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Calcium Phosphate Cement Leakage During Balloon Kyphoplasty Causing Incomplete Paraplegia: Case Report and Review of the Literature

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Abstract

Introduction: Bone cement leakage is the most common, however, it can have potentially disastrous complications during vertebroplasty and balloon kyphoplasty (BK). Polymethylmethacrylate (PMMA) is the most commonly used bone filler, however, calcium phosphate (CP) has been successfully used in spine surgery as a vertebral filler because it is not associated with exothermal reaction and is biologically very close to the vertebral bone. CP leakage during vertebral augmentation is extremely rare.

Case Presentation: A 72-year-old woman with an A2/AO type fracture of L1-vertebra underwent a transpedicular BK at the L1-vertebra with CP plus short segment pedicle screw construct (T12-L2) by minimally invasive surgery (MIS). Continuous neuromonitoring and fluoroscopy were used in this case, although no pathological signs were recorded because of the low radiopacity of CP. Two days later, incomplete paraplegia was presented due to intra and extradural cement leakage. The patient underwent an emergency T12-L2 wide decompression for removal of an epidural leak of CP plus durotomy for intradural CP removal. After removal of the cement, there was improvement of neurologic function. CP leakage should have occurred because of a violation of the medial right pedicle wall by the BK trockar and subsequently CP injection both intra and extradural. Since no direct intraoperative nerve root injury occurred, there was no pathologic sign during intraoperative neuromonitoring.

Conclusions: PMMA leakage is well documented in the literature as a common complication during BK. Calcium phosphate leakage during vertebral augmentation is rare. Furthermore, delayed onset of neurologic deficit due to CP leakage has never been reported in the current literature. Spine surgeons and interventional radiologists should always be aware of this potential disastrous complication.

Keywords: Calcium Phosphate Leakage, Ballon Kyphoplaty, Incomplete Paraplegia, Decompression, Durotomy, MIS Screw Fixation

1. Introduction

Thoracolumbar vertebral compression fractures (VCF) is commonly associated with osteoporosis in female elderly population (1). Percutaneous vertebroplasty (VP) and Balloon Kyphoplasty (BK) with PMMA are MIS techniques in order to reduce and stabilize symptomatic VCF (2). The result of BK and VP with PMMA is immediate pain reduction and vertebral body height restoration. Although, complications related to these procedures are not uncommon (3, 4).

Extravertebral and intracanal PMMA leakage, although usually without sequalae, is the most common complication during VP (4-6) and less commonly during BK (3). However, when intracanal PMMA leakage occurs it can be devastating. PMMA leakage is associated with neurologic impairment because of compression of the intracanal neural elements. Liquid calcium phosphate (CP) has been introduced to replace PMMA because of its low viscosity, compatible, quick-hardened without exothermal reaction, with osteoconductive potential, and low opacity material with almost similar mechanical properties with PMMA.

Recently, MIS pedicle screw fixation techniques have been introduced to stabilize AO type A3 and A2 with significant posttraumatic wedge deformity in addition to BK (7-9).

Our research in the literature did not disclose any case with neurologic impairment following BK with CP. Due to this, we reported on a rare case of accidentally intracanal CP cement leakage associated with paraparesis in a patient with A2/AO fracture of the first lumbar vertebra.

2. Case Presentation

A 72-year-old woman was admitted to our hospital because of pain at the thoracolumbar junction following a fall from her height at home 3 weeks ago. The initial roentgenogram had revealed a compression A1/AO-type fracture of the first lumbar vertebra. She was advised con-

