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Respective contributions of vertebroplasty and kyphoplasty to the management of osteoporotic vertebral fractures

Hervé Deramond[a,*], Guillaume Saliou[b], Mathieu Aveillan[a], Pierre Lehmann[b], Jean Noël Vallée[b]

[a] *Medical Imaging Department, Fort de France Teaching Hospitals, Pierre Zobda-Quitman Hospital, Boite postale 632, 97261 Fort de France, France (FWI)*
[b] *Radiology Department A, Amiens Teaching Hospital, 80054 Amiens cedex 1, France*

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Abstract

Among individuals aged 50–80 years, 5–20% have one or more vertebral crush fractures. One-third of these patients require treatment for acute or chronic pain. Vertebroplasty and kyphoplasty were introduced over the last two decades as treatments for incapacitating pain from osteoporotic vertebral fractures. Both techniques proved effective and safe in numerous retrospective and prospective studies. They now deserve to be incorporated into the standard treatment strategy for painful and incapacitating vertebral fractures. Kyphoplasty seeks not only to stabilize the vertebra, but also to correct the kyphosis induced by the vertebral body collapse. However, the correction is often limited (less than 15°) and has not been shown to increase the benefits in terms of pain relief or quality-of-life improvement, compared to vertebroplasty. Kyphoplasty is more costly than vertebroplasty, which is therefore emerging as the treatment of choice. However, a randomized double-blind trial comparing vertebroplasty and kyphoplasty is needed. Furthermore, a randomized comparison of vertebroplasty or kyphoplasty versus noninterventional treatment is needed in patients admitted for pain immediately after a vertebral crush fracture.
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1. Introduction

The prevalence of osteoporotic vertebral fractures in the 50–80 year age group ranges from 7% to 19% in women and 4% to 17% in men, depending on the definition of vertebral fracture [1]. About one-third of osteoporotic vertebral fractures cause symptoms, chiefly back pain [2]. The presence of pain correlates with the severity of the vertebral deformity [1]. Until the late 1980s, the treatment relied solely on noninterventional methods. Vertebroplasty was introduced in 1989 for the treatment of vertebral fractures [3]. Kyphoplasty was developed in 2001 [4]. Both vertebroplasty and kyphoplasty are effective in relieving pain caused by osteoporotic vertebral fractures. Vertebroplasty was developed in France in 1984 for the treatment of painful aggressive vertebral angioma [5]. Five years later, the indications were expanded to include vertebral fractures caused by neoplasia or osteoporosis [3]. The first results from the US were published in 1997 [6]. Vertebroplasty involves inserting a needle percutaneously into the pedicle and injecting acrylic cement to stabilize the fracture site. Kyphoplasty was developed in 2000 and the first results were reported in 2001 [4,7]. In kyphoplasty, a balloon is introduced into each half of the vertebral body and inflated to create a cavity, which is then filled with acrylic cement. In addition to stabilizing the vertebra, kyphoplasty diminishes the kyphosis induced by the fracture. The technique rapidly achieved widespread acceptance for treating pain caused by osteoporotic vertebral fractures. However, the cost of the equipment needed for kyphoplasty is 7- to 10-fold greater than for vertebroplasty.

2. Benefits of percutaneous treatment for osteoporotic vertebral fractures

Osteoporotic vertebral fractures can cause acute or chronic pain. Kyphosis secondary to the vertebral body collapse

* Corresponding author.
E-mail addresses: herve.deramond@chu-fortdefrance.fr (H. Deramond), saliou.guillaume@chu-amiens.fr (G. Saliou), mathieu.aveillan@chu-fortdefrance.fr (M. Aveillan), lehmann.pierre@chu-amiens.fr (P. Lehmann), vallee.jean-noel@chu-amiens.fr (J.N. Vallée).

