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L1 Kyphoplasty Following Unusual Fracture Through Osteoporotic Bone Containing PMMA: A Case Report

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Background: Balloon kyphoplasty is a minimally invasive percutaneous procedure performed to restore vertebral body height related to compression fractures and subsequent associated morbidity.

Case Report: We describe the case of a 76-year-old man with numerous medical comorbidities who had previously undergone kyphoplasty with an unusual transverse fracture through the L1 vertebral body containing polymethyl methacrylate (PMMA), resulting in linear cleavage of the cement.

Conclusion: Although more data is needed to fully understand the mechanics of this PMMA fracture, we hypothesize this was likely due to a translation of forces from a paraspinal osteophyte, resulting in a rotation/distraction-type fracture and subsequent breakage of the cement.

Key words: Fracture, kyphoplasty, osteoporosis, PMMA, vertebroplasty

BACKGROUND

Osteoporotic vertebral compression fractures affect up to 50% of people over the age of 80 (1). While these patients are still often treated with bed rest, pain medication, and/or immobilization, augmentation procedures such as vertebroplasty and kyphoplasty are utilized to improve quality of life and accelerate return to normal activity. In 2018, a multidisciplinary panel utilized the RAND/UCLA Appropriateness Method to develop patient-specific recommendations for use of augmentation in patients with osteoporotic vertebral compression fractures (2). Proper utilization of these techniques has become ever more important with the burgeoning literature on mortality benefits associated with augmentation vs conservative therapy.

Vertebroplasty and kyphoplasty cementation are utilized in benign compression fractures including osteoporosis, as well as in malignancy-associated compression fractures. Hirsch et al (3) concluded that both kyphoplasty and vertebroplasty were associated with a prominent mortality benefit as compared to nonsurgical treatment of vertebral compression fractures. Further, Hinde et al (4) reported in a 2020 meta-analysis of more than 2 million patients that those who underwent augmentation as opposed to nonsurgical treatment were 22% less likely to die following a 10-year period. The kyphoplasty technique works to restore vertebral body height and angular deformities by utilizing a semicompliant balloon or balloons to create an intraosseous cavity in the vertebral body. This cavity is subsequently filled with polymethyl methacrylate (PMMA) bone cement for stabilization. This procedure is commonly performed to increase mobility, alleviate pain, and stabilize the spine. However, situations requiring retreatment of the same vertebral level are uncommon.

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CASE

The patient is a 76-year-old man with a history significant for arthritis, coronary artery disease, stage 3 chronic kidney disease, hypertension, chronic back pain, and osteoporosis with prior compression fractures at multiple vertebral levels (T6 through T8 and T10 through L1). He presented as an outpatient concerned that he had sustained a new compression fracture after falling down the stairs in June of 2021. A computed tomography (CT) scan was obtained, which identified an unusual cleavage-type fracture through a remotely cemented L1 vertebral body (initial augmentation in 2010) (Fig. 1). Based on this fracture pattern, it was surmised that the fracture likely initiated at the adjacent bridging osteophyte and propagated in a transverse and superior direction, ultimately breaking through the anterior superior endplate. On clinical exam, the patient complained of point tenderness exactly at the L1 vertebral level. Conservative therapy was attempted over a 2-month period, but the patient continued to have diminished mobility and subsequent difficulty performing activities of daily living. It is unknown why the acute L1 fracture did not heal, but it is hypothesized that a combination of his low baseline function, advanced osteoporosis, prior augmentation mechanics, and immunosuppressive status were contributing factors. Given the patient's clinical condition, it was decided to perform a repeat L1 augmentation.

