (Figures 1-3).

DISCUSSION

Vertebroplasty is the term applied to percutaneous injection of methylmethacrylate cement to wedge compression fractures to facilitate both spinal stabilisation and pain relief. Although primarily employed as a treatment of osteoporotic compression fractures, Vertebroplasty is also employed as a treatment of wedge compression fractures complicating metastatic disease, myeloma, and painful or aggressive haemangioma.

Such treatment of painful wedge compression fractures, particularly in osteoporosis and multiple myeloma allows early remobilisation of the debilitated, often elderly patient preventing complications of stasis such as deep vein thrombosis, decubitus ulcers and pneumonia.

A comprehensive workup should be performed prior to initiating the procedure; history and examination to correlate the symptoms with radiological findings and to exclude any focal neurological deficit. Magnetic resonance imaging (MRI) or computed tomography (CT) scanning is required to assess the integrity of the posterior vertebral body wall, outrule significant spinal canal compromise and exclude other causes of back pain. Either the identification of bone oedema at MRI or concentration of radiotracer at bone scintigraphy is employed to indicate the presence of an active fracture likely producing ongoing back pain.

Methylmethacryalate (PMMA), the cement used for vertebroplasty, has had a proven safety record in orthopaedic surgery since its introduction in the 1960s.[4] Although widely employed to stabilise and fix orthopaedic devices and prostheses, PMMA employed as an agent to stabilise compression fractures in the spine may have catastrophic complications. When mixed with solute water, PMMA polymerisation induces a dramatic exothermic reaction. Although considered to be a necessary ingredient to pain relief by damaging neural tissues within the vertebral body, the thermal reaction may damage the dura particularly when leakage occurs. A study to measure temperature during polymerisation revealed a peak temperature between 44-113 degrees centigrade. The dwell times ranged from 0 to 8 minutes.[5] Delivery systems have now been developed to prevent any thermal damage to the radiologist. Perhaps of more immediate concern, following cement leakage through the posterior vertebral wall, is the development of spinal cord compression. In our series, cement leakage occurred through a fractured superior end plate to the adjacent disc space in one patient who at follow-up showed no adverse effects. The majority of leaks of this nature however, are not clinically relevant and have no significant effect on therapeutic outcome.[6]

Delivery of PMMA cement may be difficult as a result of viscosity. Substances are now admixed to reduce viscosity easing delivery but increasing the chances of leakage. Research is still being conducted to develop better injectable bone augmentation materials; one of the most successful is Cortoss.[7] This agent was employed successfully in three compression fractures in this series. Cortoss is a

high-strength, biocompatible, self-setting composite engineered specifically to mimic the strength characteristics of human cortical bone. In contrast to PMMA, it is inherently radio-opaque which allows excellent visualisation during its placement. During Cortoss polymerisation, the exothermic reaction reaches a temperature of 55-65 degrees centigrade for less than 30 seconds. This low temperature and short exothermic reaction time, minimises the risk of tissue necrosis but potentially reduces the beneficial impact of heat of neural damage within the vertebral body and hence pain relief. In this preliminary report, no difference was found between using methylmethacrylate cement or Cortoss. Further controlled studies are required for a more complete assessment.

On the basis of published data, the overall complication rate of vertebroplasty is reported to be 1-3%. Although one might anticipate greater complications when low viscosity cement is employed to treat metastatic compressions and hemangiomata rather than osteoporotic compressions, this has not been validated in published series. In effect, complications, which include haemorrhage, vertebral posterior element fracture, are not thought to relate to the aetiology of the vertebral collapse.

Although most studies report early pain reduction following vertebroplasty with associated spinal stabilisation, long-term follow-up studies are now reporting the development of compression fractures at levels adjacent to those of stabilisation. This is thought to occur secondary to the altered biomechanics induced by vertebroplasty, where load-bearing kinetics redistribute the forces to adjacent vertebrae.[8]When vertebroplasty strengthens a vertebra, the altered stiffness appears to alter the distribution of forces to nearby vertebrae and increase the risk of fracture of these bodies. It is equally possible that this collapse merely reflects the natural evolution of osteoporosis in the spine. Following treatment with vertebroplasty, patients may have a significant clinical improvement and engage in activities that they were previously unable to do. This may also contribute a stress and result in new compression of adjacent vertebrae.

In summary, vertebroplasty appears to be an effective minimally invasive technique. When employed vertebroplasty results in a marked reduction in pain in osteoporotic compression fractures, and significant stabilisation of hemangiomata and metastatic compression fractures.

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