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A Case Report

All-Fluoroscopic Technique for Sacral Vertebroplasty

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Background: Osteoporosis and other conditions that predispose to spinal compression fractures can also result in painful sacral insufficiency fractures. Recently percutaneous vertebroplasty has been applied to treat these fractures. Due to difficulty identifying the correct cannula depth into the sacrum under fluoroscopy alone, the procedure is typically performed using a combined fluoroscopic- and CT-guided technique. In patients who have undergone lumbo-sacral fusions with pedicle screws in place, the CT-guided image is degraded by metal artifact, making visualization of the cannula tip difficult.

Case Report: Described is a technique using fluoroscopic imaging for reliable cannula placement in a patient with a sacral insufficiency fracture and previous pedicle screw fixation.

Keywords: Vertebroplasty, sacral insufficiency fractures, osteoporosis, sacral vertebroplasty

Compression fractures of the spine are a common complication of osteoporosis and result in significant morbidity and increased mortality. These fractures often produce severe pain with weight bearing, resulting in impaired mobility and its associated complications. Vertebroplasty is now commonly used as a treatment for these fractures of the spine, and is typically performed on an outpatient basis (1). The procedure involves the percutaneous instillation of polymethylmethacrylate (PMM) cement directly into the involved vertebra, which then hardens to stabilize the compression fracture; it can also produce some restoration of vertebral height. Vertebroplasty was traditionally the domain of interventional radiologists and spine surgeons, but now is increasingly performed by interventional pain specialists. Many patients have persistent pain following successful vertebroplasty that can arise from other sources within the spine including additional vertebral fractures, spinal stenosis (often associated with the compression fracture), facet arthropathy, and very commonly from sacroiliac origins. These sources may be easily recognized and treated by interventional pain specialists who are intimately familiar with alternate sources of spine pain and its treatment.

Sacral insufficiency fractures are another important, but often overlooked, source of debilitating low back pain (2,3). These fractures often arise from the same conditions that predispose to vertebral compression fractures, such as osteoporosis, radiation exposure, steroid use, rheumatoid arthritis, or the presence of malignancy. Patients typically present with severe low back pain that is aggravated by weight bearing, and patients may be unable to ambulate secondary to the discomfort. They often have palpation tenderness over the lumbosacral or sacroiliac region, without radicular symptoms. Standard radiologic studies are often non-specific, so the diagnosis may be missed without more advanced imaging studies, and a high index of suspicion for the presence of these fractures. The diagnosis can be confirmed by CT scan, MRI imaging with special attention to the sacral region, or by scintigraphic bone scan, which will demonstrate the classic "H" sign of the sacral insufficiency fracture (4).

Several reports have been described of successful treatment of sacral insufficiency fractures by percutaneous injection of PMM cement using biplanar fluoroscopic imaging, with or without additional CT guidance for cannula placement (5-7). The sacral foramina are difficult to visualize under all fluoroscopic angles, and Garant (5) describes placing a marker needle into each of the S1, S2 and S3 foramen prior to injection of PPM cement to prevent the potential risk of cement extravasation into one or more sacral foramen. These reports also state some difficulty in determining the adequate depth of the cannula tip by fluoroscopic imaging alone, so as to be deep to the dorsal cortical bone, but not deep to the ventral sacral cortical bone. Venography was not found to be a reliable indicator of needle position, and in one case (6), dorsal extraosseous extravasation of PPM cement occurred outside the sacral cortical bone. Interestingly, despite that event the patient did achieve good pain relief.

Due to problems in determining the correct depth of cannula placement, the procedure is often performed with the aid of CT guidance. However, in order to quickly detect any stray cement extravasation, this does not obviate the need for real time fluoroscopic imaging during the injection of PMM cement. In the setting of previous surgery with hardware in place, however, CT scan images may be degraded by metal artifact, making the CT image-guided approach less effective.

The presence of hardware from previous spine surgery is a common clinical occurrence that may cause metal artifact of the image during CT-guided sacral vertebroplasty. Also, since the CT-guided technique still requires fluoroscopy,

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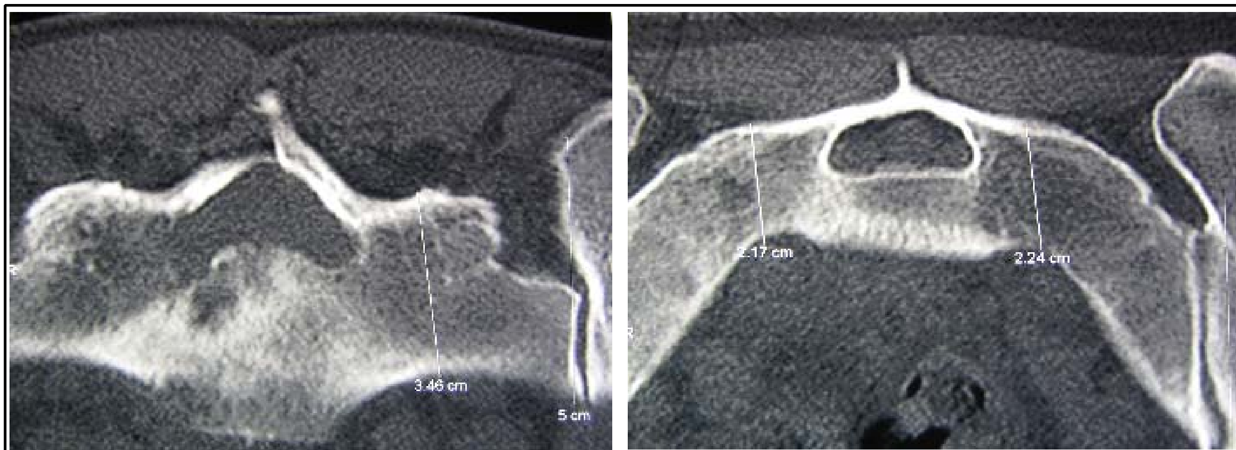

