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MUSCULOSKELETAL

Coblation vertebroplasty for complex vertebral insufficiency fractures

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Abstract
Objectives Coblation to create a cavity in the affected vertebral body was performed for complex fractures and/or when there was a posterior wall defect. This permitted a low-pressure injection and potentially reduces the risk of extravasation of cement into the spinal canal.
Methods Prospective audit for outcome measures and complications allowed retrospective review of cases treated by coblation. A commercial wand inserted via a wide-bore vertebroplasty needle created a cavity before inserting cement. A visual analogue scale assessed pain and Roland Morris scoring assessed mobility.
Results Thirty-two coblation procedures were performed. Primary diagnoses were myeloma, metastases, osteoporosis and trauma. Outcome measures were recorded with a 56 % success rate, 6 % no change and 32 % with mixed but mainly positive results; 6 % died before follow-up. No complications were observed; in particular no patient suffered neurological damage and none have developed subsequent fractures at the treated levels.
Conclusions This technique makes possible cementation of patients who would otherwise be unsuitable for vertebroplasty. The modest pain and disability improvement is partly due to our stringent criteria as well as fracture complexity. Further work will assess the efficacy of the method compared with conservative measures.

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Key Points
- *Treatment of vertebral compression fractures with possible posterior wall defects is controversial.*
- *Coblation before vertebroplasty allows a low-pressure injection into fractured vertebrae.*
- *This technique reduces risk of extravasation of cement.*
- *No serious complication of our coblation procedures was observed.*

Keywords Vertebroplasty · Spinal fractures · Multiple myeloma · Metastasis · Osteoporosis

Introduction

Vertebroplasty is a technique that was first described in a paper written in 1987 by Galibert and Deramond [1]. The initial procedure performed was for a benign tumour of the C2 vertebral body where the bone had been weakened and it was felt that cement was the safest way of treating the loss of structural strength. Subsequently the technique has been widely applied in the treatment of pain due to osteoporotic fractures [2, 3]. In tandem with the development of treatment of osteoporotic fractures, patients with metastatic malignancy and other forms of bone destruction, including infiltrative myeloma, have been offered treatment with vertebroplasty and other forms of spinal cement augmentation [4–8].

It was originally felt that patients who had a destructive lesion that destroyed the posterior aspect of the vertebral body presented too great a risk to treat by vertebroplasty in case the cement were to leak through the defect in the posterior wall, thereby compressing the spinal cord or nerve roots. Alternatively, the cement might push the tumour ahead of the cement into the spinal canal; this being arguably more dangerous than cement, as it would not be possible to detect this movement of tumour into the spinal canal by using conventional fluoroscopic techniques.

Methods that involve increasing the pressure in the vertebra by balloon expansion, stent placement or high viscosity cement all carry the risk of displacing tumour or bone through defects in the vertebra. This is a particular risk in the posterior wall. This observation is largely an intuitive deduction, as there are no studies that compare the risk with other procedures.

It has become apparent that there are many cancer patients who would benefit from spinal cement augmentation to prevent pain and also to prevent catastrophic collapse despite the risk associated with posterior wall defect. A variety of techniques have been proposed in these patients, where the posterior elements and posterior wall are invaded [5, 9]. Contrast agent introduced into the spinal canal has been advocated, in that when cement is introduced, direct visualisation of the indentation on the contrast agent column caused by tumour displacement could be visualised on the fluoroscopic image. This technique does not prevent the tumour being pushed backwards, rather it simply allows the operator some warning that this was taking place. More recently a technique has been developed allowing the destruction of the tumour itself by cold ablation (coblation) and equipment has been manufactured by Arthrocare (Arthrocare UK, Knaresborough, North Yorkshire, UK) that allows the operator to place a radiofrequency coblation "wand" through the vertebroplasty needle, passing it several times through the tumour, vaporising the tumour tissue and creating a cavity. This cavity can then be filled with cement at low pressure reducing the risk of displacing the tumour posteriorly whilst enabling the cement to be placed in a more precise fashion [10].

