

Percutaneous kyphoplasty combined with the posterior screw-rod system in treatment of osteoporotic thoracolumbar fractures

Jiang Wu, Yong-Qing Xu, Han-Fen Chen, Yong-Yue Su, Min Zhu, Chong-Tao Zhu

ABSTRACT

Background: The osteoporotic vertebral compression fractures (OVCF) have attracted more and more attention due to increase in life span globally and aging population. Percutaneous vertebroplasty (PVP) and percutaneous kyphoplasty (PKP) have been popularized rapidly by virtue of their unique advantage in minimal invasiveness. We analysed our results in osteoporotic thoracolumbar fractures using percutaneous kyphoplasty and posterior screw rod system. To investigate the possibility of treatment of rupture of the posterior vertebral osteoporotic fractures by means of kyphoplasty combined with the posterior screw-rod system.

Materials and Methods: Twenty six patients (65 years of age or older) with the single spine fractures included in study. The preoperative bone mineral density was measured by dual-energy X-ray. The PKP was done in all the cases. Decompression was done if neurological symptoms were present.

Results: The results demonstrated osteoporosis with BMD T value ≤ -2.5 ; injured posterior vertebral body (3 cases) had shown the whole damage accompanied by neurological symptoms through X-ray or CT. After 2 days, the remaining patients of back pain symptoms were relieved or disappeared except for three cases of patients with decompression incision. VAS score and Cobb angle changed from preoperative 8.23 ± 0.17 and $28.7 \pm 0.33^\circ$ respectively to postoperative 3.77 ± 0.44 and $3.8 \pm 0.2^\circ$ respectively.

Conclusion: Treatment of rupture of the posterior vertebral osteoporotic thoracolumbar fractures by means of kyphoplasty combined with posterior screw-rod system is a safe, effective procedure.

Key words: Kyphoplasty, osteoporotic fractures, thoracolumbar fractures, screw rod system

INTRODUCTION

The osteoporotic vertebral compression fractures (OVCF) have attracted more and more attention due to increase in life span globally and aging population.¹⁻⁵ Vertebroplasty has gained popularity during the past few years for the treatment of osteoporotic compression fractures.⁶⁻⁹ Several reports document its usefulness in addressing pain and prevention of further

collapse and preservation of posture.⁶⁻⁹ Meanwhile, osteoporotic spinal fractures have shown an increasing trend in incidence. The decrease in bone mass density (BMD) always leads to an internal fixation failure for older people. These compression fractures or senile burst fractures are important part of OVCFs on health care systems which can not be ignored. What's more important is that spinal fracture treatment for older people has special requirements: the surgical injury should be as little as possible, and the patients can get out of bed as early as possible. For these requirements, percutaneous vertebroplasty (PVP) and percutaneous kyphoplasty (PKP) have been popularized rapidly by virtue of their unique advantage in minimal invasiveness.^{2,6-9} Although PVP and PKP have similar analgetic mechanisms, the possible mechanisms are 1) the mechanical action after bone cement infusion causes local vascular occlusion; 2) bone cement monomers have cytotoxicity, which injure the pain nerve endings; 3) the thermal effect of bone cement damages the sensory nerve endings in the diseased vertebra; 4) bone cement shoulders a quite portion of the axial stress, which reduces the stimuli on the intrapyramidal nerves; and 5) bone cement infusion gets the vertebral body microfractures fixed and

Orthopedic Center, Kunming General Hospital of Chengdu Military Command, Kunming - 650 032, China

Address for correspondence: Mr. Jiang Wu,
Orthopedic Center, Kunming General Hospital of Chengdu Military Command,
Kunming 650032, China.
E-mail: wjchinacn@yeah.net

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increases the spinal stability. However, bone cement has the drawback of seepage, which further leads to damage to surround vital structures. The posterior wall ruptures of the injured vertebral is a contraindication to the application of bone cement. When such ruptures happen to the old patients with spinal fractures, things will become worse and more complicated. Whether surgical or minimal invasive treatment should be adopted still remains controversial. We analysed our results in osteoporotic thoracolumbar fractures using percutaneous kyphoplasty and posterior screw rod system.

MATERIALS AND METHODS

26 cases of OVCF treated with PKP combined with the posterior screwrod system between August 2006 and January 2011 were included in study. This study was conducted in accordance with the declaration of Helsinki. This study was conducted with approval from the Ethics Committee of Kunming General Hospital of Chengdu Military Command (Protocol Record D5395L00006). Written informed consent was obtained from all the participants. All the cases were single vertebral body fractures. All the patients were above 65 years. There were, 17 males and 9 females. All had history of lumbago after an external injury. The pain of vertebral osteoporotic fractures was due to biomechanical changes. So it was important to restore the spine normal force line, which was key to relieve pain. All the fractures were less than 6 weeks old. The mode of trauma was bicycle fall (n=20) and road traffic accident (n=6). Dual energy X-ray absorptiometry scanning before surgery showed that the T values of their BMDs were no more than -2.5, indicating all of them suffered from osteoporosis. The routine, X-ray and/or CT scanning showed that posterior vertebral walls were injured. Three cases had neurological involvement (obvious decrease in unilateral limb muscle strength). Metastatic fractures or multiple myeloma were ruled out in this study.

