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Cement fragmentation and delayed vertebral collapse following percutaneous vertebroplasty: A rare case report and surgical management

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Abstract
Study Design: Case report.
Purpose: To describe a rare complication of percutaneous vertebroplasty [PVP], cement fragmentation with delayed vertebral collapse, managed surgically with combined reconstruction.
Case Presentation: An 82-year-old woman with comorbidities underwent vertebroplasty for a fracture, achieving pain relief and mobility. Later, she had severe pain and neurological deficits. Radiology showed L2 collapse, PMMA cement fragmentation, and spinal compression. Tests excluded infection and malignancy.
Management and Outcome: A staged surgical approach was used. Stage one involved anterior debridement, L2 corpectomy, decompression, and fusion. Stage two involved posterior stabilisation. Histopathology showed fibrous tissue and cement fragments without infection or malignancy. Postoperatively, the patient had pain relief, neurological improvement, and regained mobility.
Conclusions: Cement fragmentation with delayed collapse after PVP can cause instability and neurological deficits. Risk factors include osteoporosis and steroid use. Prompt reconstruction can restore stability and improve quality of life. Careful patient selection, technique, and osteoporosis management are essential to minimise complications.

Keywords: Vertebroplasty; cement fragmentation; vertebral collapse; osteoporosis; spinal instrumentation.

Introduction
The occurrence of vertebral compression fractures (VCFs) due to osteoporosis or neoplastic conditions is on the rise, posing a significant healthcare challenge among the elderly [1]. Introduced by Galibert *et al*. in 1987, Percutaneous Vertebroplasty (PVP) has gained widespread acceptance for treating osteoporotic VCFs and osteolytic conditions like vertebral metastases, multiple myeloma, and aggressive hemangioma, primarily because it effectively alleviates back pain [2]. Polymethylmethacrylate (PMMA) is the most frequently utilised cement, serving as a dependable stabilising agent in vertebroplasty [3, 4]. Research by Balkarli and Mattie demonstrated that PVP facilitates quicker pain relief and enables patients to resume walking and daily activities sooner compared to conservative treatment for osteoporotic VCFs [5, 6]. However, PVP is contraindicated in cases of bone cement allergy, local or systemic infections, and severe bleeding disorders [7].
PVP is a minimally invasive technique that addresses vertebral collapse from malignant or benign causes, but has potential complications. The main issue is cement extravasation, which most patients tolerate well. However, it can cause nerve root compression and pulmonary embolism in some cases. These complications occur more frequently in cases of malignant collapse compared to osteoporotic collapse [8].
In this report, we discuss an 82-year-old woman who experienced severe back and thigh pain due to aseptic loosening, fragmentation of PMMA cement, and vertebral collapse following PVP, a rare complication and its management.

Case Report
An 82-year-old woman with multiple comorbidities and long history of steroid use presented to the hospital with complaints of inability to walk due to severe low back pain and right thigh pain after a trivial fall at home. She had undergone an L2 PVP procedure eight months ago for an L2 compression fracture at an outside hospital (Fig. 1).

She was symptom-free for eight months and mobilising well. On examination, her right femoral stretch test was positive, with right hip flexion weakness. Radiography revealed L2 vertebral collapse with cement fragmentation and focal kyphosis (Fig. 2), and MRI revealed cord compression at the L1-2 level. (Fig 3) Blood parameters, such as C-reactive protein [CRP], erythrocyte sedimentation rate [ESR], and white blood cell [WBC] count, were normal, suggesting that infection was unlikely. Her tumour marker profile was also negative.

Computed tomography revealed osteolysis of the L2 vertebra and pieces of PMMA cement embedded in the L2 vertebral body and L1 inferior end plate with vertebral collapse. (Fig 4) Her bone mineral density (BMD) was also measured preoperatively, which showed severe osteoporosis. We planned for anterior reconstruction followed by posterior stabilisation in a staged manner.

