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Percutaneous Vertebroplasty and Unilateral Pediculoplasty for Treatment of L5 Radiculopathy: A Case Report

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Background: Percutaneous pediculoplasty (PP) is a minimally invasive procedure that may be performed with concomitant vertebral augmentation in which polymethylmethacrylate (PMMA) is percutaneously injected into a fractured vertebral pedicle under fluoroscopic guidance for fracture stabilization and pain management. PP poses distinct challenges resulting from the immediate proximity of the pedicle to the adjacent nerve roots and the small size of the pedicle relative to the vertebral body. Additionally, despite being radiopaque, there can be difficulty visualizing the relatively small volume of cement deposition.

Case Report: We present the case of a 67-year-old cancer patient who had a pathologic left L5 pedicular and vertebral body fracture that was successfully treated with L5 vertebroplasty and left-sided pediculoplasty.

Conclusion: This report adds to the existing evidence that performing vertebroplasty with PP may be appropriate for some patients with middle vertebral column fractures, and it provides technical tips for the performance of this procedure. These techniques include allowing the PMMA additional time to solidify and using intraoperative cone beam computed tomography to verify in real time the correct placement of the cement.

Key words: Pediculoplasty, percutaneous pediculoplasty, vertebroplasty, vertebral fracture, pedicle fracture, PMMA, cone beam CT

BACKGROUND

Percutaneous pediculoplasty (PP) is a minimally invasive procedure that may be performed with concomitant vertebral augmentation, in which polymethylmethacrylate (PMMA) is percutaneously injected into a fractured vertebral pedicle under fluoroscopic guidance for fracture stabilization and pain management. PP poses distinct challenges resulting from the immediate proximity of the pedicle to the adjacent nerve roots and the small size of the pedicle relative to the vertebral body. Additionally, despite being radiopaque, there can be difficulty visualizing the relatively small volume of cement deposition (1). We present the case of a 67-year-old man with a pathologic vertebral fracture who was successfully treated with L5 vertebroplasty and left-sided pediculoplasty.

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CASE

The patient was a 67-year-old man with a sacral chordoma and Charcot-Marie Tooth disease who presented in March 2020 with symptoms consistent with L5 radiculopathy.

In 2018, 2 years prior to presentation, the patient's chordoma was discovered after he complained of constant, worsening pain in the right buttock and posterior thigh that radiated to the knee. Magnetic resonance imaging (MRI) demonstrated a 9.7 x 6.2 x 9.2-cm lytic lesion centered at the right sacrum which was invading the cauda equina with pathologic fracture of the right hemisacrum and right iliac bone. Computed tomography (CT)-guided biopsy revealed a conventional chordoma. Standard treatment for chordomas is wide local excision with preoperative and postoperative radiation (DeLaney et al. IJROBP, 2009); however, complete resection is often impaired by anatomic constraints, leading to frequent recurrence (2-4). For inoperable cases, high-dose radiation therapy using stereotactic radiosurgery or charged particle irradiation has been shown to achieve durable local control (5). Given the challenging location of this patient's chordoma, the mass was not resected and was instead treated with definitive photon/proton radiation therapy in June 2019. This therapy initially resulted in dramatic symptom improvement and an interval decrease in the size of the chordoma to 8.6 x 6.1 x 7.7 cm on subsequent imaging (Fig. 1).

In March 2020, 9 months after completing radiation therapy, the patient presented with sharp, shooting pain from the left posterior leg to the great toe. The pain limited his mobility to the extent that he required a walker to ambulate even short distances. He did not have back pain, buttock pain, or focal neurologic symptoms. His only other symptoms were bilateral peripheral numbness and muscle weakness consistent with his known peripheral neuropathy.

Suspicion for a spinal fracture in the setting of his sacral mass and history of local radiation warranted imaging (Fig. 2). A CT scan showed the chordoma grossly unchanged in size and known pathologic fracturing of the right hemisacrum and right iliac bone, as well as a new fracture involving the posterior aspect of the L5 vertebral body and left pedicle. It was thought that motion at the fracture might be irritating the left L5 nerve root. A decision was made to perform an L5 vertebroplasty and left pediculoplasty. It was hoped that the procedure would relieve the patient's new, radicular symptoms. The patient wished to proceed with cementation. After a delay due to the COVID-19 pandemic, the procedure was performed in May 2020.