Operative procedure

The patient was taken in prone position under general anesthesia and image intensifier. According to the presence or absence of the neurological symptom, open decompression and reduction PKP or percutaneous reduction PKP were decided.

For patients with the neurological symptom, midline posterior incision centered on injured vertebra was made and the injured vertebra and the superior and inferior vertebral articular processes exposed. Four pedicle screws were inserted, laminectomy and decompression was done, indirect reduction and PKP was performed according to the standard PKP procedures. A low viscous cement injection

technique was used. If there was an accompanied vertebral arch pedicle injury, the nerve roots were decompressed at the injured pedicle, and only unilateral puncture was performed (on the integral side of the pedicle if possible). The intertransverse graft between the transverse processes was placed. The incision was closed in layers.

For patients without the neurological symptom, a 1 cm incision was, respectively, made at the superior and inferior vertebral arch pedicles of the injured vertebra. Four screws were screwed in with the help of PKP tools, and subcutaneous rod threading was then performed for reduction. If the vertebral arch pedicle of the injured vertebra was spared, the rods would be withdrawn. After bilateral PKP on the injured vertebra was performed, the incisions were closed in 11 patients, the screws and rods were taken out directly after reduction, and PKP was then performed. The screw holes were stuffed with gelatin sponge. During surgery, the bone cement pushrod was pushed to the 1/3 site of the anterior vertebral body. Bone cement in the doughy phase was infused. The infusion was terminated when the cement arrived at the 1/5 site to the posterior wall of the vertebral body.

All the percutaneous reduction PKP patients got out of bed 24 h later after surgery the open decompression and reduction PKP patients had to stay in bed for 2 months. The X-ray (anteroposterior and lateral view) were done and antiosteoporosis treatment was started. Comparisons before and after surgery were made using the Cobb angle and visual analogue scale (0-10, VAS).

RESULTS

Only single fractures without any other complications were observed. Cement seepage occurred in five cases, including one at the superior vertebral lamina, one at the inferior vertebral lamina, two at the anterior border, and one at the para vertebra. No clinical symptoms were found. As shown in Table 1, at day 2 after surgery, lumbago in all the patients (rather than those open decompression patients) was obviously relieved or even disappeared. The VAS score was decreased to 3.77 ± 0.44 from the preoperative 8.23 ± 0.17 . The anterior border height of the vertebral body showed improvement after surgery. The Cobb angle was corrected to $3.8 \pm 0.2^\circ$ from the preoperative $28.7 \pm 0.33^\circ$. At 2 months after the surgery, lumbago gradually reappeared in 4 patients out of 12 who received treatment comparatively

Table 1: VAS score and Cobb angle (n=26, X \pm S)

Group	VAS score	Cobb angle
Preoperative	8.23 ± 0.17	$(8.7 \pm 0.33)^\circ$
Postoperative	3.77 ± 0.44	$(3.8 \pm 0.2)^\circ \Delta$

$\Delta P < 0.05$, vs. control group

earlier. Although such a symptom could be slightly relieved after rest, it progressively aggravated at 6 months. After the screws and rods were taken out, the symptom of the active pain disappeared. Therefore, considering that this symptom might be caused by osteoporotic aggravation and higher relative rigidity of the screws, and after closed reduction the screws and rods were not left behind in the following 11 patients without the neurological symptom. Canal clearance was performed on the three subjects with neurological deficit from the study. Not a similar symptom was found any more among them [Figures 1 and 2].

DISCUSSION

OVCF is a common disease among older people, and

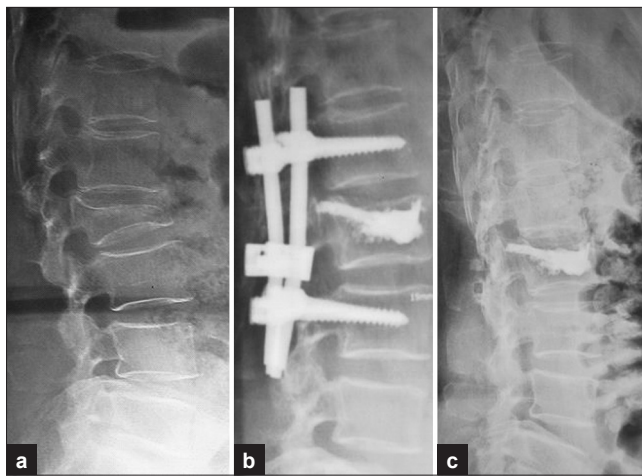


Figure 1: X-ray lateral views of a 72 years old male patient showing (a) L2 compression fracture before surgery (b) after surgery pedicle screw rod system with kyphoplasty (c) 6 months after surgery screws and rods have been removed