servative treatment with a brace at another institution. The patient was re-admitted because of increased pain. The physical examination revealed no neurologic pathology in the lower extremities. The roentgenograms that were made in our department showed an increased L1 vertebra wedge deformity and osteoporosis. Under general anesthesia, fluoroscopy, and neuromonitoring, L1 percutaneous right side transpedicular BK with liquid CP (Calcibon, Biomet, Wehrheim, Germany) plus MIS pedicle screw fixation T12 to L2 was performed in our institution. Immediately following the CP injection, cannulated 5.5 mm pedicle screws were inserted into both L1 pedicles of the fractured vertebra and subsequently bilaterally into the pedicles of T12 and L2 vertebrae to increase the stability of vertebral augmentation. No pathology was reported by the neurophysiologist during the whole intervention. The patient was mobilized on the same day following surgery without any complaints or neurologic impairment in her lower extremities. As we all know, CP needs more time to become solid due to this, it is recommended that the patient should be mobilized 24 hours or more after the procedure. However, this is not necessary if the construction includes support with screws, both in the same and in adjacent vertebrae. Furthermore, reduction of vertebrae height is not always possible, especially in those cases with delay to the surgical treatment, as in our case. Comparison between preoperative and postoperative segmental kyphosis revealed a correction of 9 degrees (from 15 to 6 degrees) (Figures 1A and B). On day 2, postoperatively, the patient reported an increase in pain in her lower extremities associated with weakness of iliopsoas, quadriceps, foot flexors, and extensors (motor Grade 2/5 in right and Grade 3/5 in left), plus hypoesthesia from L2 downwards in her lower extremities. Lower extremities deep tendon reflexes were absent bilaterally, while no sphincter disturbances were demonstrated. Plain roentgenograms and CT-scan performed in emergency disclosed extravertebral plus intracanal (epidural plus intradural) (Figures 2A and B). CP leaks with simultaneous lateral apposition of both nerve roots. The patient underwent a T12-L2 wide posterior decompression in emergency. There were no adhesions between CP mass and the dural sac, however, much effort was made by the surgeons to carefully remove as much as possible from the epidural bone cement in pieces. Due to the proximity to the conus, some amount of CP, that was stuck in the vertebral body fracture clefts and in the perforation hole from the L1 pedicle, were left in place to avoid further neural damage. Subsequently, a 4 cm long longitudinal durotomy was made to remove the intradural bone cement. There were several adhesions between bone cement mass and the arachnoid matter that were found, which with the use of magnification loops, were cautiously piecemeal removed with the use of fine Kerrison osteotome and pituary rongeurs. The entire operation area was washed with normal saline containing antibiotics and the dural sac was closed with intermitted sutures. Redon drainages were put on the epidural space. The postoperative CT-scan showed sufficient but not complete clearance of bone cement particles (Figure 3). Paraparesis was progressively alleviated in the following 6 weeks after decompression surgery. At the last follow up, 3 years postoperatively, the patient was ambulatory aid with weakness (motor grades 3/5) on the right quadriceps and foot dorsal extensors. No neurologic deficit was found on the left side.

3. Discussion

Percutaneous VP and BK with bone cements are well established and safe percutaneous MIS techniques that are currently used in the treatment of the spinal hemangiomas, osteoporotic fractures, and metastases to the vertebral bodies (1-6).

Although most spine surgeons and interventional radiologists, who are involved with these MIS procedures, are familiar and aware of potential serious complications (lung embolism, peripheral embolism, extracanal, and intracanal leakage etc.) (10) associated with these interventions, physicians rarely face disastrous neurologic complications due to intracanal PMMA leakage. The well established factors that contribute to PMMA leakage are viscosity and amount of injected PMMA cement (2, 11, 12) while others (13), on the basis of experimental studies, postulated that the extravasation cement risk is decreased when the cement viscosity, the bone pore size, the bone permeability, and the bone porosity are increased, and when the diameter of the extravasation path and the viscosity of the marrow are decreased.

BK, that is an advent of VP, has grown in popularity because it has the advantages of kyphosis and vertebral body reduction and diminished risk of cement leakage relative to VP (3, 5, 14). The risk of PMMA leakage in VP has been reported to be 19.7%, while in BK it is remarkably lower by 7.0% (8).

The authors have been using Calcibone in more than 100 cases of vertebral augmentation and have observed no neurological complications (7). Asymptomatic CP leakages have been reported with rates ranging from 0 to 48% (9) with only a single case of temporary intercostal neuralgia reported (15). Non-symptomatic extravertebral (anterior, intradiscal) CP leakages were reported in MIS lumbar hybrids with intermediate screws (fracture level) in 22% (7). In contrast to PMMA leakage, extraosseous CP cement material is almost completely resorbed as early as 2 years after the leakage occurred (16). A meta-analysis (17) that com-

