*Orthopaedic Surgery* (2011), Volume 3, No. 3, 158–160

REVIEW ARTICLE

# Comparison of vertebroplasty and kyphoplasty for complications

Ji-dong Zhang MD[1], Bart Poffyn MD[2], Gwen Sys MD[2], Dirk Uyttendaele MD[2]

[1]Department of Spine Surgery, Tianjin Hospital, Tianjin, China; and [2]Department of Orthopaedic Surgery, Ghent University Hospital, Ghent, Belgium

Vertebroplasty (VP) and kyphoplasty (KP) have been proven equally effective in providing pain relief in patients with vertebral compression fractures (VCF). Both have been reported to have multiple complications which, though rare, are potentially devastating. This literature review focuses on comparing the incidence of various types of complication of VP and KP. Local cement leakage and pulmonary cement embolism have been reported more commonly after VP than KP. It is questionable whether the relative risk of developing an adjacent level new fracture after VP is greater than after KP The relationship between a new VCF and each of these procedures has also not been clearly established. Although the majority of complications are clinically silent, their potential risks, which include a fatal outcome, should always be kept in mind by the practitioner.

**Key words:** Kyphoplasty; Osteoporosis; Spinal fractures; Vertebroplasty

As life expectancy has increased, osteoporotic fractures are more often seen, most frequently in the proximal femur and the vertebral column. Vertebroplasty (VP) and kyphoplasty (KP) are well-established techniques that have been reported to provide significant pain relief and sagittal alignment restoration of vertebrae in patients with painful vertebral compression fractures (VCFs) related to osteoporosis, multiple myeloma, hemangioma, or metastases.

The most popular two mini-invasive procedures for VCF, VP and KP, differ technically. VP involves percutaneous injection of viscous polymethyl methacrylate (PMMA) into the affected vertebral body A certain pressure is necessary to ensure that the cement fills all porosities of the fracture. With KP, a balloon is inserted percutaneously into the fractured vertebral body and inflated to create a cavity. The balloon is then deflated and removed, and PMMA is injected into the cavity.

While complications related to treatment of vertebral compression fractures are rare, they are potentially devastating[1]. VP and KP, which have been proven equally effective in achieving pain relief in patients with VCF; have both been reported to have multiple complications[2,3]. No statistical difference between VP and KP has been shown in the incidence of some general complications, including myocardial infarction, pulmonary air embolism, hematoma, rib fracture, infection, change in blood pressure or heart rate, pneumonia and hypoxia. All of these are more strongly correlated with multiple comorbidities and generalized osteoporosis than the technical differences between the two procedures[4]. This literature review focuses on the complications of VP and KP that differ in frequency of occurrence.

**Address for correspondence** Ji-dong Zhang, MD, Department of Spine Surgery, Tianjin Hospital, 406 Jiefang South Road, Hexi District, Tianjin, China, 300211 Tel: 0086-13652090295; Fax: 0086-022-28334734; Email: bird0496@sina.com

Received 3 April 2011; accepted 1 May 2011
DOI: 10.1111/j.1757-7861.2011.00141.x

## Local cement leakage with or without symptoms

Local cement leakage is the most commonly encountered complication of VP or KP. Perivertebral soft tissue leakage, extravasation, vascular migration and even one case of intradural leakage of cement have been reported[5]. Most leakages are asymptomatic; however, in some cases radiculopathy or even serious spinal cord compression has developed, necessitating emergency surgical intervention. It is commonly accepted that local cement leakage occurs much more frequently after VP than after KP[6,7]. A substantially higher incidence of cement leakage has been reported with VP (40%) than with balloon KP (8%)[8]. Another author has reported that follow-up with CT scans showed the rate of local leakage of bone cement was 87.5% (21/24) for VP and 49.2% (29/59) for KP[9]. After VP, the commonest site of local leakage was perivertebral soft tissues (n = 8, 38.1%). After KP, the commonest site of local leakage was a perivertebral vein (n = 7, 24.1%)[9].

The advantages of KP over VP include better kyphosis correction and diminished risk of cement extravasation.

Published articles describe cement leakage causing neurological injury mainly after the VP procedure. Up until August 2010, only a few case reports had described cement leakage after KP, and this had not resulted in neurological injury. However in August 2010, a report was published that presented two cases of osteoporotic VCF treated with KP in which cement leakage developed and caused significant neurological injury. In both cases a CT scan showed the leakage was due to violation of the medial pedicle wall[10].

The higher rate of cement leakage after VP can be explained by the following considerations: (i) because the cement injected during VP is in a less viscous form than that used for KP, it flows and fills the fracture gap more readily; (ii) during KP, because a cavity is first created in the affected vertebral body with an inflatable balloon, the cement can be injected directly into that cavity under a lower pressure than is required for VP; (iii) it is believed that impaction of trabecular bone against the surrounding cortical bone, which occurs more commonly with KP, reduces the risk of cement penetrating the cortex.

