Orthopaedics & Traumatology: Surgery & Research 100 (2014) S169–S179

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Review article

Kyphopasty and vertebroplasty

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ARTICLE INFO

Article history:
Accepted 15 November 2013

Keywords:
Kyphoplasty
Vertebroplasty
Vertebral compression fractures
Polymethylmethacrylate
Percutaneous

ABSTRACT

Vertebroplasty and balloon kyphoplasty are percutaneous techniques performed under radioscopic control. They were initially developed for tumoral and osteoporotic lesions; indications were later extended to traumatology for the treatment of pure compression fracture. They are an interesting alternative to conventional procedures, which are often very demanding. The benefit of these minimally invasive techniques has been demonstrated in terms of alleviation of pain, functional improvement and reduction in both morbidity and costs for society. The principle of kyphoplasty is to restore vertebral body anatomy gently and progressively by inflating balloons and then reinforcing the anterior column of the vertebra with cement. In vertebroplasty, cement is introduced directly under pressure, without prior balloon inflation. Both techniques can be associated to minimally invasive osteosynthesis in certain indications. In our own practice, we preferably use acrylic cement, for its biomechanical properties and resistance to compression stress. We use calcium phosphate cement in young patients, but only associated to percutaneous osteosynthesis due to the risk of secondary correction loss. The evolution of these techniques depends on improving personnel radioprotection and developing new systems of vertebral expansion.

1. Introduction

Vertebroplasty and balloon kyphoplasty are increasingly important options for radiologists, orthopedic surgeons and neurosurgeons managing spinal lesions.

They are percutaneous techniques, performed under radioscopic control. The principle of kyphoplasty is to restore vertebral body anatomy gently and progressively by inflating balloons and then reinforcing the anterior column of the vertebra with cement. The balloons create a cavity within the vertebral body, compressing the cancellous bone and thus limiting the risk of cement leakage from the vertebral body. In vertebroplasty, cement is introduced directly under pressure, without prior balloon inflation.

Vertebroplasty was developed in France by Galibert and Deramond in 1984 [1]. Its original indication was for aggressive vertebral angioma. Its proven efficacy led to an extension of indications to metastatic and myelomatous osteolytic lesions, and then to osteoporotic vertebral compression fractures.

Kyphoplasty was developed from the vertebroplasty concept, initially by Reiley in 1998, then taken up by Belkoff et al. in 2001 [2]. At first reserved to tumoral and osteoporotic lesions [3], it has gradually established its role in the treatment of fractures in young patients [4].

The benefit of these minimally invasive techniques compared to conventional attitudes (conservative treatment or open surgery) has been demonstrated in terms of pain and functional improvement. Cement injection into the vertebra may have an analgesic effect by consolidating microfractures and reducing the mechanical stress associated with weight and activity, and also by destroying bone nerve endings by cytotoxic and exothermal action in the course of cement polymerization.

Morbidity, moreover, is minimal, and the techniques bring cost savings over the medium term.

2. Technique

2.1. Instrumentation

Most cementoplasty instrumentation is basically similar (Fig. 1), differing in whether or not balloons or stents are used to expand the vertebra.

Instrumentation comprises beveled trocars (or Yamshidi needles) for the entry point and trajectory through the bone, blunt K-wires to guide the cannulae carrying the balloon or stent, a curette in case of dense cancellous bone, and devices for bone filling. The technique also requires an iodized contrast agent for fluoroscopic control of balloon inflation, and a dose of cement.

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1877-0568/$ – see front matter © 2014 Published by Elsevier Masson SAS.
http://dx.doi.org/10.1016/j.otsr.2013.11.005

Fig. 1. Kyphoplasty instrumentation.