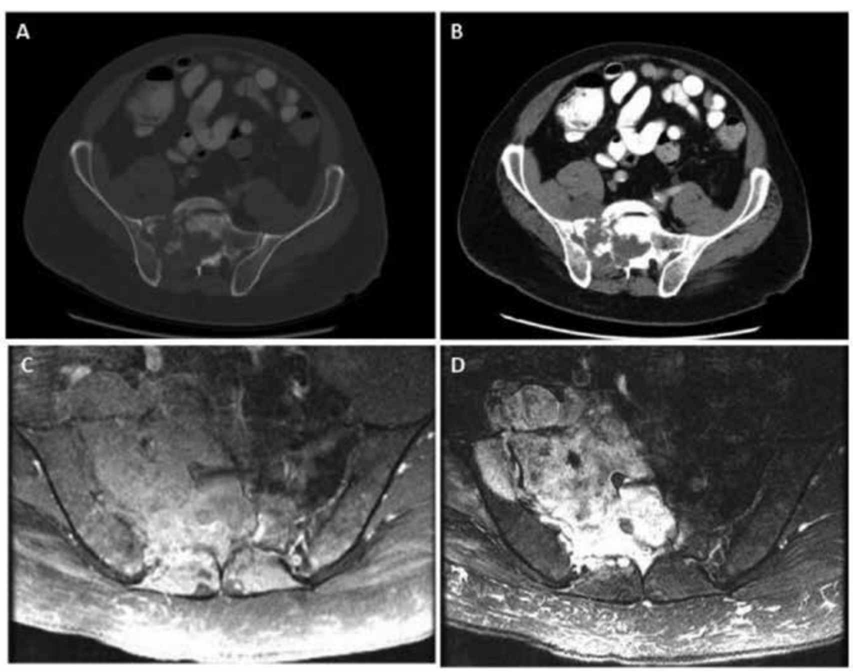


Fig. 1. Initial presentation of chordoma. Imaging on initial presentation demonstrated an 8.6 x 6.1 x 7.7-cm lytic lesion centered at the right sacrum and invading the cauda equina with pathologic fracturing of the right hemisacrum and right iliac bone.
A) axial CT image centered on tumor on bone window, B) axial CT centered on tumor on soft tissue window, C) axial T1-weighted fat-suppressed postcontrast MRI image of tumor, D) axial T2-weighted fat-suppressed MRI image of tumor.

For the procedure, the patient was placed in the prone position. Preoperative prophylactic antibiotics were given (2 g cefazolin, administered intravenously). The L5 level was verified fluoroscopically and confirmed by referencing the initial imaging. The procedure was performed under conscious sedation. In ad-