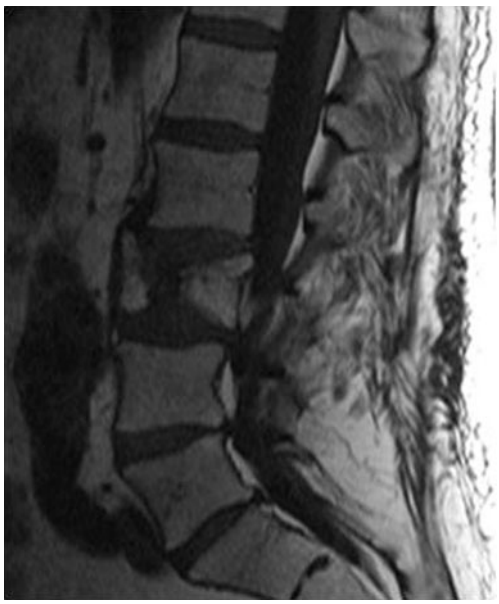

Fig. 1 Sagittal T1 FSE MR demonstrating a coronal cleft fracture. Cement injected into the centre of this vertebra would leak into both disc spaces

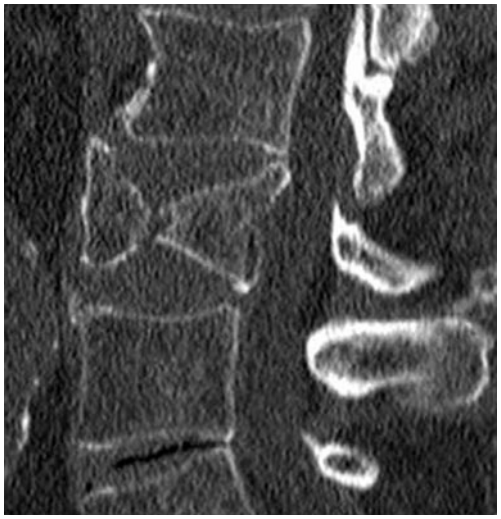

Fig. 2 CT examination of the same patient with a coronal cleft as in Fig. 1

In the treatment of patients with osteoporotic fractures there are similar technical problems in that some fractures are sufficiently severe to cause a coronal defect allowing the disc from above to come into contact with the disc below (Figs. 1, 2 and 3). Here the problem is that injecting cement into the original site of the vertebra often leads to cement entering both discs failing to fill the location where the vertebra would have been previously. This is a different

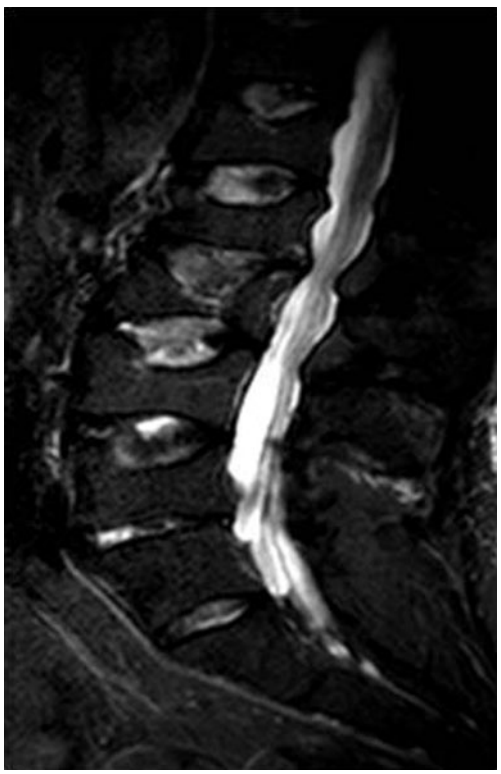

Fig. 3 MR FSTIR sagittal image showing severe biconcave fractures with "kissing discs"

