

Assisted techniques for vertebral cementoplasty: Why should we do it?

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ABSTRACT

Assisted techniques (AT) for vertebral cementoplasty include multiple mini-invasive percutaneous systems in which vertebral augmentation is obtained through mechanical devices with the aim to reach the best vertebral height restoration. As an evolution of the vertebroplasty, the rationale of the AT-treatment is to combine the analgesic and stability effect of cement injection with the restoration of a physiological height for the collapsed vertebral body. Reduction of the vertebral body kyphotic deformity, considering the target of normal spine biomechanics, could improve all systemic potential complications evident in patient with vertebral compression fracture (VCF). Main indications for AT are related to fractures in fragile vertebral osseous matrix and non-osteoporotic vertebral lesions due to spine metastasis or trauma. Many companies developed different systems for AT having the same target but different working cannula, different vertebral height restoration system and costs. Aim of this review is to discuss about vertebral cementoplasty procedures and techniques, considering patient inclusion and exclusion criteria as well as all related minor and/or major interventional complications.

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1. Introduction

Assisted techniques (AT) for vertebral cementoplasty can be considered as an evolution of the simple cement injection in the vertebral body, the so-called "vertebroplasty" (VP): AT include multiple percutaneous systems in which a vertebral augmentation is obtained through mechanical devices in order to reach the best vertebral height restoration. The first assisted technique to consider is certainly the balloon Kyphoplasty (KP) that was performed for the first time in California in 1998 [1]: this procedure consists in delivering cement—PMMA (Polymethylmethacrylate) into a fractured vertebral body under fluoroscopic guidance after creation of a cavity within the vertebral body by a dedicated expandable balloon [2].

Vertebral compression fractures (VCFs) are mostly related to osseous fragility due to porotic metabolic deficiency, causing microfractures and spine pain due to periosteal nerve fibres stretching [3].

Scope of the treatment is to combine the analgesic and stability effect of cement injection to restore a physiological height for the collapsed vertebral body and to reduce the kyphotic deformity: the target is to achieve the normal spine biomechanics, improving all systemic potential complications that could be evident in patients with VCF, such as respiratory and gastro-intestinal dysfunctions [1,2,4].

Main indications for ATs are related to fractures in fragile vertebral osseous matrix and non-osteoporotic vertebral lesions due to spine metastasis or trauma, such as primary and secondary vertebral tumours, as well as in selected primary vertebral traumatic fractures [2,4].

Common indications for those techniques are certainly porotic VCF with spinal pain refractory to non-invasive medical and/or physical treatment and orthosis devices [6–12].

The cost of ATs is much more expensive than simple VP: in terms of numbers of treated patients, 70% of patients with VCF are treated with VP and 30% with AT, but regarding to the cost and requested budget for these devices the situation is completely inverted with 70% related to AT and only 30% to VP devices [6–12]. This condition created a competition and a benchmark between many companies developing new system for AT (up to 21 system at this moment available worldwide), having the same target but different

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working cannula, different vertebral height restoration system and cost, often less expensive.

2. How to select patients

Porotic VCF with pain represents main indication to AT, also in patients with acute thoracic or lumbar spine pain refractory to bed rest and medical and/or physical therapies [2]. Reduction of the kyphotic deformity is the major target of all AT thanks to capacity of the system to recovery the vertebral height [3]. For this reason, AT should be recommended in case of lost of the vertebral height of at least 30–40% or more of the normal anatomical morphology [2,4,12]. Preliminary diagnostic approach includes MR examination with sagittal T2-STIR sequence (or any fat suppression if using a 3T MR equipment), that is mandatory to decide about the treatment and the number of vertebral bodies to treat: in fact, hyperintensity due to bone marrow oedema is a findings of not healing fracture [14].

Absolute contraindications are similar to those related to VP, such as the presence of local or systemic infections, painless vertebral fracture and allergy to PMMA. The presence of a myelopathy and radicular compression in case of spine tumours represent an obvious and urgent indication to surgical decompression [12].

Multiple myeloma and spine metastases can also be treated with AT, especially in cases of loss of vertebral height. The presence of epidural soft tissue component with thecal sac compression represent a not absolute contraindication to AT, but it requests accurate clinical evaluation in order to decide between mini-invasive therapy or surgical treatment [6,8,12].

Vertebral traumatic fractures can be defined as stable or unstable related to three- or four columns theory [13–15]; multiple classifications of vertebral trauma are available in literature [13–15]. Magerl's classification [5] is the most commonly used and considers the trauma in compression, rotation and distraction injuries with multiple subtypes. The management of spine traumatic patients is well known and defined by many protocols related to associated clinical neurological symptoms, especially in case of presence or absence of myelopathy or radicular deficit, using diagnostic imaging resources such as X-ray, MRI, MDCT or both MRI/MDCT [16].