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induces mechanical stress that puts the adjacent vertebras at increased risk for fracture [2,8]. Among patients with osteoporotic fractures, 2–10% require hospital admission for incapacitating pain [9]. Randomized trials and prospective studies have established that conservative medical treatment is usually effective in relieving the pain and restoring function within 6 weeks, albeit at the expense of prolonged immobilization, which can cause adverse events [9,10]. In numerous retrospective and prospective studies, percutaneous treatment was highly effective in relieving pain and improving function in the short and long term [9,11–16]. The adverse event rate was less than 1%, and most complications were short-lived [17–19].

Percutaneous treatment has not been compared to conservative treatment in randomized controlled studies in patients with pain from osteoporotic vertebral fractures. A recent prospective nonrandomized 2-year study compared two groups of patients admitted to the same hospital, during the same period, for pain caused by osteoporotic vertebral fractures [9]. Standard conservative treatment was used in one group and vertebroplasty in the other. Vertebroplasty provided immediate pain relief, whereas conservative treatment did not, the result being significantly less pain in the vertebroplasty group for the first 6 weeks. Function as assessed by the Barthel index was significantly better with vertebroplasty after 24 hours. Although the difference in function was no longer apparent after 6 weeks, the maximum index value was achieved more rapidly in the vertebroplasty group, explaining the 40% shorter hospital stay (mean, 10 vs. 17.5 days) [9]. Similarly, no randomized controlled trials of kyphoplasty vs. conservative treatment have been published, but a prospective nonrandomized 1-year treatment compared two groups of patients admitted to the same hospital for pain from osteoporotic vertebral fractures [16]: kyphoplasty was used in one group and conservative treatment in the other. Again, immediate pain relief was achieved with the percutaneous method but not with conservative treatment. The number of physician visits related to the vertebral fracture within the next year was twice as high in the group treated conservatively.

Both quality-of-life and life expectancy are diminished in patients who have a history of osteoporotic vertebral fracture [20,21]. No studies designed to determine whether percutaneous treatment improves these two outcomes have been reported to date. Although the study by Diamond et al. [9] was small (88 vertebroplasty patients and 38 controls), it showed excess mortality related to the vertebral fracture in the group treated conservatively. Kyphosis reduction by kyphoplasty has not been proven to improve life expectancy or quality-of-life. Randomized controlled trials with prolonged follow-ups are needed to compare the effects of vertebroplasty, kyphoplasty, and conservative treatment on life expectancy and quality-of-life. It has been suggested that vertebras adjacent to percutaneously treated sites may be at increased risk for fractures [22,23]. About 25% of patients treated percutaneously experience a further fracture within 1 year [22–25]. This second fracture usually occurs within a few weeks of percutaneous treatment; fractures adjacent to the treatment site occur earliest [23,24]. However, studies have shown that the risk of vertebral fractures in osteoporotic patients is higher in patients with prior vertebral fractures [26] or severe vertebral fractures [27]. There is no convincing evidence that further fractures are more common after percutaneous treatment than after conservative treatment [9,28,29], and randomized controlled trials would be needed to resolve this issue. In sum, there is reasonable evidence that percutaneous treatment is beneficial in patients with incapacitating pain caused by osteoporotic vertebral fractures.

3. Patient selection for vertebroplasty or kyphoplasty

In prospective and retrospective studies, both vertebroplasty and kyphoplasty were highly effective in providing long-lasting pain relief to patients with acute or chronic pain caused by one or more osteoporotic vertebral fractures, requiring level II or higher analgesics, and leading to major functional impairment [9,11–16]. In patients with acute pain, percutaneous treatment is classically reserved for patients who have failed 2 weeks of well-conducted conservative treatment [12–16]. Unfortunately, one or more weeks usually elapse between the fracture and the initiation of appropriate conservative therapy. Prompt treatment avoids prolonged immobilization and its deleterious physical and emotional effects. Vertebroplasty or kyphoplasty can be offered as early as 10 days after the fracture [9,11]. The decision rests not only on the presence of mechanical pain located exactly at the fracture site, but also on the imaging study findings. At this acute phase, fractures and microfractures are associated with marrow edema that produces characteristic signal abnormalities on T1- and T2-weighted magnetic resonance imaging (MRI) scans with fat suppression. Thus, MRI is valuable for identifying the site to be treated, most notably in patients who have multiple vertebral fractures of different ages among which only one is symptomatic. Presence of MRI signal abnormalities predicts a good response to percutaneous treatment [30]. Radionuclide bone scanning provides similar information [31]. Thus, plain radiographs, MRI or radionuclide bone scanning, and computed tomography (for planning the procedure) should be obtained prior to vertebroplasty or kyphoplasty [11, 17].

