Asymptomatic Bone Cement Leakage into Inferior Vena Cava during Cement Augmentation of Pedicle Screw for Osteoporotic Vertebral Collapse

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ABSTRACT

Bone cement augmentation of pedicle screw is an important surgical procedure for osteoporotic vertebral collapse, preventing screw loosening, migration or back-out. Bone cement leakage may develop and mostly does not compress the peripheral tissue of the vertebral body including the spinal cord. However, to our best knowledge, bone cement leakage into the inferior vena cava during cement augmentation of pedicle screws for osteoporotic vertebral collapse has been not reported in the literature. We reported an 84-year-old male with asymptomatic cement leakage into inferior vena cava during this procedure and the possible pathophysiological mechanism was also discussed.

Keywords: bone cement, inferior vena cava, osteoporotic vertebral collapse, vertebral augmentation, spine surgery

INTRODUCTION

Osteoporotic vertebral compression fracture (OVCF) occurs frequently in the elderly, and the majority with back pain improve by conservative treatment or vertebral augmentation procedures such as vertebroplasty or kyphoplasty [1]. Osteoporotic vertebral collapse (OVC), continuous pain or neurological deficits secondary to progressive bone displacement or kyphotic spinal stenosis, is uncommon, approximately about 3% of OVCF [2, 3]. Because of the neurological deficits related to OVC, many surgical procedures are described to decompress the nerve and stabilize the spinal column, such as anterior corpectomy with spinal fusion, posterior decompression with spinal fusion, posterior vertebral augmentation with short segmental fusion, or the combination of anterior and posterior fusion [1]. However, the complications of...
cement leakage, including pulmonary embolism, nerve compression, acute stroke or inferior vena cava syndrome, are mostly reported during the vertebroplasty or kyphoplasty for the painful OVCF [4]. To our best knowledge, the cement leakage during the cement augmentation of pedicle screws is rarely discussed in the literature, especially involving the inferior vena cava [5]. Here, a case of asymptomatic cement leakage into the inferior vena cava during cement augmentation of pedicle screws for OVC was reported and the possible pathophysiological mechanism was also discussed.

**CASE REPORT**

An 84-year-old male presented with a 2-month history of lower back pain after a fall. The acute OVCF in L5 level was diagnosed with magnetic resonance image (MRI) at a local clinic (Fig. 1A) and conservative treatment with painkillers and back bracing was administrated. However, progressive weakness developed in the bilateral lower limbs and legs pain two weeks before admission. At admission, the physical examination revealed the muscle strength of grade 3 over 5 and a decrease in deep tendon reflexes of bilateral low extremities. Subsequent radiograph revealed a new OVCF in L3 level and progressive OVC at L5 level. Subsequent MRI of the lumbar spine revealed wedge deformity of vertebral body in L3 and L5 level with retropulsed bony fragment causing moderate to severe spinal stenosis (Figure 1B). The bone mineral density test with dual-energy X-ray absorptiometry confirmed the diagnosis of osteoporosis according to the WHO criteria. The patient then underwent posterior laminectomies in L3 and L5 level and posterior instrumentation and fusion to decompress the neural structure and stabilize the spine.

At operation, the patient was placed in a prone posture after general anesthesia. The posterior midline approach was made after sterilized procedures. After total laminectomies in L3 and L5 level, the pedicle screws were inserted via the transpedicular route under the fluoroscopy. Because of the osteoporotic vertebrae, each pedicle screw was augmented with 2ml of polymethylmethacrylate cement (Teknimed, France), according to the Chang’s method [5]. Augmentation of four pedicle screws was performed at the same time by using one pack of cement. After the mixture of cement powder and fluid, 2ml cement was used at 2.5, 5, 7.5 and 10 minutes for the screws in right L1, left L1, right L2, and left L2, respectively. The same procedure was done for right L4, left L4, right S1 and left S1. During the insertion of screws in right L1, L2 and L4 levels following vertebral augmentation,
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the cement leakage into the inferior vena cava via the lumbar segmental veins were clearly revealed by the fluoroscopy (Figure 2).

Post-operation, the patient did not present with any symptoms related to pulmonary embolism or inferior vena cava syndrome. The subsequent computed tomographic (CT) scan revealed that bone cement accumulated significantly in the anterior wall of the inferior vena cava via the right lumbar segmental veins (Figure 3). Because of the asymptomatic cement leakage into the inferior vena cava, antiplatelet therapy was administrated. The post-operative course was uneventful with progressive complete recovery from the profound deficits. At 6-month period of follow-up, the patient still did not present with any symptom related to this vascular complication.

DISCUSSION

OVCF is a common disease in the elderly patients at advanced ages. Most patients with OVCFs present with variable back pain and may experience improvement with conservative treatment such as bed rest, bracing or analgesics [6]. About 30% of OVCF cases present with progressive deformity and 3% develop OVC with associated neurological complications such as intractable back pain, radiating leg pain, motor weakness, or urinary incontinence [2, 6]. Most OVCs occur in the thoracolumbar junction, which is significantly affected with age and the AOSpine Thoracolumbar Spine Injury Classification System [6]. However, low lumbar OVC is uncommon [3]. In a review of 30 patients with low lumbar OVC, Nakajima et al. showed 25 patients (83%) with low lumbar OCV presented with old fractures at the thoracolumbar level and radicular pain originating from foraminal stenosis by retropulsed bony fragments as the main clinical symptom [3]. However, in our case, there was no old fracture at the thoracolumbar level. The pathophysiological mechanism of progressive
OVCF at low lumbar spine and OVC in L5 level remains unclear.