problem to patients with posterior wall deficiency. Strategies for dealing with this issue include inflating balloons into the potential space and then using low-pressure cement injection into the balloon cavity. By placing a stent around that balloon, the cavity may be sustained, reducing the change of reduction in the new space before the cement is injected. Thicker varieties of cement have also been used to restrict spread. Some operators give an injection of normal saline before cement is injected. This is thought to fill the cracks and fissures that enter the disc and limit the spread of cement into the disc. None of these strategies is an ideal technique and there are occasions when they are attempted and fail.

As for tumours, some patients with osteoporosis have fractures that rupture the posterior wall (Fig. 4).

We have introduced the technique of coblation vertebroplasty, otherwise known as cavity vertebroplasty or cavity cement augmentation, and report on our experience over the last 4 years in our practice in Oxford.

Materials and methods

Patients referred for treatment of vertebral compression fractures were seen in an outpatient clinic by an experienced clinical radiologist with over 20 years of cement augmentation experience. All cases underwent MR examination and were reviewed clinically. Their analgesic use, disability and pain were noted. Roland Morris disability scores and visual analogue pain scores (VAS) were recorded. Where there were indications for treatment by interventional techniques, a decision was made whether to proceed directly to cement augmentation; this was usually where there was risk of further vertebral collapse, or whether pain management was the priority. In those with pain as the primary problem, patients were offered a local anaesthetic infiltration at the level of pain. Only those who failed to respond to this treatment after 14 days were offered cement augmentation.

Before proceeding to cement augmentation, the complexity of the fracture was studied using the recent MR examination. When there was concern regarding the integrity of the wall of the vertebral body, this was augmented by a CT study at the level of the fracture.

If there were defects in the endplates or vertebral walls that might lead to cement extrusion, then the patients were offered coblation vertebroplasty. Other cases were treated either by conventional vertebroplasty or kyphoplasty.

Informed consent was obtained in the clinic with warnings of allergy, infection, increased pain, nerve damage, paralysis and pulmonary embolus. A full medical review was undertaken considering potential risks of sedation or anaesthesia.

Patients selected for coblation vertebroplasty were treated in an interventional fluoroscopy suite within the operating theatre complex. They were admitted as day cases and reviewed by an anaesthetist with the benefit of a recent electrocardiogram, and they were given either heavy sedation or light general anaesthesia.

The procedure was undertaken whilst the patient was prone, using fluoroscopic guidance and full aseptic technique. The needle routes were planned using the cross-sectional imaging and position marked on the back using

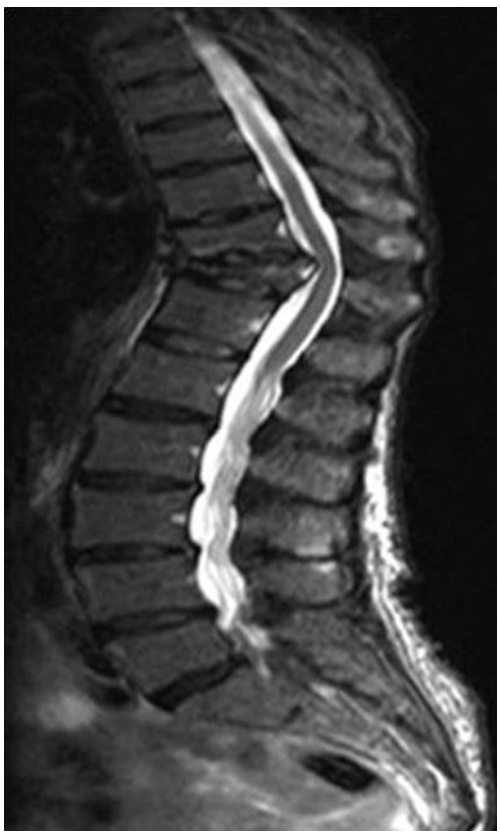

Fig. 4 Severe compression fracture with posterior wall disruption. Cement may leak into the spinal canal