Stage I: Patient was placed in the right lateral position. An oblique anterolateral incision was made on the left flank along the left 11th rib. The external oblique, internal oblique, and transverse abdominis muscles were divided in line with the skin, and the muscles retracted. Retroperitoneal blunt dissection was performed, and the left 11th rib was removed. The anterior border of the psoas muscle was identified, and blunt dissection was performed to visualise the L1-2 segment. Upon reaching the affected segment, no evidence of purulent material or infective fluid was found. Cement was found to be fragmented into small pieces. (Fig 5) Fragmented cement pieces, fibrous tissue, disc material, and collapsed bone tissue were removed using disc forceps and curettes. The retropulsed fracture fragment was thinned out with a burr and then removed using a small curette. During this incidental durotomy, was noted with herniation of rootlets which was managed by repositioning the rootlets and a duragen patch was applied. The patient underwent anterior L2 partial corpectomy, thorough debridement, anterior decompression, and fusion with a titanium mesh cage and bone graft. A bone graft was prepared using the previously removed 11th rib.

Stage II: The Patient was then placed in the prone position. L1-3 posterior minimally invasive spine [MIS] fixation and stabilisation with cement-augmented pedicle screws and rods were performed.

The microbial culture report was negative, and histopathological examination showed broken bone tissue and large amounts of cellulose fibre. The patient was stable postoperatively and experienced good pain relief. She was ambulated with the help of a walker from the next day and was started on anti-osteoporotic treatment. Post-operative radiography showed implants in good position with removal of all PMMA cement fragments. (Fig. 6)

Discussion

Here, we report a rare case of aseptic loosening and fragmentation of PMMA cement in a postoperative percutaneous vertebroplasty patient. As a result, she developed severe pain due to vertebral collapse and subsequent kyphotic deformity. This affected her ambulation, day-to-day life activities, and living. She underwent combined anterior and posterior surgery after which her pain was completely relieved, and she could ambulate and perform her daily activities easily.

Osteoporosis stands as the most common metabolic bone disorder worldwide, primarily attributed to the rise in life expectancy [9-11]. Vertebral compression fractures (VCFs) are among the most prevalent fractures due to bone fragility [12]. Unlike other fractures, a substantial number of VCFs, ranging from two-thirds to three-quarters, remain undiagnosed in clinical settings [12, 13] and are often later identified through imaging techniques [14]. Percutaneous vertebroplasty is a widely recognised and practised treatment for VCFs. Although it effectively addresses vertebral collapse, it also presents a risk of complications [8]. Al-Nakshabandi *et al*. classified PVP complications into mild, moderate, and severe categories. Mild complications included temporary pain increase and transient hypotension. Moderate complications involved infection and cement leakage into the foraminal, epidural, or dural spaces, as well as fractures in adjacent vertebrae. Severe complications included cement leakage into paravertebral veins, potentially leading to pulmonary embolism, cardiac perforation, cerebral embolism, or even death [15]. Laredo *et al*. suggested safety measures to reduce the risk of cement leakage, such as employing high-quality permanent radiological guidance for early detection, conscious sedation, a bilateral transpedicular approach at thoracic and lumbar levels, precise bone penetration site selection for a single vertebral needle path, careful needle placement to prevent cortical breakthrough, and the use of well-opacified and refrigerated cement [8]. Mo *et al*. investigated the impact of bone cement distribution on outcomes after PVP, finding that inadequate cement distribution may result in less pain relief and could lead to progressive vertebral collapse and kyphotic deformity post-PVP [16]. Adjacent vertebral fractures are among the most frequent complications of PVP. Zhang *et al*. conducted research to identify risk factors for new vertebral fractures following PVP, discovering that elderly patients, women, and those with a history of smoking and diabetes are at higher risk for new vertebral fractures post-PVP. Patients should be encouraged to quit smoking and alcohol consumption, manage their blood glucose levels, engage in sufficient physical activity, and adhere to osteoporosis treatment to prevent new vertebral fractures [17]. Cao *et al*. conducted a similar study, finding that low bone mineral density, multiple treated vertebrae, and a history of steroid use were linked to new VCFs after vertebroplasty [18]. Huang *et al*. described a case akin to ours involving PMMA fracture and vertebral collapse following PVP. He proposed that factors such as prolonged steroid use, recent injuries, and inadequate correction of kyphosis post-PVP might contribute to such a collapse. In this instance, salvage surgery was undertaken, and stability along with kyphosis correction, was achieved through a combined anterior and posterior approach [19]. Yoshi *et al*. detailed a case where a patient developed a severe kyphotic deformity due to collapse at the cemented and adjacent vertebrae after PVP with calcium phosphate cement [CPC]. He attributed this to the injection of a large volume of cement and localised focal kyphosis. The patient underwent a highly invasive reconstruction, involving both anterior and posterior procedures, as a form of salvage surgery.(20) Cerny *et al*. performed a comparative study on the effectiveness and complication rates of percutaneous vertebroplasty [PVP] and percutaneous kyphoplasty [PKP] in treating VCFs. They found no significant difference in the risk of cement leakage between PKPs and PVPs. Both

