



Contents lists available at ScienceDirect

Current Anaesthesia & Critical Care

journal homepage: www.elsevier.com/locate/cacc

FOCUS ON: GENERAL ANAESTHESIA

Anaesthesia for vertebroplasty and kyphoplasty

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S U M M A R Y

Keywords:

Anesthetics
Spinal diseases
Orthopaedic procedures
Intra-operative complications
Vertebral compression fractures

Vertebroplasty and kyphoplasty are minimally invasive techniques used in the treatment of vertebral compression fractures. Both procedures may be performed under general or local anaesthesia. The patients having these procedures tend to be elderly with significant medical comorbidities, and thorough pre-operative assessment is vital. Intra-operative patient positioning is often challenging. Complications associated with vertebroplasty and kyphoplasty are serious but occur uncommonly.

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1. Introduction

Vertebral compression fractures (VCFs) are one of the most common fractures associated with osteoporotic bone disease¹ and place great demands upon health care services in terms of both treatment costs and hospital length of stay.²

The prevalence of a radiologically identified vertebral deformity is 5% between the ages 50 and 54 years rising to 50% at the age of 80–84 years.³ These figures are likely to increase in line with the changing population demographics of the United Kingdom. Due to the lack of a consensus of diagnostic criteria for VCF⁴ this prevalence is likely to be a gross underestimate. It has been suggested that only 35% of VCF are actually diagnosed.⁵

Pain is the most common symptom associated with VCF and conventional treatment focuses upon analgesia, bed rest and spinal support. Radiotherapy is also used for the treatment of pain secondary to bony metastases and primary vertebral malignancies. Surgical treatment is considered in those patients with severe pain that remains refractory to medical treatment.

2. Vertebroplasty and kyphoplasty

These are minimally invasive, percutaneous techniques for the treatment of VCF.

Vertebroplasty may be performed under general anaesthesia or with local anaesthesia in combination with sedation. The patient is placed in the prone position and a trocar is passed percutaneously

into the affected vertebral body under fluoroscopic or CT guidance. The approach is usually transpedicular, but may be also be paravertebral. In order to achieve optimal vertebral filling each vertebral body has two trocars inserted, one either side of the midline. Polymethylmethacrylate (PMMA) that has been rendered radio-opaque by the addition of barium or tantalum is then injected into the medulla of the vertebral body via the trocars. This is performed under direct fluoroscopic visualisation so that any extravasation of the PMMA can be immediately recognised.

Kyphoplasty, or balloon-assisted vertebroplasty, is a variation of vertebroplasty. After the puncture of the vertebral body by the trocar, a balloon (or inflatable bone tamp) is delivered into the vertebral body itself. The balloon is then inflated with a radio-opaque contrast medium under direct fluoroscopic visualisation, in order to restore vertebral body height. The balloon is then deflated and removed and the cavity formed within the vertebral body is subsequently filled with PMMA as in a vertebroplasty.

Several vertebral levels can be treated in a single session (Fig. 1a and b).

3. Indications

The National Institute for Health and Clinical Excellence, an independent organisation responsible for providing national guidelines on treatments within the United Kingdom, has approved the use of vertebroplasty and kyphoplasty for patients with severe painful osteoporosis with loss of height or compression fractures of the vertebral body, and also for those with symptomatic vertebral haemangioma and painful vertebral body tumours (metastases or myeloma).^{6,7} The American Societies of Interventional Radiology, Spine Radiology and the American Association of Neurological Surgeons produced a joint position statement in 2007 recommending the use of kyphoplasty and vertebroplasty for painful vertebral compression fractures refractory to medical treatment.⁸

Abbreviations: VCF, vertebral compression fracture; PMMA, polymethylmethacrylate.

