Paraparesis due to refracture of a previously cemented vertebra and new fracture of the adjacent vertebra after kyphoplasty for an osteopenic thoracolumbar burst fracture: a case report

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Although adjacent-level fracture is a well-known complication after vertebroplasty (VP) or kyphoplasty (KP), refracture of a cemented vertebra is a relatively rare complication. Moreover, it is very uncommon for 2 fractures to occur in a single patient, and exceptionally rare for refracture to cause spinal cord (SC) compression or neurological deficits. We report a case of paraparesis due to refracture of a cemented vertebra and a new fracture of an adjacent vertebra after KP. An 80-year-old woman underwent KP for an osteopenic burst fracture at T12 with an intravertebral vacuum cleft (IVC). Six weeks post-KP, the patient presented with pain and paraparesis. Imaging studies revealed refracture at T12 and a new compression fracture at T11. The SC was severely compressed by the fracture fragment. The patient underwent anterior corpectomy of T12, removal of bone cement and fracture fragment, anterior interbody fusion, and pedicle screw fixation. In the present case, it is thought that an uneven distribution of bone cement with a solid lump pattern and excessive restoration of vertebral body height and kyphotic angle might have increased the risk of refracture of the cemented vertebra. These points should be avoided during VP or KP, especially when an IVC is present.

Keywords: Fractures; Vertebroplasty; Kyphoplasty; Osteonecrosis

Case Report

An 80-year-old woman with diabetes mellitus, hypertension, and cognitive impairment presented with back pain for 2 weeks. The pain began after falling on her buttocks and gradually worsened.
The patient could not sit or walk for a long time because of severe pain. On neurological examination, no abnormal findings were found. The patient underwent total knee arthroplasty on both knees for degenerative arthritis 2 years ago and posterior lumbar interbody fusion at L4–L5 for lumbar spinal stenosis a year ago.

On the lateral view of plain X-ray, anterior wedging of T12 vertebral body (VB) was observed and anterior VB compression percentage was about 39% and kyphotic angle by Cobb’s method was about 23° [9,10,12] (Fig. 1). Computed tomography (CT) scan, and magnetic resonance imaging (MRI) showed recent burst fracture with intravertebral cleft (IVC) or osteonecrosis at T12 (Fig. 1). On bone densitometry test, T-score of the left femur neck, the left femur total, and L1, L2, L3 were –2.1, –1.6, and –0.8, respectively.

Unilateral percutaneous balloon KP was performed and 7 mL of polymethylmethacrylate bone cement was filled. Postoperative anterior VB compression percentage was about 19% and kyphotic angle by Cobb’s method was about 18° (Fig. 1). Bone cement was distributed relatively evenly from side to side in the X-ray anteroposterior view. But bone cement was filled mainly in the anterior portion of VB and was distributed solid lump pattern without interlocking with surrounding cancellous bone [9,12,13]. Bone cement was not filled in the upper portion of the VB near the upper endplate of T12 (Fig. 1). Within one day after the KP, the patient’s pain alleviated and the patient was able to sit and walk without much discomfort. The patient was discharged on the 4th day after the KP.

Six weeks after the KP, the patient came to the hospital in a wheelchair and presented with worsening pain in the back, inguinal area, and lower extremities (LEs), and progressive weakness in the LEs. The pain and weakness of LEs began 1 week ago without a history of significant trauma. Neurological examination revealed muscle strength of the LEs as 2/5 bilaterally and the patient could not stand and walk alone. Plain X-ray showed reframe at T12 and new fracture at T11 near the inferior endplate of T11 (Fig. 2). CT scan and MRI showed a new compression fracture at T11 and an aggravated burst fracture at T12 with fracture fragment severely compressing the SC (Fig. 2). Anterior corpectomy of T12, removal of bone cement and fracture fragment, anterior interbody fusion with expandable cage filled with artificial bone chip, pedicle screw fixation at T10, T11, L1, and L2, and cross-link fixation were performed (Fig. 2). After the surgery, the pain was reduced and the muscle strength of the LEs was slightly recovered compared to the preoperative period. But the patient was still under analgesics for daily living. The patient could barely stand for a short time with the help of others, but could not walk even with help or support at 6-month-follow-up.

