Anterior Transpsoas Approach for Removal of Cement Leakage after Sacroplasty

James M. Mok[1], Jason A. Strelzow[2], Van L. Vallina[3] and Lukas P. Zebala[1]

1) Department of Orthopaedic Surgery, NorthShore University HealthSystem, Skokie, Illinois, USA
2) Department of Orthopaedic Surgery and Rehabilitation Medicine, University of Chicago, Chicago, Illinois, USA
3) DuPage Medical Group, Elmhurst, Illinois, USA

Abstract:

Introduction: Sacroplasty is a minimally invasive treatment option for severe pain due to sacral insufficiency fracture. Cement leakage is a known risk of sacroplasty. Despite the elevated risk to the L5 nerve root and lumbosacral trunk from cement leakage anterior to the sacral ala, there are no reports regarding surgical management of this complication.

Technical Note: We describe an anterior retroperitoneal transpsoas approach to the sacral ala to remove cement leakage causing acute L5 radiculopathy in a 57-year-old gentleman who had undergone sacroplasty for sacral insufficiency fracture (Denis zone 1). The approach provides rapid and excellent visualization of the sacral ala without manipulation of the iliac vessels.

Conclusions: We recommend that surgery be considered in a timely fashion, to utilize neuromonitoring, and that surgeons be aware of the considerable variability of the neurologic structures that will be encountered, which is described in this technical note.

Keywords:

sacroplasty, complication, surgery, cement leakage, PMMA, polymethylmethacrylate, L5 radiculopathy

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Introduction

Sacral insufficiency fractures due to osteoporosis or tumor can cause severe, prolonged, debilitating lower back pain[1]. Sacroplasty is a minimally invasive treatment option for severe pain refractory to conservative modalities[2-4]. The sacroplasty procedure involves the percutaneous injection of polymethylmethacrylate (PMMA) cement into the fracture site[5]. Numerous case series have reported its safety[2-4,6], but as with any invasive procedure, there are risks, including the potential for neurologic or vascular injury, embolism, and leakage of the cement[7].

Treatment options for symptomatic cement leakage include observation, medication, steroid injection, and surgical decompression. Because most sacral insufficiency fractures occur lateral to the sacral foramina (Denis zone 1), leakage into the zone 1 fracture gap has a high risk of affecting the L5 nerve root in its course over the sacral promontory[7]. To the best of our knowledge, there is no published technique for the surgical management of this complication. We describe the surgical removal of cement leakage causing an L5 radiculopathy performed via an anterior retroperitoneal approach, review the relevant anatomy, and compare alternative approaches for anterior decompression.

Technical Note

Case presentation

The patient is a 57-year-old man with seronegative rheumatoid arthritis who presented with atraumatic right-sided sacral pain with acute worsening over 8 weeks, refractory to pain medication and activity modification. Subsequent evaluation by magnetic resonance imaging (MRI) showed a non-displaced right sacral fracture (Denis zone 1) with bony edema. The patient was diagnosed with symptomatic sacral insufficiency fracture. Because of worsening pain and after a discussion regarding risks and alternatives, the patient chose

Corresponding author: James M. Mok, jmok@northshore.org
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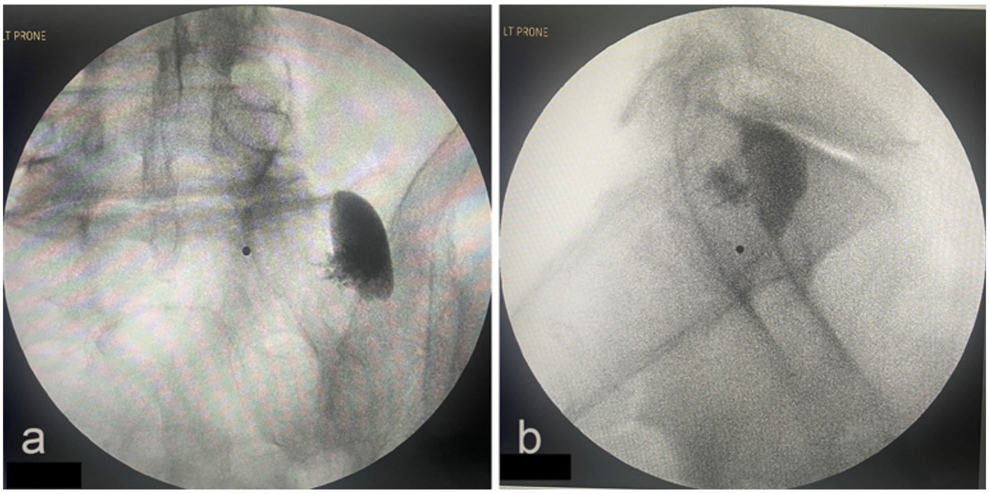