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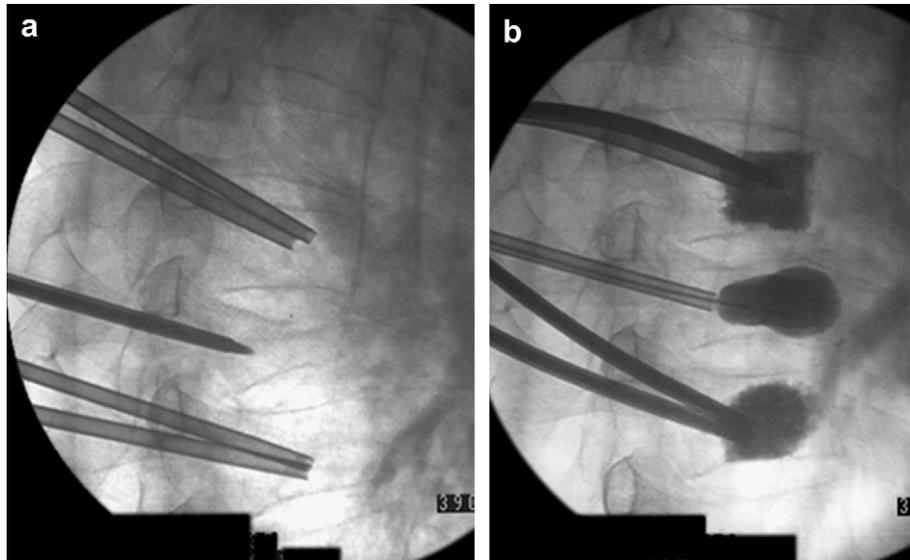


Fig. 1. (a) Three-level vertebroplasty and kyphoplasty. Lateral radiograph showing the trocars inserted into the three vertebrae that are to be treated. (b) The top and bottom vertebrae have undergone vertebroplasty, with the injected PMMA radio-opaque cement visible. The middle vertebral body is undergoing a kyphoplasty, with the balloon tamp being inflated.

Vertebroplasty has also been used in the treatment of traumatic fractures, in cases where either the patient has not been medically fit enough, or the fracture unsuitable, for traditional surgical management.

4. Contraindications

Due to the invasive nature of the procedure, both vertebroplasty and kyphoplasty are contraindicated in patients with coagulation disorders or who are receiving therapeutic anticoagulation for another condition. Extensive vertebral body collapse (that is, collapse to less than one-third of the normal vertebral body height) may make the procedure technically difficult, and is a relative contraindication.⁹ Neurological symptoms are not an absolute contraindication to either procedure, but great care must be taken to avoid cement extravasation, which has the potential to exacerbate any pre-existing nerve compression.

5. Evidence for vertebroplasty and kyphoplasty

At this time there are no published randomised control trials comparing vertebroplasty and kyphoplasty to conservative treatment, although studies are currently ongoing. Multiple case series and non-randomised comparative studies have shown vertebroplasty to produce a statistically significant improvement in pain and functional ability. Kyphoplasty has a similar success rate to vertebroplasty, but appears to offer no extra advantage in terms of pain relief or vertebral height restoration. Both procedures have similar rates of complications.¹⁰

6. Anaesthesia for vertebroplasty and kyphoplasty

6.1. Pre-operative

VCF is predominately a condition affecting the elderly and as a result patients will often have a number of associated comorbidities. A careful assessment of the cardiovascular system is vital, as prone positioning may result in a significant fall in cardiac output. Patients with a VCF occurring as a result of malignancy (either myeloma or bony secondaries) require special consideration.

Myeloma is a plasma cell malignancy associated with osteolytic pain lesions and pathological fractures. Vertebral involvement is common with 60% of patients having vertebral disease at diagnosis.¹¹ This tends to occur between the T6 and L4 vertebral bodies. Due to the accumulation of abnormal plasma cells within the bone marrow, patients are at risk of a number of complications that are pertinent to anaesthetists:

1. Bone destruction resulting in hypercalcaemia. Other malignancies may also result in hypercalcaemia by the same mechanism or alternatively through the ectopic production of parathyroid hormone. Hypercalcaemia may be exacerbated by dehydration resulting from a prolonged starvation period pre-operatively.
2. Bone marrow infiltration may result in anaemia, neutropenia and thrombocytopenia. Patients are, therefore, at a greater risk of post-operative infection and intra-operative bleeding. Conversely, high levels of circulating paraprotein produced by the plasma cells may produce a hyperviscosity syndrome, making peri-operative thromboembolic events more likely.
3. Renal impairment may be present and is multifactorial in origin. This can be due to light chain (excess immunoglobulin produced by the plasma cells) deposition, hypercalcaemia, hyperuricaemia, analgesic nephropathy or amyloid deposition.
4. Cardiorespiratory systems may be adversely affected by chemotherapy agents such as cyclophosphamide and melphalan. In addition, patients may be on long-term steroid therapy and thus be at risk of adrenocortical depression.