procedures provided rapid and substantial pain relief for patients with VCFs. He hypothesised that kyphoplasties might be more effective than vertebroplasties in preventing further vertebral body collapse [21]. Chen *et al*. suggested that greater restoration of anterior vertebral height and the use of solid lump filling cement are risk factors for refracture of cemented vertebral bodies. They proposed that symmetrical cement distribution and fluid aspiration could potentially prevent refracture of these cemented vertebral bodies [22].

Although the exact cause of vertebral collapse and cement fragmentation remains unclear in our case, long-term steroid use, osteoporosis, lack of focal kyphosis correction, and large anterior vertebral height restoration may be potential causes of failure. In such cases, achieving good sagittal balance by correcting focal kyphosis is important. In this case, because the patient had severe back pain and thigh pain due to cord compression, a combined anterior and posterior approach was used, and L2 partial corpectomy with removal of cement fragments with debridement was performed. Stabilisation and kyphosis correction were achieved with anterior mesh cage fusion with bone graft, and posterior MIS fixation was performed with pedicle screws and rods.

Fig 1: Immediate postoperative L2 vertebroplasty X-ray Lumbosacral spine- A) Anteroposterior view B) Lateral view

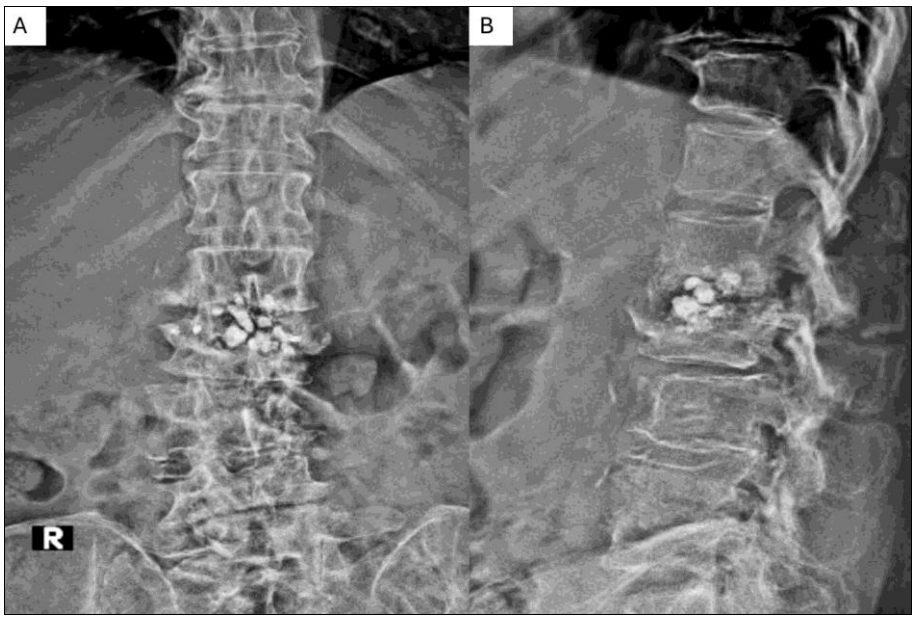

Fig 2: Eight-month post-L2 vertebroplasty follow-up X-ray Lumbar spine- A) Anteroposterior view B) Lateral view