## Pulmonary cement embolism

To date, pulmonary cement embolism after VP or KP has been described in about 13 cases, 3 of which were fatal[11]. Gangi *et al*. reported a frequency of symptomatic PMMA embolism of 1.1% following VP[12], whereas leakage of PMMA into the perivertebral venous system was found to occur in 16.6% of KP-treated patients[13]. Because patients do not routinely undergo chest radiography after the procedure, and in any case the diagnosis would be not be made in some asymptomatic patients even with routine chest radiography, the true incidence of PMMA pulmonary cement emboli is unknown. With CT examination, Yeom *et al*. found that vertebroplasty material escapes into the paravertebral veins in more than 80% of cases, and that this cannot be verified by conventional radiographs[14].

Three mechanisms appear to be the major determinants of cement embolism: (i) insufficient polymerization of PMMA at the time of injection allows its migration into the inferior vena cava; (ii) variations in needle position with respect to the basivertebral veins; and (iii) overfilling of the vertebral body can facilitate cement migration into the venous system[15].

Although the mechanism for local cement leakage is similar, pulmonary cement embolism has been reported more commonly after VP than after KP. Because of the scarcity of reported cases, whether this difference in incidence is statistically significant is not known. According to a systematic meta-analysis of published reports, the prevalence of pulmonary embolus was 33 of 3601 (0.9%) for VP versus 2 of 565 (0.4%) for KP, this difference did not reach statistical significance[4].

Given the widespread acceptance and application of VP, as well as the evolution of newer techniques such as KP, the frequency of symptomatic pulmonary cement emboli may increase in the clinical setting. The clinician should be aware of this rare complication and include it in the differential diagnosis of acute chest pain and respiratory symptoms after these procedures.

## Adjacent level new fractures

Trout *et al*. reported that the relative risk of developing a new VCF at a level adjacent to a VP level is 4.62 times greater than at a nonadjacent level[16]. It is still controversial whether adjacent level compression fractures after VP or KP are a consequence of rigidity caused by augmentation with bone cement or simply due to the natural progression of osteoporosis. Studies of the natural history of VCF have reported a four times greater risk of developing additional VCFs after the initial one than in patients without VCF[17]. Movrin *et al*. compared the incidence of adjacent level fractures in VP and KP[18]. They found quite a low risk for this complication and no difference between the procedures. The most important factors affecting the incidence of new VCFs after a percutaneous augmentation procedure are the degree of osteoporosis and altered biomechanics in the treated area of the spine due to resistant kyphosis. However, in a meta-analysis of published reports, Jason *et al*. found that the risk of a new VCF was significantly greater after VP than after KP[4]. This is likely related to the increased risk of cement extravasations associated with VP. Komemushi *et al*. determined the only independent variable associated with VCF was cement leakage into the intervertebral disc[19]. Other variables, including age, sex, bone mineral density, number of procedures, number of vertebrae treated, amount of cement injected, and cement leakage into the soft tissues or veins did not increase the risk of new VCF. Meanwhile, Kim *et al*. found a correlation between increased risk of new VCF at the adjacent level and increased height restoration after VP[20]. Based on this finding, new VCFs would be expected more commonly after KP because of the superior height restoration achieved with that procedure[21]. This expectation is supported by the results of Fribourg *et al*.[22]

In conclusion, both VP and KP are relatively safe but are still associated with multiple complications. However, the frequency of these complications may increase because of the widespread use of percutaneous VP and KP for osteoporotic compression fractures. The incidence of certain complications differs accordingly to the different techniques adopted in VP and KP. Local cement leakage

and pulmonary cement embolism have been reported more commonly after VP than after KP. It is uncertain whether the relative risk of developing an adjacent level new fracture after VP is greater than after KP; even the relationship between a new VCF and these procedures is controversial. Although the majority of complications are clinically silent, their potential risks, which include death, should always be kept in mind by the practitioner. An understanding of the causes, prevention, identification, and management of complications when they occur will serve to improve patient care and reduce morbidity.

## Disclosure

No benefits of any type have been, or will be, received from a commercial party related directly or indirectly to the subject of this manuscript.