The vertebroplasty procedure was performed using fluoroscopy under monitored anesthesia care. The patient was placed in a prone but extended position on the biplane C-arm table and preoperative antibiotics were given per institutional protocol. The L1 vertebral level was targeted, and local anesthetic was instilled into the overlying soft tissues and periosteum. Scout radiograph of the L1 vertebral fracture can be seen in

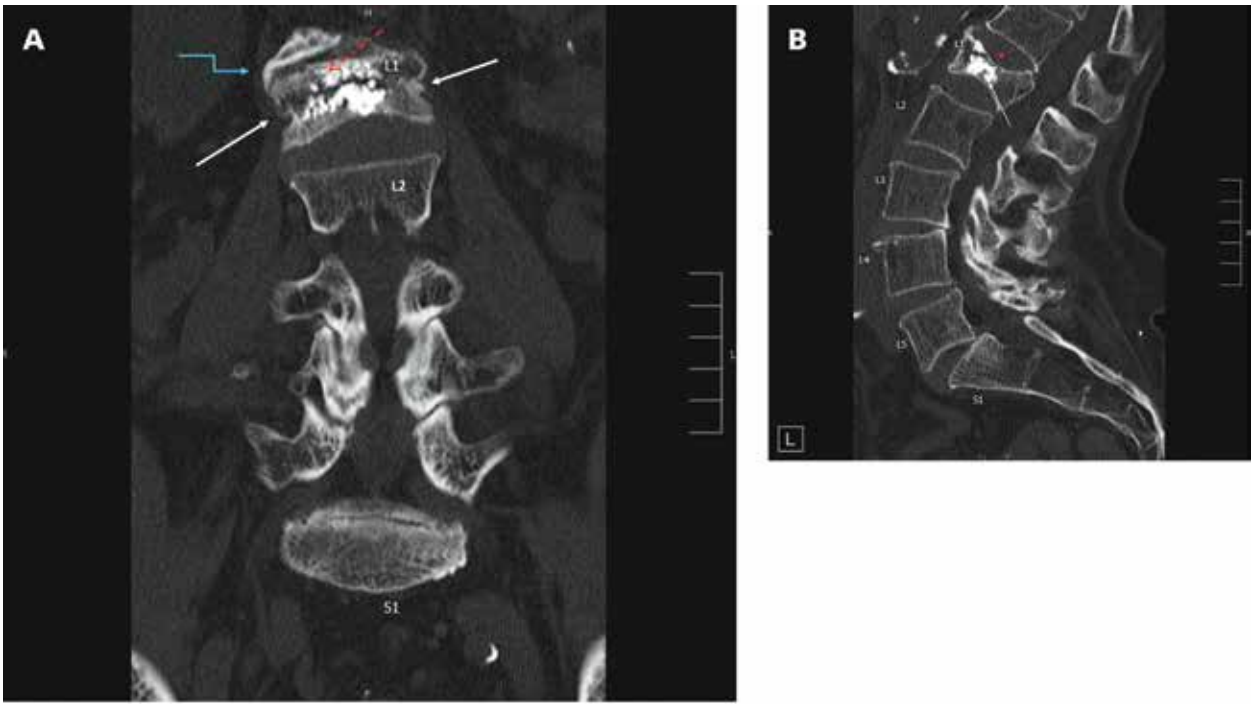

Fig. 1. A. Coronal CT of the thoracolumbar spine in bone windows demonstrating a horizontally oriented fracture cleft (white arrows) through the L1 vertebral body with vertical extension through the right lateral aspect of the superior endplate (dashed red arrow). The fracture involves both the osseous and previously cemented PMMA components of the vertebral body. Note the bridging T12/L1 paraspinal osteophyte and associated disc degenerative changes (blue arrow). B. Sagittal CT of the thoracolumbar spine in bone windows demonstrates an endplate compression fracture of the L1 vertebral body with changes related to prior augmentation (white arrow). There is an acute fracture cleft through the osseous and PMMA cement of the anterior and middle third of the vertebral body (red arrow) with extension through the superior endplate. Of note, severe generalized osseous demineralization is present.

Fig. 2. A 10-gauge needle was advanced in a posterior to anterior fashion via a transpedicular approach under pulsed fluoroscopic guidance. The working cannula was placed into the posterior third of the vertebral bodies bilaterally. The process was repeated on the contralateral side. On the left, a curved needle (known as a BFD or bone filler device) was used to extend past the midline and through the fracture cleft anteriorly. On the right, given the successful placement of the curved needle into the center of the cleavage plane, a straight needle (BFD) was used (Fig. 3).