Figure 2: X-ray images (lateral view) in a 68 years old male patient (a) preoperative X-ray showing compression fracture L1 vertebra (b) postoperative X-ray after kyphoplasty

most of the cases are subjected to low energy injuries.² Previously, the common treatment method for OVCF was either conservative treatment or posterior screw-rod internal fixation. The conservative treatment in form of long bed rest may lead to more risky complications, like aggravation of the osteoporotic severity, increased nursing burden and cost. Therefore, conservative treatment is not preferred in clinic nowadays.¹⁰ Meanwhile, traditional open surgery always causes great trauma and hemorrhage to which most aged patients are intolerant. Since the first successful application in C2 vertebral hemangioma treatment in the 1980s,¹¹ PVP has been widely applied for in vertebral osteoporosis and tumor treatment. The potential of the technique also offers the possibility to apply localized pressure in the bone and push fragments in a well-controlled manner. However, PVP has a high bone cement seepage rate,¹² which can lead to a fatal complication, i.e., pulmonary embolism (PE). For this, the application of PVP has been limited to a certain degree. PKP is another treatment method following PVP. It takes the advantage of the balloon catheter technique to reposition part of the collapsed vertebral body directly and promote the formation of the intrapyramidal air cavity, which can obviously decrease the risks of bone cement seepage¹³ and PE. Therefore, the application of PKP in OVCF treatment has shown an increasing trend in recent years.¹⁴ But, posterior vertebral wall ruptures are still a generally accepted contraindication to PKP clinical application.

The possible consequences caused by the use of PKP alone for OVCF patients with posterior vertebral wall ruptures may be: 1) the broken posterior vertebral wall causes bone cement to infuse into the spinal canal along the ruptures, which ultimately leads to disastrous effect on the contiguous spinal cord and nerves due to the heat produced during cement solidification; and 2) the stress produced during balloon inflation forces the bone fragments into the spinal canal to compress the nerves. Therefore, PKP must be carefully performed under the condition of an broken posterior vertebral wall.¹⁵ The benefit from screw-rod reduction before bone cement infusion lies in that the posterior longitudinal ligament can be propped open to enhance the strength of the posterior wall by letting the retro pulsed bony fragment fall in its place.¹⁶ A short-segment fixation was performed in these cases in order to reset the fractures which was easy to cause active pain. Therefore, for OVCF patients with posterior vertebral wall ruptures, screw-rod reduction before PKP is a better option. In the current study, in order to prevent too fast flow speed of liquid bone cement under a high pressure and to better control the penetration speed, cement in the doughy phase was infused rather than that in the drawing-off phase. Furthermore, for the sake of safety from the bone cement delayed effect, the infusion was terminated when the

cement arrived at the 1/5 site in the vertebral body to the posterior wall. The duration of followup and the average followup were 6 month or less.

Bone cement infusion can achieve the goals of analgesia as well as internal fixation at the same time. However, as the sclerotin of older osteoporotic patients cannot hold the internally fixated screws tightly, the screws are apt to cut the sclerotin leading to screw loosening and shedding-off. The pain of vertebral osteoporotic fractures disappeared immediately after the removal of implant. This can be used to explain the active pain cases at 2 months after surgery in the current study. Such symptom disappeared after the screws were taken out. As the purpose of screw used in the current study was for intraoperative reposition, of retro pulsed fragment by indirect reduction the screws could be taken out when such purpose was achieved. However, whether delayed fractures will happen to the vertebral body due to sclerotin injuries after screw withdrawing and whether there is a need to infuse a small amount of bone cement to prevent such an injury, still remains to be explored.

As this technique is a mature one, it has been confirmed that some biomechanical/cadaveric studies were conducted before the clinical use of the technique. Meanwhile, although the balloon involved in the PKP technique has a certain role in reduction, more and more scholars and clinical experts point out that PKP cannot achieve a satisfactory reduction effect on a compression of more than 80%, based on which some physicians adopt PKP combined with postural reduction.^{17,18} In the current study, the results show that PKP combined with the screw-rod system can achieve a better effect than PKP alone. Even for osteoporotic fractured vertebral bodies with an integral posterior wall, PKP combined with minimally invasive screw-rod reduction will be safer and more effective in treating osteoporotic fractures with a vertebral compression of above 2/3 than PKP combined with postural reduction. As long as experienced doctors control the needle position better and grasp the bone cement viscosity, PKP combined with the posterior screw-rod system would be applied more and more widely.

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