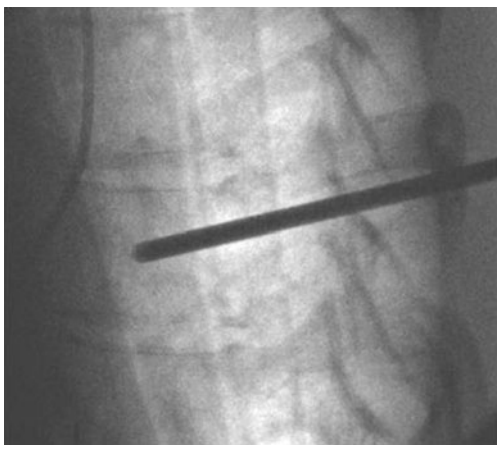

Fig. 5 Fluoroscopic lateral view images of coblation procedure: needle placement

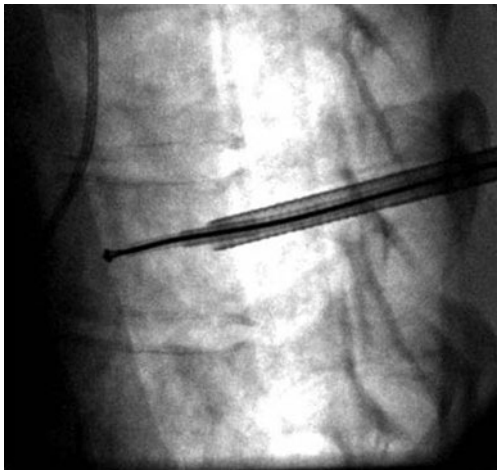

Fig. 6 Fluoroscopic lateral view images of coblation procedure: coblation

fluoroscopy. Local anaesthesia was administered to the skin and the periosteum.

A vertebroplasty 11-G needle was placed using an oblique parapedicular or an oblique paravertebral approach to the centre of the affected vertebra (Fig. 5). A guide wire was placed through this needle and the needle was withdrawn. A larger diameter (10-G) cannula was introduced over the guide wire to the posterior aspect of the vertebral body. A coblation wand was introduced through the cannula and six passes were made with 10 s of coblation per pass; the area was irrigated with normal saline to allow effective coblation (Fig. 6). Care was taken to create a cavity in the central part of the vertebra towards the anterior two-thirds of the diameter of the body. Defects in the walls were noted in advance and the side of entry was selected to avoid the defects. Consideration was given to potential routes of cement leakage when planning entry paths.

Coblation was carried out at a level of 6/12 whilst rotating the wand through 360°. This was monitored by continuous