Metastatic malignancies other than myeloma need careful assessment of potential problems depending upon the site of the primary tumour and any other metastases. For example, lung primaries and lung function, or liver metastases and clotting abnormalities.

In view of these factors, all patients undergoing vertebroplasty should have a full blood count, urea and electrolytes, calcium and a clotting profile performed prior to surgery. Due to the close proximity of the iliac vessels, inferior vena cava and descending aorta to the thoracolumbar vertebral bodies, a group and save sample should be taken in case of haemorrhage, although this is an exceedingly rare complication. Other investigations (such as lung



Fig. 2. Positioning for vertebroplasty. The neck is relatively hyperflexed, which can result in the patient's chin impacting upon the bolster under the patient's chest.

function tests, electrocardiograms and radiological imaging) should be requested in line with usual practices as determined by the patient's age and associated comorbidities.

6.2. Intra-operative

6.2.1. Location

Vertebroplasty and kyphoplasty may be performed either in an operating theatre or within a radiology department. In the latter case the potential problems associated with providing anaesthesia in a distant site need to be considered before undertaking the procedure.

6.2.2. Anaesthetic technique

Single vertebral level vertebroplasty or kyphoplasty can be performed under either local anaesthesia with sedation or general anaesthesia. If more than one vertebral level requires treatment then general anaesthesia is preferable. This is due to patient discomfort secondary to prolonged positioning in the prone position and the requirement for large volumes of local anaesthetic that may approach maximal safe levels.

Sedation is normally achieved with benzodiazepines, propofol target controlled infusions, or a combination of the two. Analgesia is an important component of the procedure. The passage of the trocar through the periosteum of the vertebral body is particularly painful. Intraosseous lidocaine has been shown to be as effective as intravenous opiate and paracetamol in providing analgesia for this

part of the procedure.¹² Alternatives include short acting opiates such as alfentanil or fentanyl boluses, or remifentanyl infusions. The inflation of the balloon tamp during a kyphoplasty is another markedly stimulating part of the procedure. The pressure within the balloon can exceed 500 kPa and intravenous opiates are often required in order to maintain patient comfort.

For cases performed under general anaesthesia the patient is paralysed and the trachea is intubated with an armoured endotracheal tube. Neuromuscular blockade is monitored by a peripheral nerve stimulator. All other monitoring is as per the Association of Anaesthetists (AAGBI) standards. All patients have a large bore venous cannula sited and a low threshold for invasive blood pressure monitoring is advisable. Cardiovascular instability often occurs due a combination of the patient's age and the physiological demands involved during the transition to the prone position. Urinary catheterisation is not usually required unless a lengthy procedure is anticipated.

6.2.3. Positioning

All the usual precautions associated with prone positioning should be employed, such as protection of pressure points, meticulous eye care and avoidance of nerve traction or compression. Due to the need for fluoroscopic screening during the procedure, the operating surgeon may prefer the patient positioned upon simple pillows rather than bolsters or a Montreal mattress, in order to prevent degradation of the radiographic images. The benefits of this technique have to be offset against the risks of abdominal compression and pressure area damage, particularly if the procedure is likely to be prolonged. This is of particular importance in the severely osteoporotic patient as the development of rib fractures secondary to prone positioning has been described.¹³

The positioning of the patient for a kyphoplasty or vertebroplasty is slightly different from the standard position adopted for most other spinal surgery. In order to position the vertebral bodies optimally it is preferable for the lumbar spine to be in a more kyphotic position. This produces relative hyperflexion of the neck and can make positioning of the head difficult, as the patient's chin can be forced against the bolster under the chest (Fig. 2).