Fig 1. *Sacral ala marrow cavity depth (left) and S3/4 marrow depth (right)*

a reliable all-fluoroscopic technique for successful sacral vertebroplasty would be a welcome alternative to the combined approach. Presented here is an all-fluoroscopic technique for sacral cannula placement that addresses the problem of cortical depth in a patient with hardware in place from a previous lumbar fusion.

Case Report

The 76-year-old female patient had undergone L3 through S1 spinal fusion with transpedicular screw fixation for low back and radicular pain. She did well following the procedure until 7 months postoperatively when she developed a new onset of severe low back pain that required her hospitalization. On scintigraphy scan she was found to have a sacral insufficiency fracture. During her hospitalization, she was treated with an epidural steroid injection, without appreciable improvement. She was discharged on pain medication but her symptoms persisted and she was unable to bear weight. On office examination she presented in a wheelchair and had severe lumbosacral pain with weight bearing, and tenderness over both sacroiliac regions. She did not report any radicular symptoms and she had no lower extremity weakness. Given the patient's severe pain despite conservative management and her inability to bear weight, the patient was scheduled for percutaneous sacral vertebroplasty.

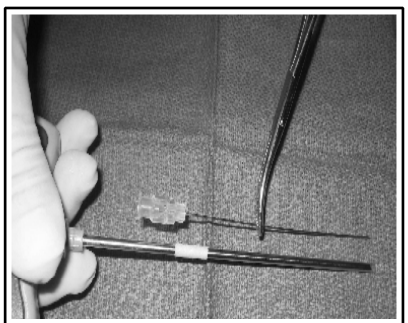

Fig. 2. *Sounding needle depth marked 2 cm deeper on cannula.*

To estimate the approximate depth for cannula placement, a sacral CT scan from the radiology film library was reviewed. Careful measurements were made of the depth of the sacral marrow space from the dorsal to ventral cortex at the level of the sacral ala and the S3/4 level (Fig 1). The scan revealed that the ala has a marrow depth of about 3.5 cm while at the S3/4 level the depth is only 2-2.5 cm. The sacroplasty was to be performed via a single cannula per side at the level of the ala only, so an additional 2-3 cm of depth was deemed adequate to be safely within the marrow cavity. If additional cannula were to be placed in a more caudad aspect of the sacrum, only a 1-2 cm additional cannula depth would be required.

Prior to the procedure, the patient received one gram of cefazolin, then was taken to the operating room and placed in the prone position. An anesthesiologist delivered monitored anesthesia care, and the lumbosacral region was prepped and draped in the usual sterile fashion. The sterile draped fluoroscope was positioned into an AP view and the previous L3-S1 fusion with hardware was visualized. The lumbo-sacral junction was centered and the C-arm adjusted until the S1 foramen could be visualized.

A 22-gauge 3.5-inch styletted needle was advanced under fluoroscopic guidance into each foramen to mark their location prior to cementing. Only the S1 foramen was marked because the remaining foramen are typically along the same line as the L5 pedicle and the S1 foramen. As long as any cement remains lateral to this line, there should be no extravasation into a foramen.

After identification of the S1 foramen, the C-arm was rotated in a cephalad direction until the sacral ala curvature aligned and blended with the proximal iliac curvature, then the fluoroscope was rotated to a right oblique view until the cephalad portion of the_left sacroiliac joint was well visualized. A 1% lidocaine skin wheal was placed over the mid-portion of the left sacral ala, 3 cm caudad from the superior most margin.

A 20-gauge spinal needle was inserted through the skin wheal and advanced until contact was made with the cortical bone on the dorsal surface of the sacral ala; periosteal infiltration with 0.5% Marcaine was then performed. The cortical bone depth of the "sounding needle" was noted by clamping a mosquito forceps at the skin level and the needle was withdrawn.