Figure 1. Postprocedural fluoroscopy showing (a) AP and (b) lateral images immediately following right sacroplasty.

to undergo sacroplasty. The sacroplasty was performed in the prone position under light intravenous sedation via a posterior approach with fluoroscopy (Fig. 1). Shortly afterward, the patient reported increasing pain and weakness in his right lower extremity. MRI and computer tomography (CT) scan showed extravasation of cement anterior to the fracture site, resulting in near-circumferential encompassment of the L5 nerve root and lumbosacral trunk (Fig. 2, 3). The patient presented for surgical consultation on postprocedure day 14. He was found to have severe pain, decreased sensation in the right L5 dermatome, and ankle dorsiflexion weakness (3/5). Because of the severity of the pain and progressive neurologic deficit, surgical excision of the cement was recommended to decompress the L5 nerve root.

Description of technique

The patient underwent a standard bowel prep before surgery. Surgery was performed under general anesthesia in the supine position. Intraoperative neurophysiological monitoring with somatosensory evoked potentials (SSEPs) and electromyogram (EMG) modalities was utilized. Continuous SSEPs were obtained for bilateral upper and lower extremities via stimulation of the posterior tibial nerve and ulnar nerve and measured by needle electrodes placed in the scalp overlying the sensory cortex. Surface pad electrodes were placed over the tibialis anterior, medial gastrocnemius, vastus medialis, and iliopsoas muscles bilaterally to monitor spontaneous EMG activity.

Incisional planning was performed using A-P (anterior-posterior) fluoroscopy directly over the cement in the right sacral ala. A transverse incision was made directly overlying the cement, starting at the midline of the abdomen and extending to the lateral border of the rectus abdominis muscle. The rectus was mobilized starting from its medial border in a circumferential fashion. The retroperitoneal space was entered lateral to the rectus. The peritoneum and ureter were swept superiorly and medially using blunt dissection. Thus, the anterior retroperitoneal approach was used to access the right psoas muscle[8]. The right common iliac vein was visualized, but no retraction was necessary. A ring retractor system was placed. The psoas muscle and overlying genitofemoral nerve were visualized. An expandable retractor system was initially placed over the cement, but because of robust EMG activity, it was replaced with handheld blunt retractors. Inspection of the field revealed multiple elements of the lumbar plexus anterior lateral to the cement. The amount of retraction was adjusted to minimize EMG activity, which remained active albeit at a lower intensity. Under loupe magnification, the neural elements were mobilized readily with a Penfield retractor. It was possible to develop a plane between the L5 nerve root and overlying cement, and 1- and 2-mm Kerrison rongeurs were used to resect a small portion of the cement until it became loose. The cement was then excised en bloc. Spontaneous EMG activity lessened and resolved. No further loose cement was visualized, and fluoroscopy confirmed the removal of the extra-osseous portions of the cement. The estimated blood loss was 25 mL. Postoperatively, the patient reported immediate improvement of symptoms and was discharged the next day.

New symptoms related to the surgery, including surgical site pain, groin pain, and dysesthesias involving the anterior thigh, improved by 2 weeks postoperative. At follow-up 3 months postoperative, the patient reported substantial improvement of the right lower extremity pain. There was a persistent burning pain in the right forefoot and weakness in dorsiflexion (4/5). Because of the restoration of mobility and no need for strong pain medication, he reported satisfaction with the outcome of surgery.