Magerl A1 type traumatic vertebral fractures [6] represents main indication for AT, but this kind of patients can also be treated with orthosis devices, bed rest as well as medical and/or physical therapy at least for 3–6 months. However this treatment could be not always able to exclude the possibility of worsening of the VCF with an increase of the kyphotic deformity [17,18]; it should

be considered also all the problems related to the orthosis such as cardio-respiratory diseases, sleep disorders and gastro-intestinal motility reduction [17,18]. Thanks to the capacity of the AT to restore the physiologic vertebral height and to obtain a more homogeneous distribution of the cement with a better axial resistance to load, this treatment certainly represents a good indication in patients affected by Magerl A1 fractures [5,12]. The patients having Magerl's lesions A2 and A3 type [5] can also be considered for this treatment in selected cases, such as in polytrauma with co-morbidities (long bones fractures, abdominal traumatic lesion, etc), in elderly people not suitable for surgical intervention and in all cases in which the surgical and anaesthesiologist risk is too high [2,4]. There is no absolute rule about the timing of AT; the only difference is about timing of vertebral traumatic fracture that should be performed as soon as compared to older patients. Because the bone metabolism is much more active in young people than in elderly, it should be preferable to submit younger patients to the AT treatment as soon as possible [19].

3. How to approach the vertebral body

A preliminary bilateral trans-peduncular approach under fluoroscopic guidance is always mandatory in all AT procedures to obtain a good vertebral body height restoration and an homogeneous cement filling. High quality fluoroscopy is also very important to achieve a complete anatomical control of the spine, in order to obtain a correct peduncular approach avoiding complications even in case of patients affected by aged scoliosis [16,19,21,23–27] (Figs. 1–3). Dimension of the peduncles is important to lead a correct anatomical approach and their size should be checked before to make a treatment decision. An oblique approach with the typical “scotty dog” imaging appearance is also useful to reach the third anterior of the vertebral body [10].

AT can be performed in local anaesthesia, but in several cases a general anaesthesia could be required (especially in case of more than one single level or in young traumatic patients): this condition is related to the cannula calibres used in KP (10–11 G) compared to the ones used in VP (13 or 15 G). Moreover, the time procedure is certainly longer in AT respect to VP interventions [23–27]. Traumatic fractures in young patients are often more painful than in elderly patients due to the different bony structure: for this reason they need to be treated in general anaesthesia [19]. A VP intervention associated to AT could represent a potential solution to prevent fractures to above and below spine metamers especially at the level of thoraco-lumbar junction [20].

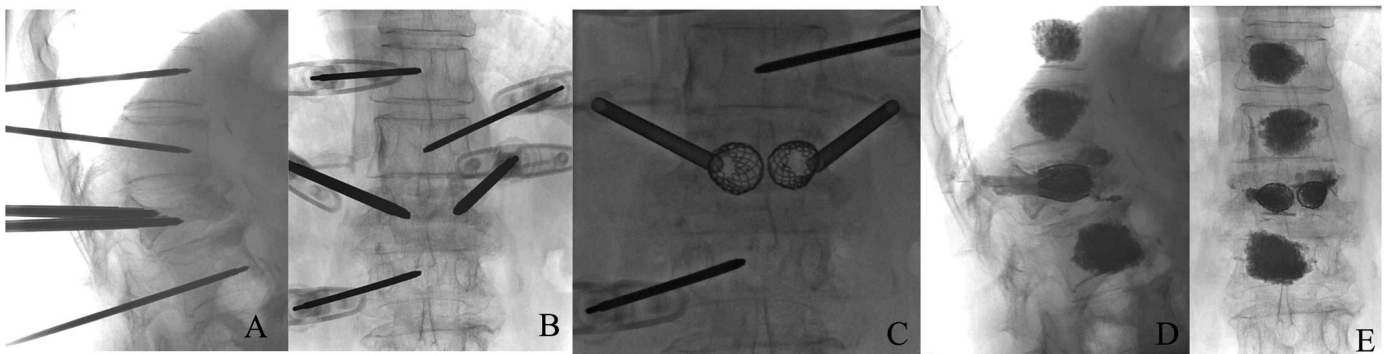


Fig. 1. (A–E) Seventy two years old female affected by symptomatic porotic VCF at D12 level. (A and B) The LL and PA fluoroscopy control show the needles placement into T10,T11,T12,L1 soma by bi-peduncular approach of T12 and monopeduncular preventive VP of T10,T11 and L1 level. (C) The PA fluoroscopy control after the delivery of the vertebral body stenting device into T12 soma. (D and E) The LL and PA fluoroscopy control after vertebral body stenting device of T12 and preventive vertebroplasty of T10, T11 and L1 level showing a good vertebral augmentation effect of T12 without leakage.

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