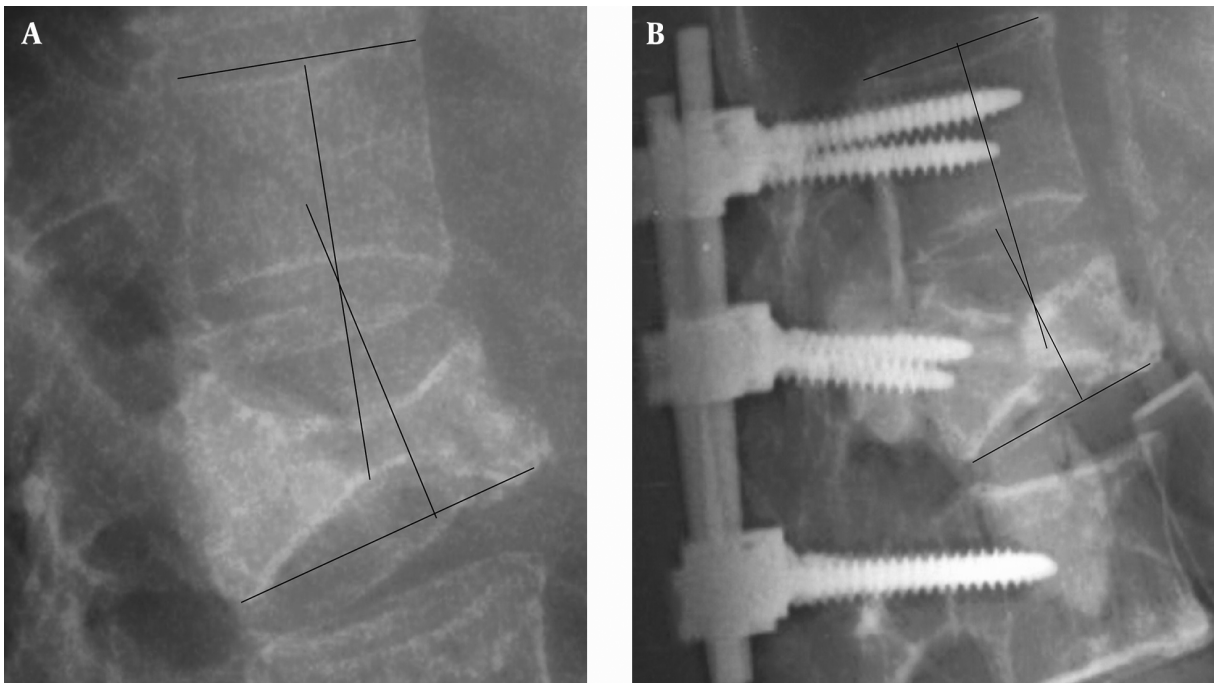


Figure 1. A, Preoperative segmental kyphosis: 15 degrees; B, Postoperative segmental kyphosis: 6 degrees.

pared VP and BK in the treatment of VCF concluded that there are some major drawbacks regarding mixing, transfer, and injection of traditional CP cements.

Identifying cement leakage early during BK is challenging for surgeons but useful to prevent severe neurologic injury. In contrast to PMMA, that is easily visible during cement implantation through C-arm fluoroscopy images, calcium phosphate has low radiopacity and thus some small leakages are often invisible. Therefore, at times, cement leakage can be overlooked during a procedure. There are several methods to detect cement leakage, such as oblique image intraoperatively (14), constant monitoring with high-resolution biplanar fluoroscopy (6), and associated neurologic complications by neuromonitoring. Urgent CT-scan is mandatory in case of suspicion of leakage. In our case, it is remarkable that despite continuous neuromonitoring but conventional fluoroscopy, no intraoperative signs indicative for neurologic damage were detected. In our case, the factors that may have contributed to the failure to early detect CP leakage were the low viscosity and radiopacity of CP, the perforation of the pedicle and accidentally the dural sac by the BK trockar and subsequently injection of bone cement intra-, and extradurally (18).

Neurologic damage onto the cord and cauda caused by PMMA leakage is due to PMMA mass direct pressure on the neural elements after hardening and also by the exothermal injury (6). In our case however, CP hardening is not associated with significant local temperature increase and thus thermal injury to the conus and cauda equina cannot be considered.

Conclusively, we believe that the CP leakage should have occurred by a perforation of the dural sac by the BK trockar and cannula bone cement filler, after perforating the medial wall of the right L1 pedicle (Figure 1A). Thus CP after has occupied the BK balloon void in the vertebral body leaked retrograde into the spinal canal and dural sac. Since no direct intraoperative nerve root injury occurred, there was no pathologic sign during intraoperative neuromonitoring.

Regarding the possible contribution of the use of pedicle screws in this case, there was CT-evidence for any involvement to this CP leakage and subsequent neurologic deterioration (7-9). To prevent neurologic complications associated with the use of low viscosity bone cement in MIS vertebral augmentation procedures, spine surgeons and interventional radiologists should always take into consideration the preoperative CT-scan to ensure that the posterior vertebral body wall and pedicles are intact, use continuous biplane fluoroscopy, and neuromonitoring (19). Spacers that safeguard cement maintenance are recommended (19, 20).