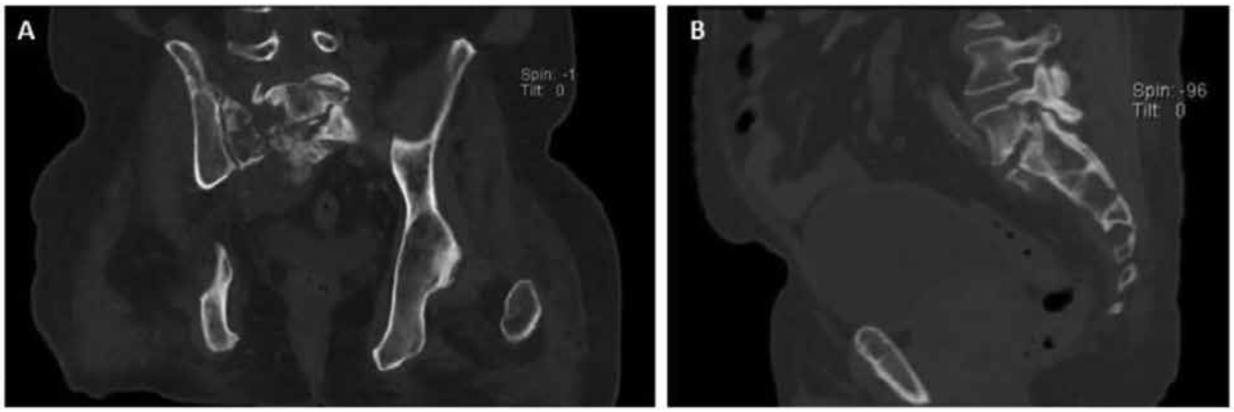


Fig. 2. Preoperative imaging. Suspicion of a spinal fracture in the setting of the patient's sacral mass and history of local radiation warranted imaging. Imaging showed the chordoma grossly unchanged in size and known pathologic fracturing of the right hemisacrum and right iliac bone, as well as a new fracture involving the posterior aspect of the L5 vertebral body and left pedicle. Representative images in coronal (A) and sagittal (B) planes.

dition, local anesthesia using 25 mL of 1% lidocaine was administered to the periosteum near the left L5 pedicle. A 10-gauge needle was then advanced into the pedicle. The needle was difficult to pass through the bone, which was sclerotic in the context of prior local radiation. A drill was required to position the needle anterior to the fracture line in the vertebral body. A bone filler device (BFD) was tested and shown to cross the fracture line. The PMMA was mixed and allowed to thicken beyond normal protocol; more viscous cement was preferred, as it would be less likely to seep out of the intended position in the fracture line. Under anterior-posterior (AP) and lateral fluoroscopic guidance, the BFD and needle were continuously adjusted until a satisfactory amount of PMMA was deposited using manual pressure. The cement preferentially filled the fracture lines: the fracture line in the posterior aspect of the vertebral body was cemented first, and the oblique fracture line in the pedicle was filled as the needle was withdrawn. The BFD and needle were removed with minimal bleeding. Hemostasis was achieved with manual pressure. An intraoperative cone beam (or C-arm) CT scan was utilized to evaluate PMMA placement in real time (Fig. 3). A postoperative CT was also performed to verify correct cement placement (Fig. 4). Cone beam CT utilizes fluoroscopic images acquired from a rotation of the C-arm to reconstruct cross-sectional slices.

There were no immediate complications of the procedure. The patient had deconditioned dramatically during the pandemic as he had been unable to mobilize or perform his activities of daily living (ADLs) secondary to the new onset radicular pain. He thus remained in the hospital for monitoring and pain management for several days after the procedure. He was discharged directly to home 6 days post procedure. Currently several months after the procedure, the patient's symptoms have significantly improved, and he is able to ambulate and perform his ADLs as prior.

DISCUSSION

PP was first performed in 2002 by Gailloud et al (6) for treatment of 2 patients with lytic pedicular lesions, including a plasmocytoma and a vertebral hemangioma. Although rarely performed, PP has since been shown to be effective in treating neoplastic pedicle infiltration, pathologic fractures, osteoporotic fractures, and traumatic fractures (1). PP is typically conducted alongside percutaneous vertebroplasty (PV). A case series by Eyheremendy et al (7) in 2004 concluded that performing either PV with PP or isolated PP may be appropriate for some patients with vertebral fractures. PV is extensively used for bone strengthening and pain relief, but is not always successful – 10% of patients do not experience pain relief after PV. Eyheremendy et al hypothesized that a subset of these PV failures may be explained by pedicle involvement and reported successful treatment of 5 cases of osteoporotic compression fractures with PV and concurrent bilateral pediculoplasty. Our case report adds evidence to this theory that PV with PP may be appropriate for patients with vertebral fractures that involve the pedicle.