6.2.4. Temperature

As most elderly patients are prone to hypothermia and the procedure may take place under laminar airflow, forced warm area

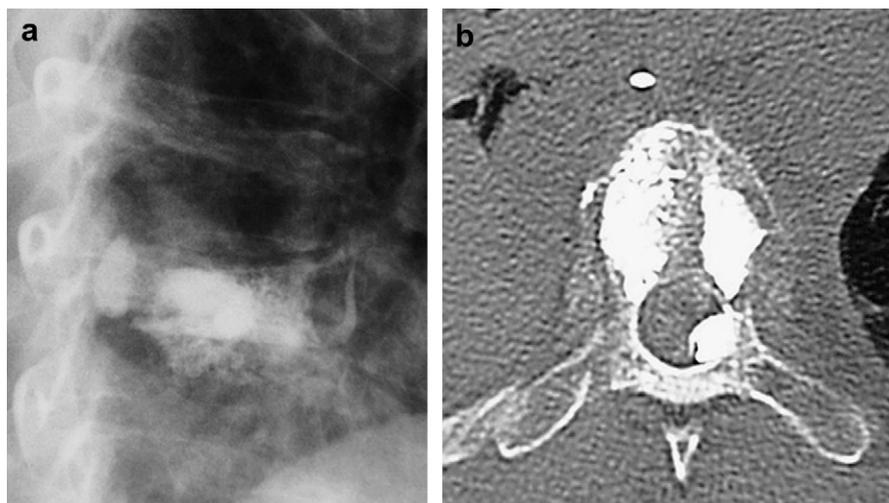


Fig. 3. Extravasation of PMMA cement. (a) The radio-opaque cement can be seen spreading outside the vertebral body. (b) The radio-opaque cement is visibly encroaching upon the vertebral canal.

blankets should routinely be used and the patient's temperature monitored. Minimal intravenous fluids are required, as no significant fluid shifts occur and bleeding is unusual, but it is our practise to use a fluid warmer for all patients.

6.2.5. Complications

The incidence of complications associated with vertebroplasty is between 1 and 10%⁸ depending upon the cause of the VCF. Vertebroplasty for an osteoporotic fracture carries a complication rate of 1.3%, which increases to 10% for fractures caused by malignant disease.¹⁴

The main risk associated with both vertebroplasty and kyphoplasty is the extravasation of cement into adjacent structures (Fig. 3a and b). Asymptomatic cement leakage may complicate up to 70% of cases.¹⁵ Spinal cord or nerve root compression by cement that has leaked has an incidence of approximately 5%, although in the vast majority of cases decompressive surgery is not required.^{15,9} Pulmonary emboli have occurred after migration of PMMA through the epidural or venous vasculature,¹⁶ but these are rarely clinically insignificant.⁸ The chance of cement extravasation increases with the number of vertebral levels treated.

The use of PMMA in hip arthroplasty is commonly associated with a degree of haemodynamic instability. A single case report has described this occurring during vertebroplasty¹⁷ but a large retrospective review of PMMA use in vertebroplasty found no correlation between its use and haemodynamic instability.¹⁸

Infection is a recognised complication of both procedures (although at a rate of <0.5%) and all patients should receive prophylactic antibiotics in the form of a cephalosporin or vancomycin in cases of penicillin sensitivity.

6.3. Post-operative

Post-operative complications are rare and the procedure may be done as a day case if the patient's general health and social circumstances are appropriate. Pain is usually mild to moderate, and indeed many patients notice an immediate decrease in their usual level of pain. A combination of intra-operative local anaesthetic use with regular paracetamol and opiates such as tramadol or codeine is usually adequate. Patients with a long history of strong opiate analgesic use, such as fentanyl patches or liquid morphine, should have these continued in order to avoid withdrawal phenomena, but the doses required may decrease rapidly and thus should be reviewed regularly. In light of the fact that most patients undergoing vertebroplasty are elderly, non-steroidal anti-inflammatory drugs are best avoided.

Patients with an underlying malignancy should receive thromboprophylaxis in the form of compression stockings and subcutaneous heparin.

7. Summary

Vertebroplasty and kyphoplasty are techniques that have a favourable complication rate and an excellent evidence base of

patient benefit. The use of both procedures is becoming more widespread and is likely to increase further over the coming years. Due to the elderly nature of the population undergoing these procedures and the high incidence of associated medical comorbidities, thorough pre-operative assessment in tandem with meticulous intra-operative care is necessary to avoid potentially serious complications.

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