Chronic pain that is still present several months after the fracture is also a good indication for percutaneous treatment [32,33]. Nevertheless, a careful clinical and radiological evaluation is in order to select those patients most likely to benefit from the procedure. Incapacitating mechanical pain requiring the use of level II or higher analgesics and originating at the fracture site must be present. MRI evidence of bone marrow edema was consistently associated with a good response [34]. In the same study, 80% of patients who had no marrow edema by MRI benefited from vertebroplasty. Patients with normal MRI findings may have abnormal radionuclide bone scans [31]. Osteonecrosis is common in long-standing vertebral fractures [35,36]. MRI visualizes the necrotic zone as a cystic cavity. More rarely, osteonecrosis is seen as vacuum phenomenon on plain radiographs or CT scans

[35,36]. In this situation, percutaneous therapy is successful in 80–90% of cases [33,35].

4. Choosing between vertebroplasty and kyphoplasty

No randomized comparisons of vertebroplasty and kyphoplasty are available. In a recent prospective study, no significant differences were noted between the two procedures regarding pain relief after 24 hours, 6 months, or 1 year [37]. Vertebroplasty and kyphoplasty share similar adverse event profiles [18,19]. Whether vertebral height restoration and kyphosis correction militate in favor of kyphoplasty deserves discussion. Studies have shown that both percutaneous methods ensure partial vertebral height restoration and kyphosis correction both in vitro [38] and in vivo [15,16,39–41]. The extent of vertebral height restoration and kyphosis correction is greater after kyphoplasty than after vertebroplasty. Nevertheless, even kyphoplasty produces only 47% height restoration and less than 10% kyphosis correction. These percentages are only slightly smaller after vertebroplasty [39,40]. With both methods, the pain-relieving effect is independent from the extent of height restoration or kyphosis correction [15,16]. No long-term prospective studies of the contribution of kyphosis correction to quality-of-life gains and persistence of pain relief have been published. Larger degrees of kyphosis correction are achieved when several adjacent vertebral fractures are treated by kyphoplasty [42]. Treatment within 3 weeks after the fracture increases the degree of height restoration and kyphosis correction with kyphoplasty. In sum, kyphoplasty may be preferable over vertebroplasty in patients with severe or multiple wedge deformity that developed within the last 3 weeks. Nevertheless, whether partial kyphosis correction is associated with better pain relief, longer life expectancy, and improved long-term quality-of-life remains to be determined.

5. Conclusion

Although no randomized comparisons of percutaneous treatment versus conservative treatment are available, numerous prospective and retrospective studies in several thousand patients have established that vertebroplasty and kyphoplasty are effective and safe for the treatment of pain due to osteoporotic vertebral fractures. The consistent efficacy of percutaneous treatment suggests that randomized double-blind trials in patients with incapacitating pain due to osteoporotic vertebral fractures despite optimal conservative treatment may be unwarranted. In contrast, randomized studies would be useful at the acute phase, in patients admitted within 2 weeks of the fracture. The results would serve to determine the optimal treatment at this early phase. At present, the role for kyphoplasty in patients with pain from osteoporotic vertebral fractures is limited, since the higher cost of kyphoplasty is not counterbalanced by increased efficacy or safety compared to vertebroplasty. Randomized double-blind trials comparing these two methods regarding long-term pain relief, life expectancy, and quality-of-life would be timely.

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