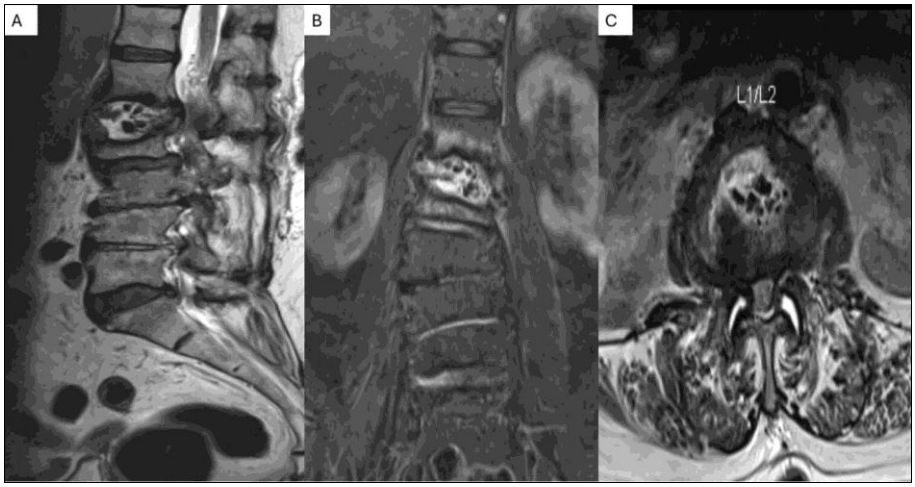

Fig 3: Eight-month post-L2 vertebroplasty follow-up Magnetic resonance imaging scan – showing a hyperintense fluid-filled cavity at L1-2 disc space on T2-weighted image with fragmentation of PMMA cement. A) Sagittal section B) Coronal section C) Axial section

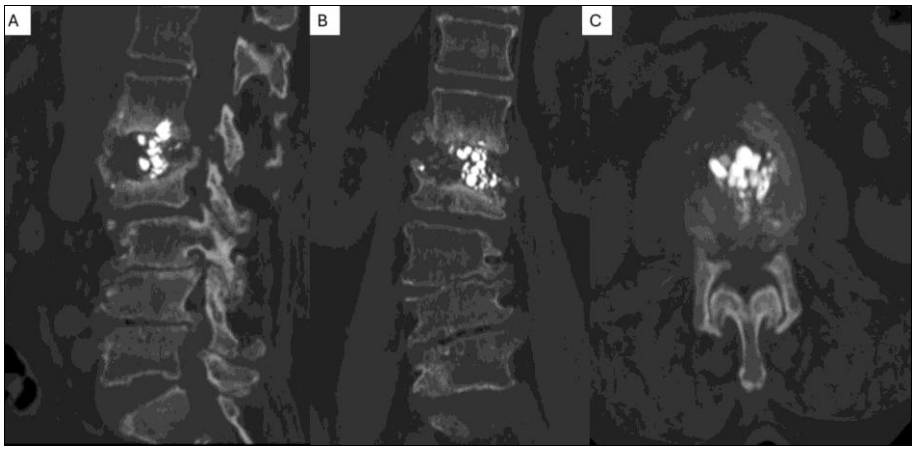

Fig 4: Eight-month post-L2 vertebroplasty follow-up Computed tomography scan – showing fragmented PMMA cement particles with destruction of the L2 vertebral body. A) Sagittal section B) Coronal section C) Axial section