Discussion

We demonstrate the feasibility of the removal of sacroplasty cement leakage via an anterior approach. To the best of our knowledge, this is the first description of a transpsoas approach for decompression of an L5 nerve root compressed by cement leakage. The advantages of this ap-

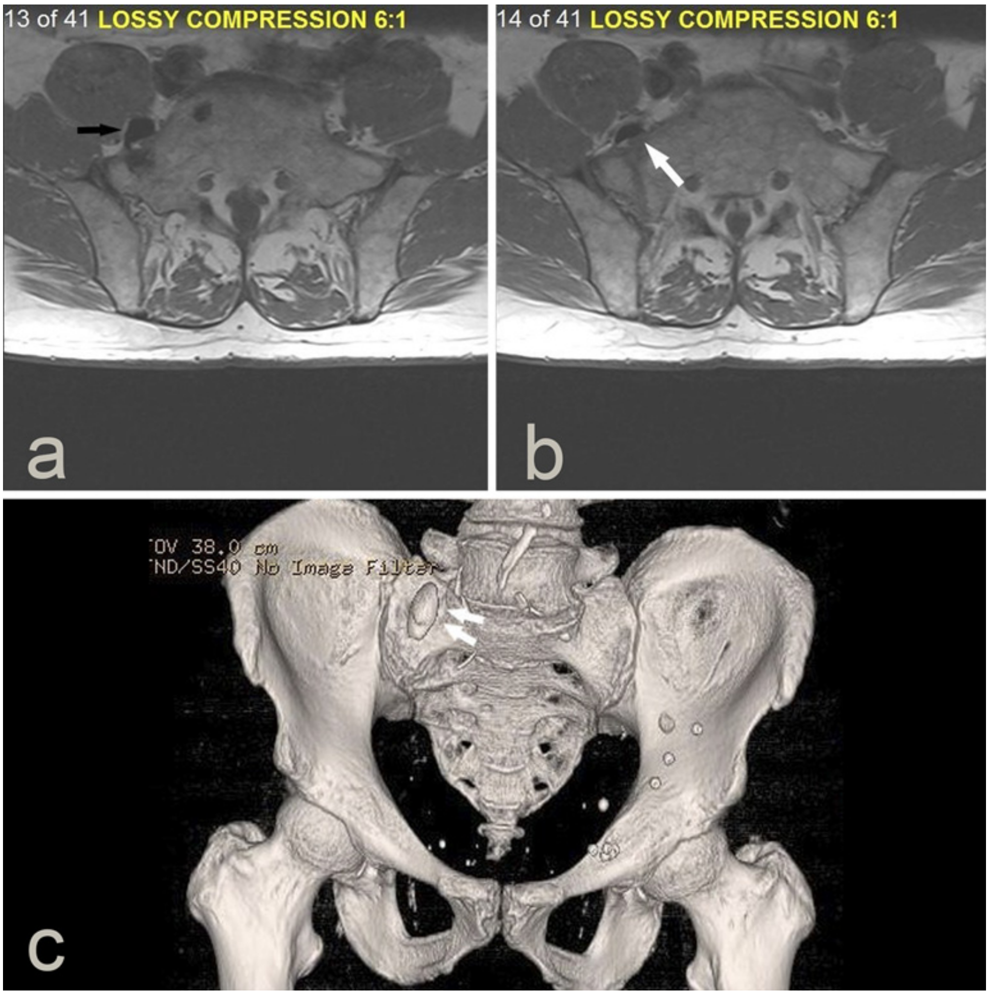

Figure 2. (a, b) Axial T1-weighted MRI demonstrating leakage of cement, indicated by a black arrow in (a), causing compression of the L5 nerve root, indicated by a white arrow in (b). (c) 3D reconstruction of CT scan demonstrating a large amount of cement leakage anterior to the right sacral ala, indicated by double white arrows.

proach are its low morbidity, excellent visualization of neural structures, minimal manipulation of the common iliac artery and vein, and direct access to the anterior sacral ala. The approach allows access to the area of the sacrum most frequently involved in sacral insufficiency fractures (zone 1), which is more lateral than other pathologies causing L5 radiculopathy such as far-out syndrome, osteophytes arising from the L5-S1 disc space, and high-energy pelvic trauma[9-11,4].

Sacroplasty has been shown using numerous case series to be an effective treatment option for severe and debilitating pain resulting from sacral insufficiency fracture that does not improve sufficiently with conservative treatments[3,4,12]. Although cement leakage is a known complication, details regarding surgical excision are sparse. Most descriptions are brief mentions of posterior decompressions[6] despite the special risk of cement leakage anterior to the sacrum. Barber reported a case of cement removal utilizing a posterior approach to decompress the S1 nerve root within the foramen[13]. The authors voiced concerns regarding the risk of cement removal, including technical difficulty and adherence of PMMA to the nerve root.