PP is uniquely challenging due to the immediate proximity of the pedicle potentially to the spinal cord

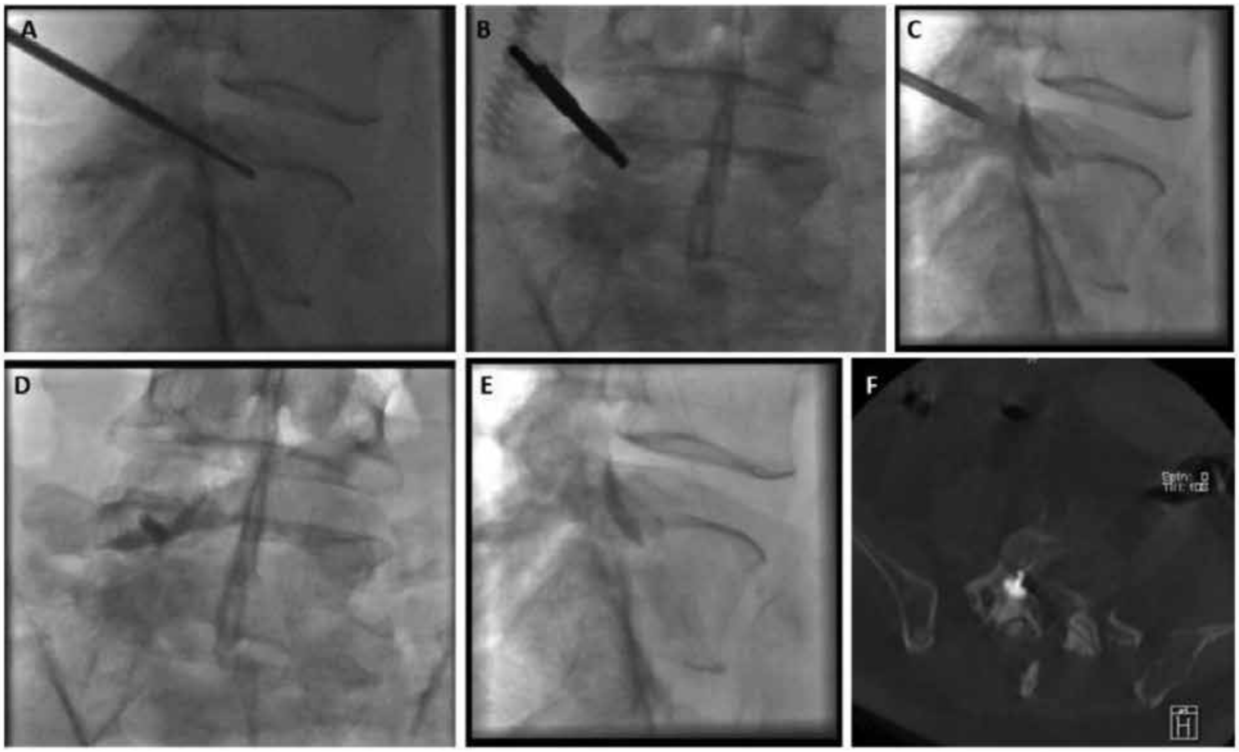
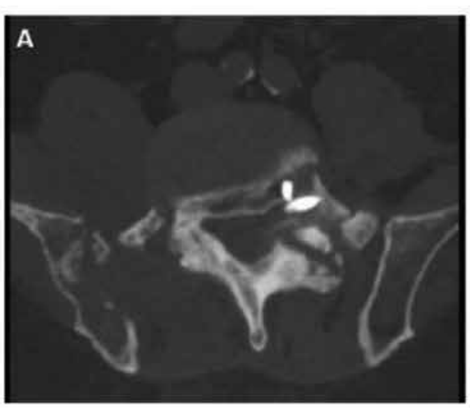


Fig. 3. Intraoperative imaging. The procedure was performed under continuous AP and lateral fluoroscopic guidance. The fracture line in the posterior aspect of the vertebral body was cemented first, and the oblique fracture line in the pedicle was filled as the needle was withdrawn. A cone beam CT scan was used to verify cement placement.
A) sagittal fluoroscopy image showing needle placement, B) AP fluoroscopy image showing needle placement, C) sagittal fluoroscopy image showing cement administration, D) AP fluoroscopy image after cement deposition, E) sagittal fluoroscopy image after cement deposition; F) axial reconstructed cone beam CT image showing extent of cement deposition.