PMMA was mixed and cement was instilled into the vertebral body through each BFD. Digital subtraction angiography was used intermittently to discriminate between new vs old PMMA (Fig. 4). PMMA was noted, insinuating through the fracture plane and filling the cleft anteriorly. The treatment endpoint was reached when a small amount of PMMA was identified leaking superior to the vertebral body (Fig. 5). On the right, PMMA was injected through the straight BFD and filled the anterior, inferior, and posterior aspects of the vertebral body. When a satisfactory amount of PMMA had been instilled, the injection was discontinued. The bone filler devices were removed. The patient was transported to the recovery area in stable condition. There were no immediate complications. Postoperatively (Fig. 6) and at follow-up, the patient reported a 90% improvement of pain-associated symptoms and a dramatic increase in daily activity levels.

Fig. 2. Lateral single shot fluoroscopic projection demonstrating a horizontally oriented fracture cleft through the anterior and middle 1/3 of the L1 vertebral body with disruption of the ventral cortex (white arrow). There is subtle disruption of the PMMA along the superior endplate related to fracture extension (red arrow).

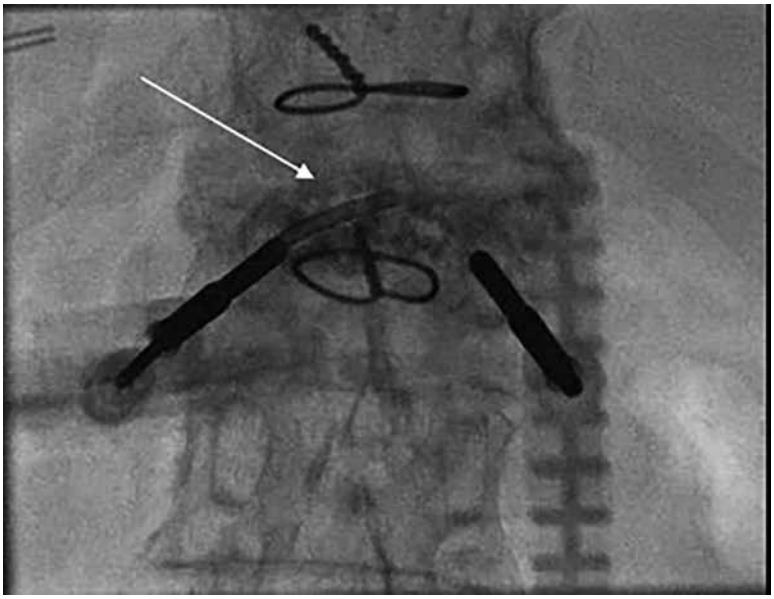

Fig. 3. Anterior to posterior single shot fluoroscopic projection demonstrating placement of a left curved BFD (white arrow) coaxially placed through a trocar needle via a transpedicular approach. On the right, there is a transpedicular placed trocar needle. Note cement related to previous L1 vertebral body augmentation.

Discussion

In this report, we present an unusual case of an L1 vertebral fracture through a previously cemented vertebral body.

Vertebral compression fractures are the most common complication of osteoporosis (5). The risk of developing a compression fracture is strongly correlated with a decrease in bone mineral density, which has been shown to decline in men and women after 40 years of age. While genetics seem to strongly contribute to one's bone mineral density, the presence of coexisting morbidity, lifestyle,

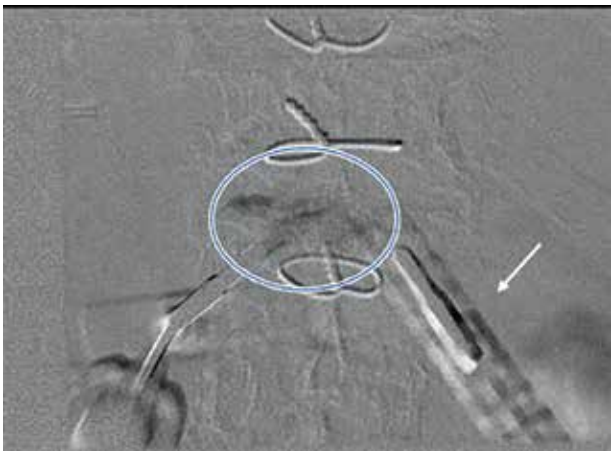

Fig. 4. Anterior to posterior fluoroscopic projection utilizing DSA. Bilateral BFDs (white arrow) are within the L1 vertebral body via a transpedicular approach. DSA was used to "subtract" out cement from the prior intervention which allows for improved visualization of the new PMMA cement being deposited (black material within the white circle).