Surgical intervention is the main treatment modality for OVC because of the neurological complication related to the neural structure compression by retropulsed bony fragment [1-3]. Severe surgical procedures are described to manage the OVC, including the anterior spinal fusion, posterior spinal fusion or anterior combined posterior spinal fusion following decompression procedures [1]. However, the osteoporotic vertebra structure is the surgical challenge for advanced elderly patients with OVCs, especially for instrument stabilization [3]. Nakajima et al. reported that 8 patients (26.7%) developed postoperative complications including progressive vertebral collapse and loosening and migration of pedicles screws, which mostly occurred before union of posterolateral fusion [3]. How to prevent complications such as screw loosening, migration or back-out in OVC therefore remains a challenge for surgeons.

In 2008, Chang et al. described a novel technique of polymethylmethacrylate augmentation of pedicle screw for osteoporotic spine surgery [5]. Before screw insertion, 3ml and 2 to 2.5ml of bone cement were injected for lumbar spine and thoracic/sacral spine, respectively. This method significantly prevents the pedicle screws from migrating after PMMA augmentation. However, 26.2% of screws insertion had spotty or linear cement leakage, which contained 68% and 32% cement leakage via the segmental vein and basivertebral vein respectively. There was no significant compression to the peripheral tissue of vertebral body including the spinal cord, and no cement leakage into the inferior vena cava has been described for cement augmentation of these pedicle screws, like in our case.

Vertebroplasty or kyphoplasty is considered as a safe and effective procedure for treating acute painful OVCF [4]. However, cement leakage into the external vertebral venous plexus has been frequently reported [7, 8]. Pulmonary embolization, inferior vena cava syndrome or transient arterial hypotension are severe and devastating vascular complications following these vertebral augmentation procedures [4]. Based on the general venous drainage of spinal anatomy, the four lumbar segmental veins connected between ascending lumbar veins and inferior vena cava in the lumbosacral level. The cement leakage into the inferior vena cava via the perivertebral lumbar segmental vein is the significant predisposing factor to developing pulmonary embolization [7]. The cement viscosity, fracture severity, fracture type, cortical disruption, and the presence of cleft are considered as significantly independent and predicting factors for cement leakage [8, 9]. However, intraosseous venography during vertebral augmentation has been advocated to prevent the bone cement leakage due to 2.2% venograms revealing direct venous drainage without staining the vertebral body [4, 10].

To our best knowledge, cement leakage into the inferior vena cava via the lumbar drainage vein following cement augmentation of pedicle screw for osteoporotic spine surgery has not been reported in the literature. In our case, the procedure of cement augmentation of pedicle screw with a 4mm diameter of bone biopsy needle is similar to Chang’s method [5]. Neither an inflatable bone tamp nor the intraosseous venography was performed before cement injection. Although the intraoperative fluoroscope was used, the cement extravasation into the inferior vena cava
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via the lumbar segmental vein was still revealed when there was no low-pressure preformed cavity. The liquid consistency of the cement also plays an important role in the cement leakage. The more viscous phase may decrease the risk of cement leakage, even involving the inferior vena cava. The ideal relationship between the volume of bone cement and the diameter of pedicle screws remain unclear and should be investigated in further biomechanical studies. In our opinion, intraosseous venography may play an important role in cement augmentation of pedicle screw for OVC, despite the viscous phase and volume of injected cement. Otherwise, multidetector computerized tomography angiography which can delineate the lumbar venous drainage also may provide more pre-operative assessment [11].

When the cement leaks into the inferior vena cava, the patients may develop the associated symptoms based on the degree of occlusion, including dyspnea, arthralgia, myalgia, or progressive leg pain, redness, swelling and weakness [12]. Postoperative chest radiography may reveal the pulmonary cement emboli [13]. However, CT imaging is the gold standard diagnostic modality to detect the cement emboli and the reconstructed CT angiography may provide the severity of occlusion [12]. In general, interdisciplinary management including antiplatelet/anticoagulant therapy, endovascular embolectomy or clinical observation is recommended based on the severity of the devastating vascular complication [4, 7, 14]. Patients presented with asymptomatic or mild dyspnea can be treated with antiplatelet/anticoagulant therapy [13]. However, endovascular embolectomy to retrieval the cement embolic is necessary to solve the fetal symptoms [13, 15].

In conclusion, although cement augmentation of pedicle screw is advocated for OVC, cement leakage into the inferior vena cava via lumbar segmental veins can develop, like in our reported case. Intraosseous venography may provide venous drainage of spine to prevent devastating complication.

REFERENCES


骨質疏鬆性椎體塌陷骨水泥增強椎弓根螺釘置入手術時無症狀性骨水泥滲漏到下腔靜脈

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中文摘要

骨水泥增強椎骨螺釘置入術是治療骨質疏鬆性椎骨塌陷的重要手術過程，主要目的是防止螺釘鬆動、移位或脫出。而手術中骨水泥滲漏是可能發生的，但大部份都不壓迫脊椎椎體周圍組織，包含脊髓。然而，據我們所知，骨質疏鬆性椎體塌陷骨水泥增強椎弓根螺釘置入術時無症狀性骨水泥滲漏到下腔靜脈，在文獻中並沒有報導過。我們報告了一個 84 歲的男性，骨水泥增強椎骨螺釘置入術時，發生無症狀的水泥滲漏到下腔靜脈的個案，並討論了可能的病理生理機制。

關鍵字：骨水泥、下腔靜脈、骨質疏鬆性椎體塌陷、椎體增強手術、脊椎手術

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