Discussion

Although it remains controversial as to whether VP or KP increas-
es new vertebral fractures adjacent to the treated level or refractures at the treated level, recurrent fracture is one of the complications that can occur after VP or KP [1,5]. The incidence of refractures of the cemented vertebrae is reported in a wide range by studies [6–12]. Chen et al. [6] reported the incidence of refracture of the cemented vertebrae after VP was 0.5% (10/1,820 VCFs). Heo et al. [7] reported the incidence was 2.6% (11/423 VCFs). Lin et al. [11] reported the incidence was 63.3% (62/98 patients), but their definition of refracture was more than 1mm reduction of anterior VB height between post-VP and follow-up. However, it is very rare that both refracture of the previously cemented vertebra and new fracture of the adjacent vertebra after VP or KP occur in one patient, as in the present case. In the report of Kang et al. [9], 27 of the 60 patients who received VP developed recurrent fractures, and only 2 of these 27 patients had both refracture of the previously cemented vertebra and new fracture of the adjacent vertebra.

Even if refractures of the previously treated vertebrae occur, it has been reported that it usually occurs without a history of trauma, and is rarely accompanied by compression of the SC [6,7]. In the report of Chen et al. [6] and Heo et al. [7], refracture of the cemented vertebrae occurred in 10 of 1,820 patients and 11 of 343 patients with osteoporotic VCFs treated with VP, respectively. But there was no history of trauma before refracture or recurrent pain and no SC compression due to refracture was accompanied [6,7]. However, in the present case, refracture resulted in severe SC compression and catastrophic neurological deficits. Although the authors could not estimate the exact cause, the patient had dementia and the possibility that the patient could not remember the history of minor or significant trauma could not be ruled out.

Several factors such as bone cement distribution within the fractured VB, IVC or osteonecrosis, anterior VB height restoration, and kyphotic angle correction have been suggested as risk factors for refracture of the cemented vertebrae after VP or KP [6–16]. Bone cement distribution in the VB after VP or KP affects the rate of refracture of the cemented vertebrae [9,10,12–15]. Hou et al. [14] reported the refracture rate of the cemented vertebrae after VP was significantly lower when more bone cement was in the middle portion of the VB or in contact with both upper and lower endplates in their retrospective study. Lv et al. [15] reported the refracture rate of the cemented vertebrae after KP was significantly higher when the bone cement formed compact masses than formed spongiform dispersive masses. He et al. [13] reported the refracture rate of the cemented vertebrae after VP was significantly lower when bone cement was distributed sponge-like pattern but contiguous internal filling within the VB or when bone cement was interlocked with the surrounding cancellous bone even though bone cement formed compact and solid mass.

IVC is a sign of avascular necrosis of the VB, and the substances in the IVC area are composed of necrotic cancellous bone, hyaline cartilage with fractured callus, and fluid collections, all of which were associated with underlying avascular necrosis [16]. Yu et al. [16] reported refracture rate was significantly higher in patients with IVC, especially in those with IVCs in the inferior endplate in their retrospective review of 594 patients who underwent VP to treat osteoporotic VCFs. They argued that the presence of preoperative IVC had a great effect on bone cement distribution pattern [16]. When the IVC was present within the fractured VB, injected bone cement was mainly filled with solid lump pattern into the

Fig. 2. Imaging studies of the thoracolumbar spine 6 weeks after kyphoplasty. (A) A plain lateral X-ray shows refracture of T12 and new fracture of T11. (B, C) A sagittal image of a computed tomography scan (B) and magnetic resonance imaging (C) show a new compression fracture at T11 (arrow) and an aggravated burst fracture at T12, with the fracture fragment severely compressing the spinal cord (arrowhead). (D) A postoperative plain lateral X-ray shows an interbody cage in the corpectomy site, pedicle screws at T10, T11, L1, and L2, and cross-linking.