Fig. 5. Lateral single shot fluoroscopic projection demonstrating complete filling of the vertebral body fracture cleft with a minimal amount of cement extruding into the T12/L1 intervertebral disc space (white arrow).

Fig. 6. A. Coronal CT of the thoracolumbar spine in bone windows demonstrating postvertebroplasty changes with new PMMA cement filling the fractured osseous and cemented portions of the L1 vertebral body (white arrow). B. Sagittal CT of the thoracolumbar spine in bone windows demonstrates complete filling of the fracture cleft through the anterior and middle third of the L1 vertebral body (white arrow). Of note, a small amount of cement is seen within the T12/L1 intervertebral disc (red arrow). Cement is also identified within the T10 and T11 vertebral bodies from prior augmentation.
Abbreviations: BFD, bone filler device; CT, computed tomography; DSA, digital subtraction angiography; PMMA, polymethyl methacrylate

and environmental factors are also shown to play a role. Additional predisposing factors that may increase risk include a lack of exercise, excessive use of tobacco or alcohol, poor dietary calcium intake, low vitamin D, and prolonged use of glucocorticoids (6).

The first-line treatment for a vertebral compression fracture is supportive care. This consists of rest, non-narcotic and narcotic analgesic medication, physical therapy, and progressive return to mobility if the patient is clinically able (7). If conservative therapy is unsuccessful, more invasive treatment options, such as augmentation, likely offer benefits. Vertebroplasty

involves the direct injection of PMMA into the vertebral body. It was pioneered in France and then brought to the United States in the mid-1990s. The first kyphoplasty procedure was performed by Dr. Mark Reiley in 1998 (8). Since then, multiple studies, including those reported in the Vertebroplasty for Painful Chronic Osteoporotic Vertebral Fractures II (VERTOS II) trial (9) as well as the Vertebroplasty for Acute Painful Osteoporotic Fractures (VAPOUR) study (10) found vertebral augmentation to be more efficacious when to compared to conservative management alone.

With respect to needing a second intervention on a single vertebral level, a literature search utilizing the PubMed database was performed. We identified a similar case of a vertebral collapse and subsequent breakage of PMMA in an elderly patient as reported by Huang et al (11). Their case described a 72-year-old patient with a 10-year history of rheumatoid arthritis treated by a daily 10-mg dose of methylprednisolone. This patient also sustained a compression fracture at the L1 vertebral level, which required removal of PMMA through a gap on the left side of the transverse process and lateral pedicle. Following the retreatment of this patient and over the 2-year follow-up period, the patient's pain had significantly improved with a decrease in the ODI (Oswestry Disability Index) from 98 to 27.

The present case is notable in that the fracture pattern suggests a rotation and distraction mechanism of injury, unusual given the clinical context. The adjacent flowing osteophytes and ligamentous ossification further complicated the issue. Given the numerous comorbidities of this patient and after reviewing the case and his imaging, the multidisciplinary spine team felt it best to initially try salvage augmentation rather than open surgery. One month following the procedure, the patient reported improved mobility and 90% improvement in his back pain.

CONCLUSION

The present case presents an unusual occurrence of rotation/distraction fracture of a vertebral body, related to a mechanical fall, following a previous augmentation. The fracture involved both the osseous and PMMA components of the vertebral body. Although more data is needed to fully understand the mechanics of the PMMA fracture, we hypothesize this was likely due to the translation of forces from a paraspinal osteophyte, resulting in a sheering mechanism through the cement, similar to a bottle opener removing a bottle cap. Following repeat augmentation with the technique described above, the fracture was able to be treated, and the patient had resolution of his presenting symptomatology and sustained clinical improvement. Subsequent clinical visits have demonstrated durability of the therapy.

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