An 11-gauge vertebroplasty cannula was then placed alongside the sounding needle and the depth to dorsal cortical bone was marked on the cannula. A small piece of sterile tape was then placed an additional 2 cm above the sounding depth on the vertebroplasty cannula (Fig. 2). This would allow the cannula tip to advance an additional 2 cm deep to the cortical surface, well into the mar-

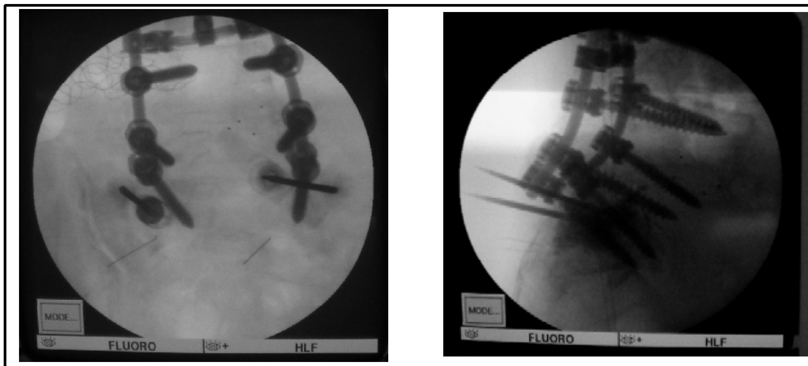

Fig. 3. *Cannula placement for sacroplasty and sacral foramen marker needles, AP view. Lateral view shows PPM cement and cannula position. Note the pedicle screws fall into the field of view in the lateral image.*

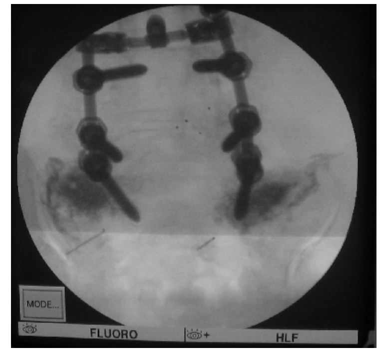

Fig. 4. *Final AP view of PMM cement placement with cement in sacral ala and lateral to sacral foramen located at the tips of the marker needles.*

row space of the sacral ala, but would prevent breaching the anterior cortical bone. The 11-gauge cannula was inserted under fluoroscopic guidance until bony contact was made, then it was advanced the additional 2 cm until the marker tape was at skin level. A cross table image was obtained and 3 cc of Isoview contrast was injected to rule out intravascular injection and to help confirm the cannula tip position.

The same procedure was then performed to place the cannula on the opposite sacral ala. The vertebroplasty PPM cement containing barium was prepared (Spineplex Radiopaque Bone Cement, Stryker Interventional Pain, Kalamazoo, MI) and 6 cc was injected on the right side and 4 cc on the left under continuous fluoroscopic imaging in the AP plane. No cement was seen to pass near the sacral foramen that were clearly marked with the previously placed spinal needles (Figs. 3 and 4). Both cannuli were removed and the patient was transported to the recovery room and kept supine for 2 hours. On follow up several days after the procedure, the patient had good symptomatic pain relief and was able to ambulate without assistance.

Discussion

Sacral insufficiency fractures are a painful debilitating condition that can be successfully treated with sacral vertebroplasty. A high index of suspicion and appropriate diagnostic imaging studies are necessary to identify a sacral insufficiency fracture in patients with low back pain who are at high risk for this condition. The all-fluoroscopic technique is a safe and effective alternative to the combined CT-guided technique, particularly in the presence of previous lumbar fusion with hardware where metal artifact degrades CT images.

The sacral S1 or S2 foramen should be directly identified by placing a secondary needle near or within the foramen prior to cementing to prevent intra-foramenal extravasation. The sacral foramen tend to align on the same vertical line as the L5 pedicle, so not every individual sacral foramen would need to be marked. As long as the PMM remains lateral to the L5 pedicle/sacral foramen line, cement extravasation into a foramen can be averted.

The problem with cannula depth placement to ensure intra-osseous delivery of cement may be addressed by prior sounding of the dorsal cortical depth with a second needle as described. The sounding depth can then be marked on the 11- or 13-gauge vertebroplasty cannula, with an additional 2-3 cm to ensure the needle tip is deep to the dorsal cortical bone, and within the marrow cavity. The ala has a thickness of 3-3.5 cm, whereas more caudad at S3/4 the thickness is only 2.5 cm, so the additional depth should be adjusted for the level of entry into the sacrum.

Continuous biplanar fluoroscopic imaging should be utilized throughout the actual injection of cement for early detection of cement trespass into undesirable areas. With the cement remaining lateral to the L5 pedicle/S1 foramen line, intra-foramenal extravasation may be avoided.

In this, and other reported cases, a single cannula was placed in each side of the sacrum. Often, placement of more than one cannula on a given side can cause difficulty with crisscrossing or crowding of the proximal cannula hubs due to the sacral curvature and the angles of entry required. The optimum number of cannula placements remains to be determined, but as in this report, good results have been obtained with even a single cannula per side.

Conclusion

Insufficiency fractures of the sacrum should be suspected in patients with osteoporosis and persistent lumbosacral pain that is significantly worse with weight bearing. After obtaining appropriate diagnostic studies, these fractures may be successfully treated with sacral vertebroplasty. The procedure may be effectively performed under fluoroscopy alone as described, which offers a useful alternative in similar clinical situations where CT imaging may be compromised by metal artifact, or a CT/fluoroscopy system may not be available.

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