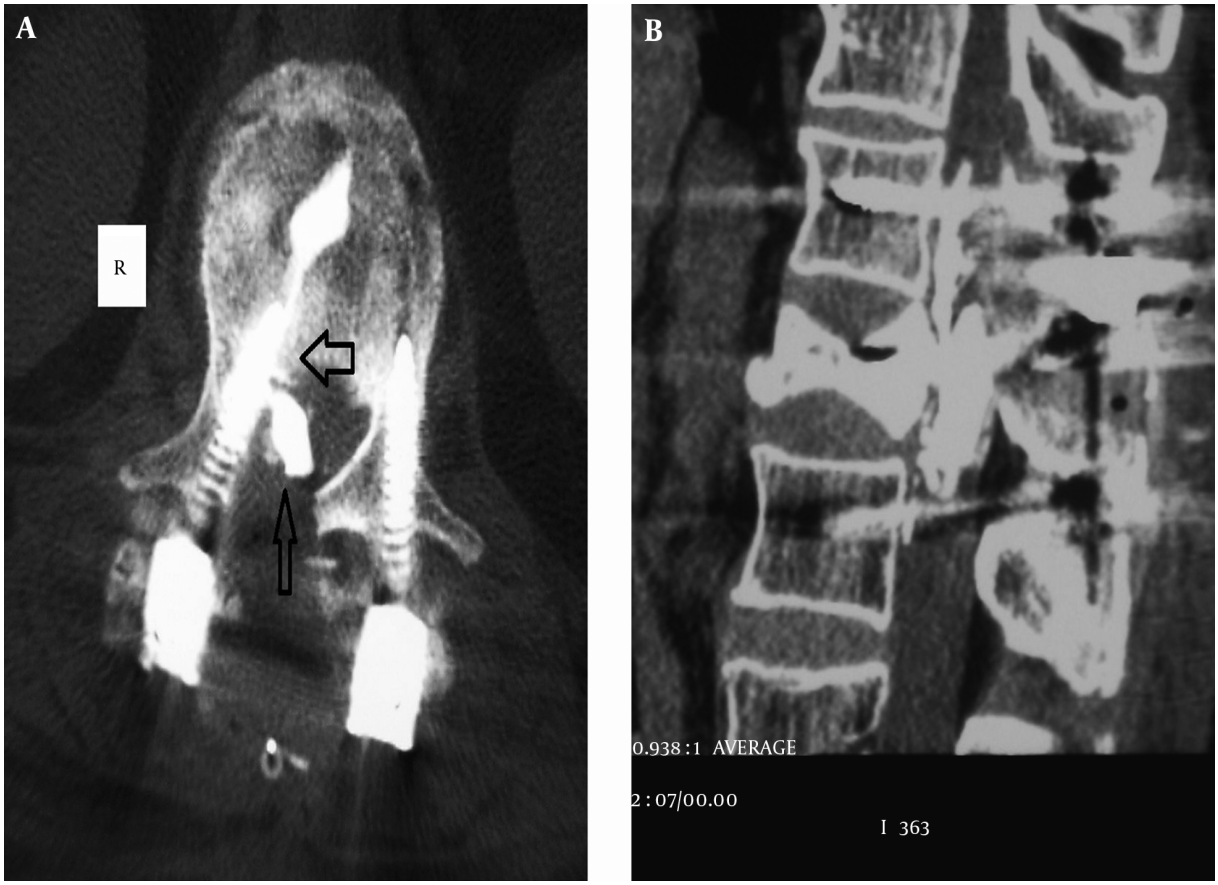
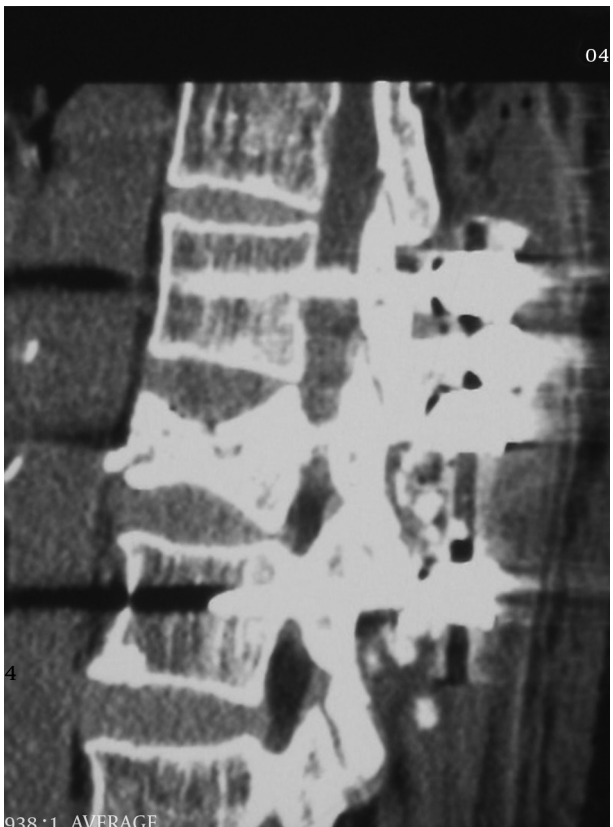


Figure 2. A, Postoperative axial view of L1 vertebra demonstrating epidural/intradural leakage of CP and a medially misplaced L1 screw on the right; CP seems to emerge from the medial wall of the right L1-pedicle; B, Sagittal CT-scan reconstruction image showing both intradural and epidural CP leakages.



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