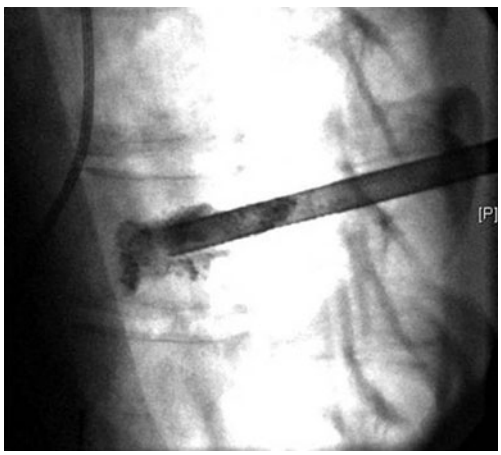

Fig. 7 Fluoroscopic lateral view images of coblation procedure: cement injection

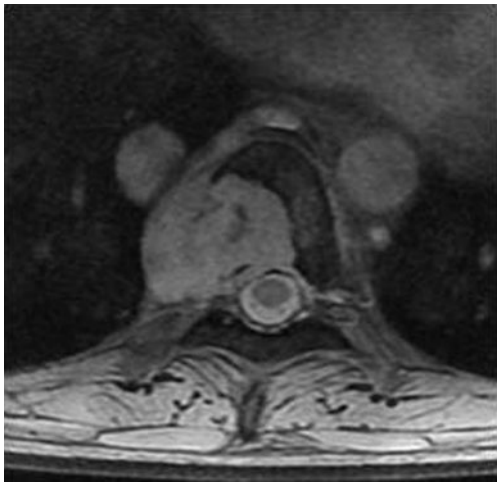

Fig. 8 Metastatic deposit from a cholangiocarcinoma in a patient aged 31. The MR shows posterior wall defects. The patient was in severe pain and at risk of catastrophic vertebral collapse

fluoroscopy. Methylmethacrylate cement of conventional viscosity was introduced via the cannula under continuous lateral projection fluoroscopy (Fig. 7). The cannula was withdrawn 14 min after cement mixing and a skin dressing was applied.

The patients spent 20–60 min in a recovery ward and were then transferred to a conventional ward. They were reviewed 60–120 min after the procedure and, if the pain was controlled, there were no complications and they were observed walking, they were discharged the same day.

At 2 weeks, a telephone review was undertaken by an experienced research coordinator. Pain scores and Roland Morris questionnaires were completed. At 1 month, the patients were reviewed in the clinic and the pain scores and disability scores were repeated. Any complications were recorded.

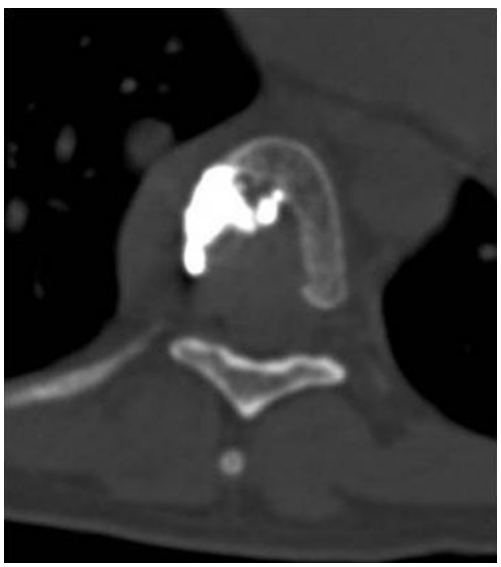

Fig. 9 CT after coblation vertebroplasty in the patient with a cholangiocarcinoma metastasis

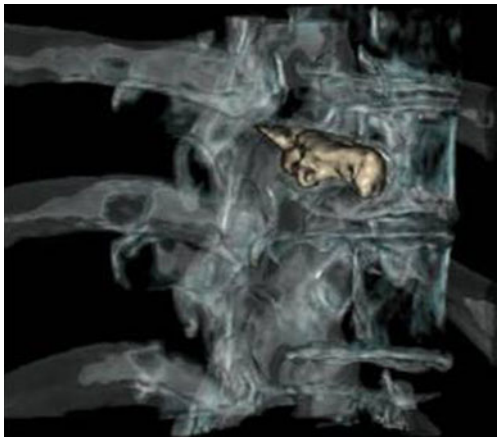

Fig. 10 Three-dimensional reconstruction of the CT examination from Fig. 9

Review of the outcome measures was based on routine baseline and post-procedure pain and disability scores. We employed a visual analogue scale for pain assessment and the Roland Morris 29-point disability score. These techniques have been validated and we use them as part of our routine vertebroplasty practice [11, 12]. We consider that a minimum of a two-point improvement on a VAS score and a four-point improvement on the Roland Morris disability index indicate success.

This review is a retrospective audit and permission was granted by the NHS Research Ethics Committee, South Central Oxford A, to collect and publish this material.