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IVC area [16]. And bone cement with solid lump pattern could act to concentrate stress on the surrounding fragile cancellous bones [16]. Especially when IVC was in the inferior endplate, bone cement was mainly filled into the inferior aspect of the VB but the space located in the superior aspect of the VB was not sometimes fully filled with bone cement [16]. In the biomechanical studies, it was demonstrated that the stress was higher in the superior aspect of the affected VB than in the inferior aspect [16]. Thus, refracture of the cemented vertebrae can occur more easily when the bone cement is filled into the inferior aspect of the VB with solid lump pattern [16].

In the present case, bone cement was mainly filled in the antero-inferior portion of the fractured VB and was not in contact with the upper endplate. The bone cement within the VB formed a solid and compact lump or mass and was not interlocked with the surrounding cancellous bone. These points were thought to have increased the risk of refracture of the cemented vertebra. The external force applied during the physiologic loading or minor trauma might cause hard anterior portion of the VB filled with bone cement with solid lump to exert a force on weak posterior part of the VB that was not filled with bone cement. And the weak posterior part of VB was pushed back by this force or stress, causing SC compression and resultant paraparesis.

More anterior VB height reduction rate (RR) and larger reduction angle (RA) were considered to be another risk factor for refracture of the cemented vertebrae [6,7,11,12]. Too much restoration of VB height or kyphotic angle might cause increased stress on surrounding paravertebral soft tissue which then led to increased mechanical loading on the cemented vertebrae or more instability in the fractured VB [4]. Consequently, refracture of the cemented vertebrae is more likely to occur with a greater degree of VB height restoration or kyphotic angle reduction [12]. Yu et al. [12] suggested the risk score for recollapse of the augmented vertebrae after VP in osteoporotic VCFs: preoperative IVC was assigned 1 point, solid lump cement distribution pattern 1 point, more than 7% for anterior VB height RR 1 point, and more than 3° for RA 1 point. In their retrospective study, the risk score for recollapse showed high predictability of recollapse, with incidence rates of 10% for those with a score of 0 and 87.5% for those with a score of 4 [12]. They argued when the risk score for recollapse is 3 or 4, careful observation is needed to prevent deterioration of patients’ clinical course [12].

In the present case, there were preoperative IVC, solid lump cement distribution pattern, about 20% for anterior VB height RR, and about 5° for RA. According to the risk score for recollapse mentioned above, the risk score was 4 and the incidence rate of recollapse was 87.5%. Considering these points, the patient should have been followed up more frequently in order to detect recurrent fracture.

To reduce the risk of refracture of the cemented vertebrae, Yu et al. [12] suggested the target puncture technique. Especially when there is IVC, the needle tip is placed at the cancellous bone around the IVC, not in the IVC area. Bone cement should be infiltrated from peripheral cancellous bone into the IVC area and should be in contact with both upper and lower endplate. By this method, the injected bone cement can be integrated or interlocked with peripheral cancellous bone around the IVC and can be distributed with diffuse pattern [12]. Zhang et al. [17] suggested a second puncture and injection technique to prevent refracture of the cemented vertebrae. If bone cement is not filled below the upper endplate or above the lower endplate on the C-arm fluoroscopy, the needle is pulled out to the midportion of the pedicle immediately. Then the puncture angle is adjusted, the needle is advanced to near the endplate where bone cement is not filled, and then bone cement is injected. By this method bone cement is fully distributed in the VB, especially between the upper and lower endplates and this can reduce the risk of refracture of the cemented vertebrae [17].

In the present case, although the tip of the VP needle was positioned above the IVC area, bone cement was not filled in the upper portion of the VB near the upper endplate. But no additional attempts were made to fill the upper or middle part of VB with bone cement, which was believed to have increased the risk of refracture of the cemented vertebra.

**Conclusion**

To reduce the risk of refractures of the cemented vertebrae and resultant catastrophic neurological deficit, bone cement should be distributed diffusely within the VB and in contact with both upper and lower endplate during VP or KP, especially when IVC is present within the fractured VB. And excessive VB height reduction and excessive correction of kyphotic angle should be avoided. In addition to these technical considerations related to VP or KP, when the risk score of recollapse is high, more careful clinical and radiological follow-up is necessary.

**Conflicts of interest**

No potential conflict of interest relevant to this article was reported.
References