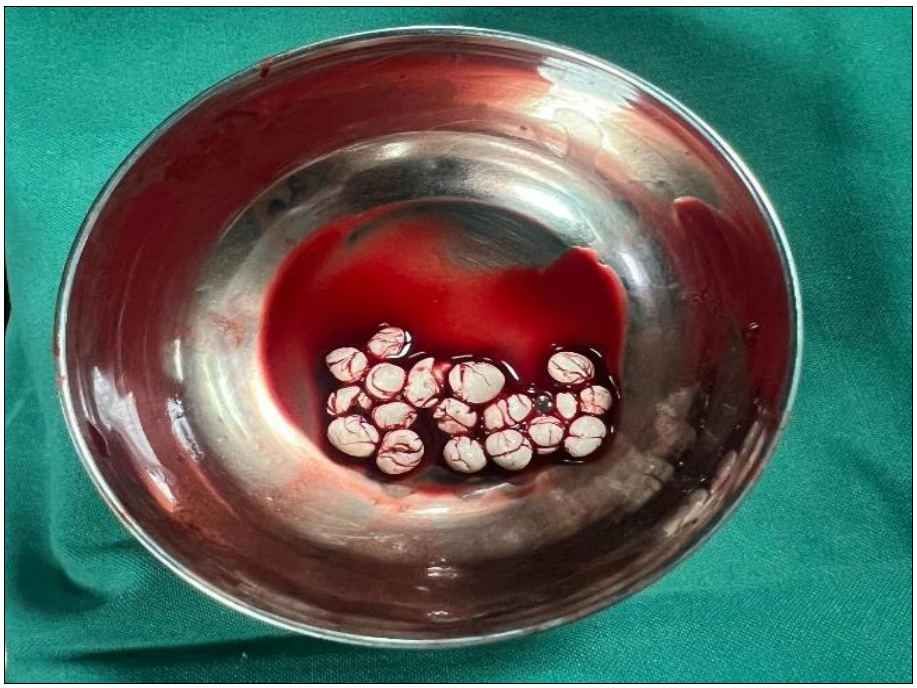

Fig 5: PMMA cement fragments removed intraoperatively.

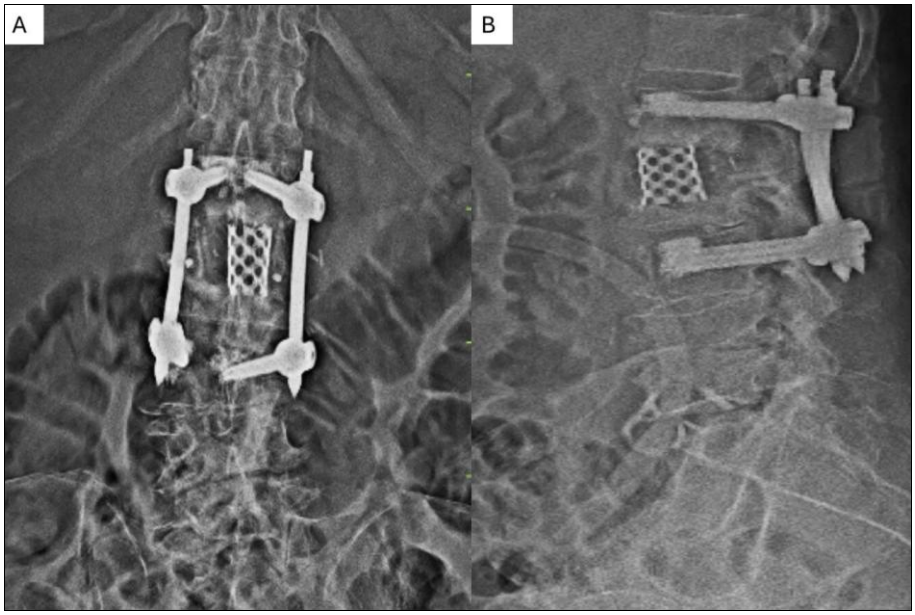

Fig 6: Post-Revision surgery X-ray Lumbosacral spine – showing L1-2 interbody fusion with titanium mesh cage and bone graft, L1-3 posterior fixation with pedicle screws and rods. A) Anteroposterior view B) Lateral view

Conclusion

PVP is a proven effective tool for treating osteoporotic vertebral compression fractures in the elderly population. Although it is a minimally invasive procedure, it has its own set of complications that can occur. Therefore, it is of prime importance to inform patients about these complications, which include refractures, cement fragmentation, vertebral collapse, cement leakage, and may require revision surgery in the future if PVP fails. The natural course of osteoporosis plays a significant role in the occurrence of these VCFs, and factors contributing to osteoporosis, such as steroids and low BMD, should be considered, and the patient should be started on anti-osteoporotic treatment as early as possible.

Conflict of Interest

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

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