Results

Patients were recruited consecutively as referrals in a vertebroplasty practice. In the same period of time, a total of 452 patients were referred and 244 patients were offered some form of cement spinal augmentation. Of these, 47 % were patients with metastatic malignancy (Figs. 8, 9 and 10),

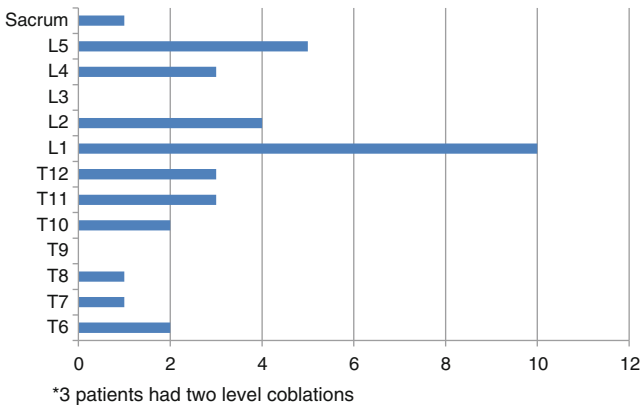

Fig. 11 Levels treated

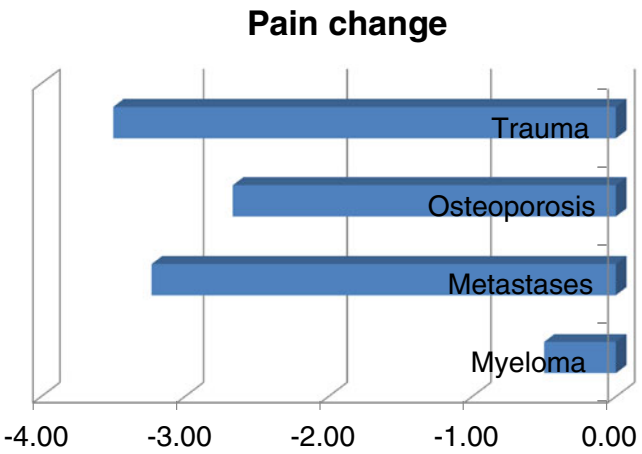

Fig. 12 Outcome measurements—pain change

28 % were patients with simple osteoporosis, 19 % were patients with osteoporotic type fractures occurring in myeloma and 6 % were fractures due to trauma (Figs. 11, 12 and 13).

No complications of the procedures were observed. However, one patient had to have a further coblation procedure at the same level as their pain and disability scores were the same after the first procedure, and a further MRI showed oedema remaining within the vertebral body. After the second procedure the pain score was −3 and the disability score was −4, but the patient believed that they did not gain as much pain relief as expected. A further facet joint injection was performed 1 month later before stem cell therapy, as it was possible that sagittal imbalance had led to an overload of these joints. The patient has not returned for any further treatment.

Discussion

The technique of coblation vertebroplasty adds approximately 10–15 min to the procedure time. The equipment is more complex and increases the cost of the procedure by