## References


1. François K, Taeymans Y, Poffyn B, *et al*. Successful management of a large pulmonary cement embolus after percutaneous vertebroplasty: a case report. Spine, 2003, 28: E424–E425.
2. Kumar K, Nguyen R, Bishop S. A comparative analysis of the results of vertebroplasty and kyphoplasty in osteoporotic vertebral compression fractures. Neurosurgery, 2010, 67 (3 Suppl Operative):171–188.
3. Röllinghoff M, Siewe J, Zarghooni K, *et al*. Effectiveness, security and height restoration on fresh compression fractures—a comparative prospective study of vertebroplasty and kyphoplasty. Minim Invasive Neurosurg, 2009, 52: 233–237.
4. Eck JC, Nachtigall D, Humphreys SC, *et al*. Comparison of vertebroplasty and balloon kyphoplasty for treatment of vertebral compression fractures: a meta-analysis of the literature. Spine J, 2008, 8: 488–497.
5. Chen YJ, Tan TS, Chen WH, *et al*. Intradural cement leakage: a devastatingly rare complication of vertebroplasty. Spine, 2006, 31: E379–E382.
6. Schofer MD, Efe T, Timmesfeld N, *et al*. Comparison of kyphoplasty and vertebroplasty in the treatment of fresh vertebral compression fractures. Arch Orthop Trauma Surg, 2009, 129: 1391–1399.
7. Lee MJ, Dumonski M, Cahill P, *et al*. Percutaneous treatment of vertebral compression fractures: a meta-analysis of complications. Spine, 2009, 34: 1228–1232.
8. Taylor RS, Taylor RJ, Fritzell P. Balloon kyphoplasty and vertebroplasty for vertebral compression fractures: a comparative systematic review of efficacy and safety. Spine, 2006, 31: 2747–2755.
9. Lee IJ, Choi AL, Yie MY, *et al*. CT evaluation of local leakage of bone cement after percutaneous kyphoplasty and vertebroplasty. Acta Radiol, 2010, 51: 649–654.
10. Park SY, Modi HN, Suh SW, *et al*. Epidural cement leakage through pedicle violation after balloon kyphoplasty causing paraparesis in osteoporotic vertebral compression fractures—a report of two cases. J Orthop Surg Res, 2010, 5: 54.
11. Abdul-Jalil Y, Bartels J, Alberti O, *et al*. Delayed presentation of pulmonary polymethylmethacrylate emboli after percutaneous vertebroplasty. Spine, 2007, 32: E589–E593.
12. Gangi A, Dietmann JL, Guth S, *et al*. Computed tomography (CT) and fluoroscopy-guided vertebroplasty: result and complications in 187 patients. Semin Intervent Radiol, 1999, 16: 137–142.
13. Vasconcelos C, Gailloud P, Beauchamp NJ, *et al*. Is percutaneous vertebroplasty without pretreatment venography safe? Evaluation of 205 consecutive procedures. AJNR Am J Neuroradiol, 2002, 23: 913–917.
14. Yeom JS, Kim WJ, Choy WS, *et al*. Leakage of cement in percutaneous transpedicular vertebroplasty for painful osteoporotic compression fractures. J Bone Joint Surg Br, 2003, 85: 83–89.
15. Tozzi P, Abdelmoumene Y, Corno AF, *et al*. Management of pulmonary embolism during acrylic vertebroplasty. Ann Thorac Surg, 2002, 74: 1706–1708.
16. Trout AT, Kallmes DF, Kaufmann TJ. New fractures after vertebroplasty: adjacent fractures occur significantly sooner. AJNR Am J Neuroradiol, 2006, 27: 217–223.
17. Klotzbuecher CM, Ross PD, Landsman PB, *et al*. Patients with prior fractures have an increased risk of future fractures: a summary of the literature and statistical synthesis. J Bone Miner Res, 2000, 15: 721–739.
18. Movrin I, Vengust R, Komadina R. Adjacent vertebral fractures after percutaneous vertebral augmentation of osteoporotic vertebral compression fracture: a comparison of balloon kyphoplasty and vertebroplasty. Arch Orthop Trauma Surg, 2010, 130: 1157–1166.
19. Komemushi A, Tanigawa N, Kariya S, *et al*. Percutaneous vertebroplasty for osteoporotic compression fracture: multivariate study of predictors of new vertebral body fracture. Cardiovasc Intervent Radiol, 2006, 29: 580–585.
20. Kim SH, Kang HS, Choi JA, *et al*. Risk factors of new compression fractures in adjacent vertebrae after percutaneous vertebroplasty. Acta Radiol, 2004, 45: 440–445.
21. Shindle MK, Gardner MJ, Koob J, *et al*. Vertebral height restoration in osteoporotic compression fractures: kyphoplasty balloon tamp is superior to postural correction alone. Osteoporos Int, 2006, 17: 1815–1819.
22. Fribourg D, Tang C, Sra P, *et al*. Incidence of subsequent vertebral fracture after kyphoplasty. Spine, 2004, 29: 2270–2277.