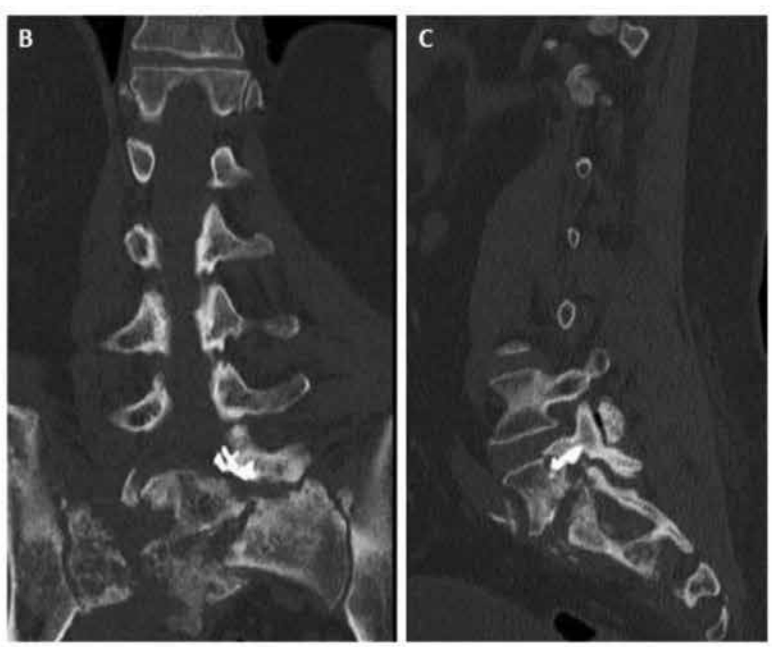


Fig. 4. Postoperative imaging. Postoperative imaging confirmed correct placement of cement. A) axial CT, B) coronal CT, C) sagittal CT.
Abbreviations: AP, anterior-posterior; CT, computed tomography; MRI, magnetic resonance imaging

and nerve roots, the small size of the pedicle, and the difficulty in visualizing the relatively small volume of cement deposition (1). Previous reports have tried various methods of improving precision during the procedure. First, several reports have discussed allowing the PMMA additional time to solidify before injecting the cement, theoretically decreasing the risk of seepage from the fracture line. Second, Martin et al (8) manipulated the orientation of the bevel of the needle to control the direction of applied forces and cement deposition. This study found that directing the needle bevel medially during passage through the pedicle resulted in external deviation of the needle, thus avoiding injury to the spinal canal. Secondarily, orienting the needle bevel externally during PMMA deposition resulted in preferential delivery of cement to the lateral part of the pedicle, away from the spinal canal. We incorporated the former of these techniques in the procedure described above. We allowed the PMMA additional time to solidify before injecting the cement and believe that this helped prevent seepage from the fracture line.

Fluoroscopy is the preferred method of monitoring during PP. Continuous fluoroscopy permits visualization of the boundaries of the osseous central canal and the medial wall of the pedicle adjacent to the neural foramen, as well as real-time monitoring of PMMA distribution to facilitate early detection of leakage into the central canal (1). Medial/lateral and superior/inferior leakage may be detected by AP and lateral fluoroscopic projections, respectively (1,6-9). Oftentimes, however, visualization of the pedicle may be impaired, for instance if the patient had prior PMMA injections in the vertebral body that obscure the pedicle on AP projection. In these instances, the position of the contralateral pedicle and/or the medial wall of the pedicles directly above and below may be used as landmarks for guidance (1,6). Martin et al (8) also reported success in mixing additional barium with PMMA to better follow the cement distribution under lateral fluoroscopy. One could theoretically add additional radiopaque materials like tantalum to the PMMA mixture. While performing this procedure, the target L5 vertebral body was well-visualized using continuous AP and lateral fluoroscopic projections. We also used intraoperative cone beam CT to verify the correct placement of the cement.

CONCLUSION

We report the case of a 67-year-old man who presented with a radiation-associated vertebral fracture and was treated with an L5 vertebroplasty and left pediculoplasty. There were no complications of the procedure. This report adds to the existing, albeit limited evidence that performing PV with PP may be appropriate for some patients with vertebral fractures that involve the middle column. We recommend that clinicians consider using the techniques incorporated in this procedure, which proved to be effective. These techniques include allowing the PMMA additional time to solidify and using intraoperative cone beam CT to verify in real time the correct placement of the cement.

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