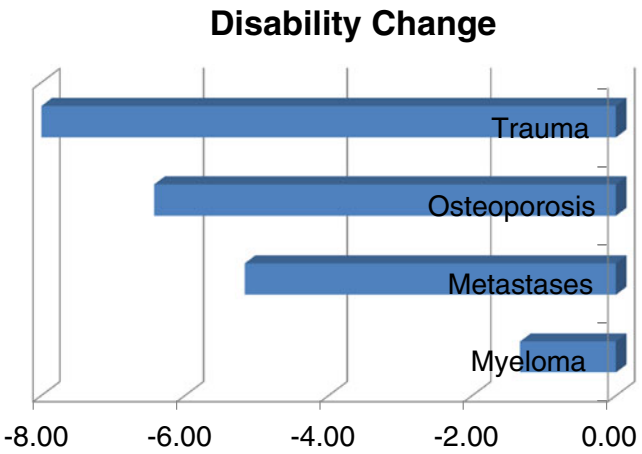

Fig. 13 Outcome measurements—disability change

approximately €420. We have not seen an increase in complications caused by using this technique. This is important considering that the cases are more difficult and complex and are likely to involve side-effects. Our outcome measures are not as successful as those obtained by conventional vertebroplasty in the simpler cases, where we would expect outcome scores of around 85 %. It is our view that this technique increases the safety of performing cement augmentation in patients with potentially catastrophic tumour invasion, and it also makes possible reasonable cementation in patients who would otherwise be unsuitable for treatment by vertebroplasty.

Limitations of this study are the lack of a control group and the small numbers. Readers will recognise the difficulty in designing a study of cancer patients with a control group.

We accept that others are undertaking cement augmentation in patients with posterior wall defects but we are sure that they have similar concerns regarding the risk of neurological damage and take precautions to minimise this risk. We believe that the techniques that we describe will assist in that process.

We regard the findings as preliminary data that in our view suggest that this technique may increase the number of patients who are safely treatable by cement augmentation

The modest pain and disability responses are in part the result of our relatively limited measure of success but probably mainly because of the complexity of the fractures treated by this method. Further work is required to judge the efficacy of the method compared with conservative measures. These studies should take into account the potential risks of the catastrophic collapse of vertebral lesions.

In conclusion, coblation vertebroplasty may be a safe way of performing cement augmentation in patients for whom conventional methods would be hazardous or impractical. Its efficacy in pain relief may be modest. It is difficult to assess any reduction in the rate of catastrophic vertebral collapse, but this is an important potential outcome which should be investigated further.

References

1. Galibert P, Deramond H, Rosat P, Le Gars D (1987) [Preliminary note on the treatment of vertebral angioma by percutaneous acrylic vertebroplasty]. Neurochirurgie 33:166–168
2. Wilson DJ (2011) Vertebroplasty for vertebral fracture. BMJ 343:d3470
3. Kallmes DF, Jensen ME (2003) Percutaneous vertebroplasty. Radiology 229:27–36
4. Yang X, Blezek DJ, Cheng LT, Ryan WJ, Kallmes DF, Erickson BJ (2009) Computer-aided detection of intracranial aneurysms in MR angiography. J Digit Imaging 24:86–95
5. Saliou G, Kocheida el M, Lehmann P et al (2010) Percutaneous vertebroplasty for pain management in malignant fractures of the spine with epidural involvement. Radiology 254:882–890
6. Jensen ME, Kallmes DE (2002) Percutaneous vertebroplasty in the treatment of malignant spine disease. Cancer J 8:194–206
7. Predey TA, Sewall LE, Smith SJ (2002) Percutaneous vertebroplasty: new treatment for vertebral compression fractures. Am Fam Physician 66:611–615
8. Murphy KJ, Deramond H (2000) Percutaneous vertebroplasty in benign and malignant disease. Neuroimaging Clin N Am 10:535–545
9. Doria C, Tranquilli Leali P (2010) Percutaneous techniques in the treatment of osteoporotic, traumatic and neoplastic fractures of thoraco-lumbar spine: our institutional experience. Injury 41:1136–1139
10. Gerszten PC, Monaco EA 3rd (2009) Complete percutaneous treatment of vertebral body tumors causing spinal canal compromise using a transpedicular cavitation, cement augmentation, and radiosurgical technique. Neurosurg Focus 27:E9
11. Ostelo RW, de Vet HC, Knol DL, van den Brandt PA (2004) 24-item Roland-Morris Disability Questionnaire was preferred out of six functional status questionnaires for post-lumbar disc surgery. J Clin Epidemiol 57:268–276
12. Kallmes DF, Comstock BA, Heagerty PJ et al (2009) A randomized trial of vertebroplasty for osteoporotic spinal fractures. N Engl J Med 361:569–579