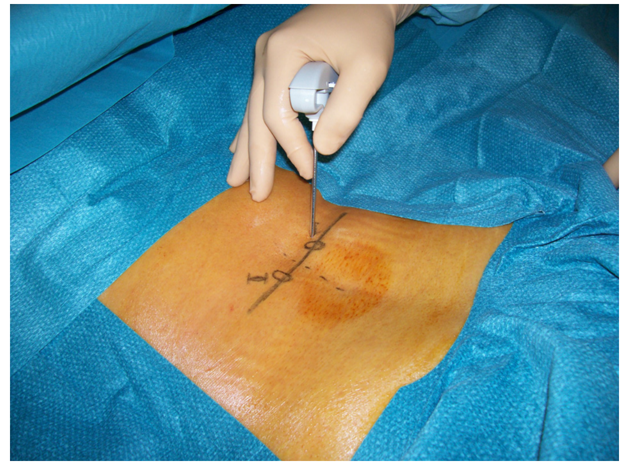

Fig. 3. Insertion of Yamshidi needle.

2.2. Patient positioning

Our attitude is to perform the procedure in theater under general anesthesia. The patient is positioned in ventral decubitus on the spine-surgery table in hyperlordosis, thus partially reducing the traumatic vertebral kyphosis (Fig. 2).

The procedure requires peroperative radioscopic control using one or two fluoroscopes to obtain AP and lateral views; we advise using two fluoroscopes, so as the limit the risk of infection associated with manipulating them during surgery. The frontal fluoroscope tank should be placed upwards. Having two surgeons, one on either side of the patient, reduces surgery time and irradiation time by operating on both sides simultaneously.

One technical variant is to operate under CT. This provides better visualization of the vertebra than radioscopy, especially in small tumoral lesions. However, it does not allow injection under fluoroscopy or monitoring the progress of the cement within the vertebral body.

In upper thorax procedures, superimposition of the two shoulders on lateral views hinders peroperative fluoroscopic control, and may even lead to abandoning cementoplasty. This is especially true in squat or muscular patients, for whom 3D fluoroscopy or peroperative CT seems indispensable. In other cases, it is usually possible to "eliminate" the shoulders, either by positioning the arms along the body and strapping them down or by holding them in antepulsion in the so-called "Superman posture" (although the latter incurs a risk of stretching the brachial plexus and generally requires a relatively narrow operating table such as the new carbon fiber models).

Fig. 2. Patient positioning.

2.3. Surgery

2.3.1. Spinal approach

For dorsal and lumbar vertebrae, an extrapedicular posterolateral or a transpedicular approach is possible, the latter having the general advantage of avoiding dorsal pleural-parenchymal complications or lumbar psoas hematoma, with much less cement leakage from the vertebral body through the puncture hole; however, it is not feasible in case of pedicular lysis or presence of internal fixation material. The lesion level is determined before draping and the position of the vertebral pedicles is marked on the skin.

2.3.1.1. Transpedicular approach. As the objective is to inject cement into the center of the vertebral body, the incision should be shifted about 1 cm away from the pedicular skin landmark so that the cannulae converge horizontally. Vertically, the height of the incision depends on how steeply the cannula is to descend: for a very steeply descending orientation, the incision had to be shifted about 1 cm upward of the projection of the pedicle (Fig. 3).

The trocar entry point is determined manually, at the base of the superior articular process at the junction with the transverse process (Fig. 4A, B). The trocar advances to the inner edge of the pedicular ring seen on AP view; the ring is not to be crossed before the posterior wall of the vertebral body, seen on lateral view, has been; otherwise the trocar will penetrate the spinal canal (Fig. 5A, B). The trocar is introduced beyond the posterior wall of the vertebral body (Fig. 6). The major risks of this transpedicular approach are radicular lesion or dural breach through the medial pedicular cortical bone; this risk can easily be corrected by rigorous frontal fluoroscopic control of the pedicle or by adapting the caliber of the trocar to the size of the pedicle, especially in the superior dorsal region.

2.3.1.2. Extrapedicular posterolateral approach. We reserve the posterolateral approach to cases in which the transpedicular approach is contraindicated: pedicular lysis or internal fixation material. Some authors prefer a posterolateral approach at dorsal level where pedicle size is reduced. The entry point is about one hand-width from the spinous processes. At dorsal level, it is essential to make sure that the needle is always behind the line of pleural reflection: otherwise, the risk is a pleural wound and possible hemothorax. At lumbar level, the risks are the same as in vertebral body