The rate of cement leakage may be higher than expected. Looking specifically for cement leakage, Bastian found cement extravasation in 20 of 63 (32%) sacroplasties, mostly within the fracture gap[7]. Some authors have advocated routine use of CT guidance to better visualize the upper sacrum and neural foramina to address this risk[12]. Considering that sacroplasty is often indicated for zone 1 fractures[2], risks should be weighed appropriately, including the risk of serious neurologic injury.

Understanding the relevant anatomy of neurologic structures is necessary for this approach. The L4 and L5 nerve roots and lumbosacral trunk are fixed well to the sacral ala by fibrous connective tissue. The L4 nerve root enters the pelvis an average of 17.86 mm medial to the sacroiliac joint and merges with the more medial L5 nerve root to form the lumbosacral trunk, which courses inferolaterally so that at the pelvic brim it is 5.31 mm medial to the joint. The lumbosacral trunk is located medial to the psoas major and descends in front of the lateral aspect of S1 and the sacroiliac joint[14]. The surgeon should be aware of considerable vari-

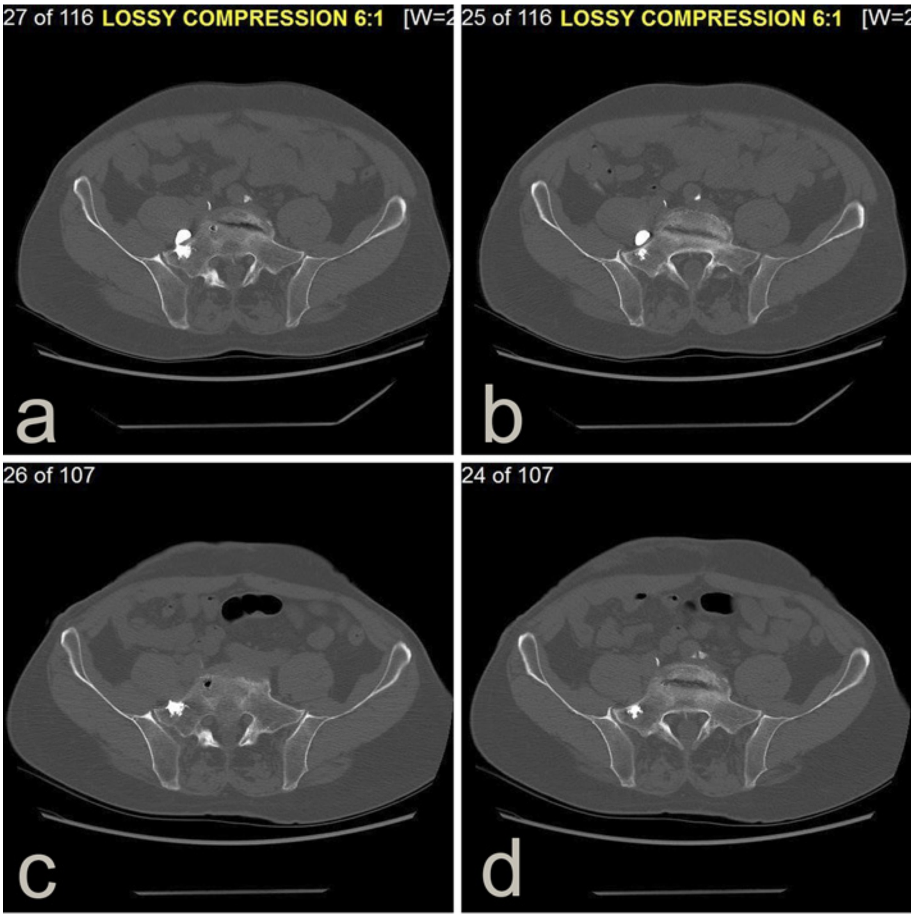

Figure 3. Axial CT images before (a, b) and following (c, d) the removal of the extra-osseous portion of the cement via an anterior retroperitoneal transpsoas approach.

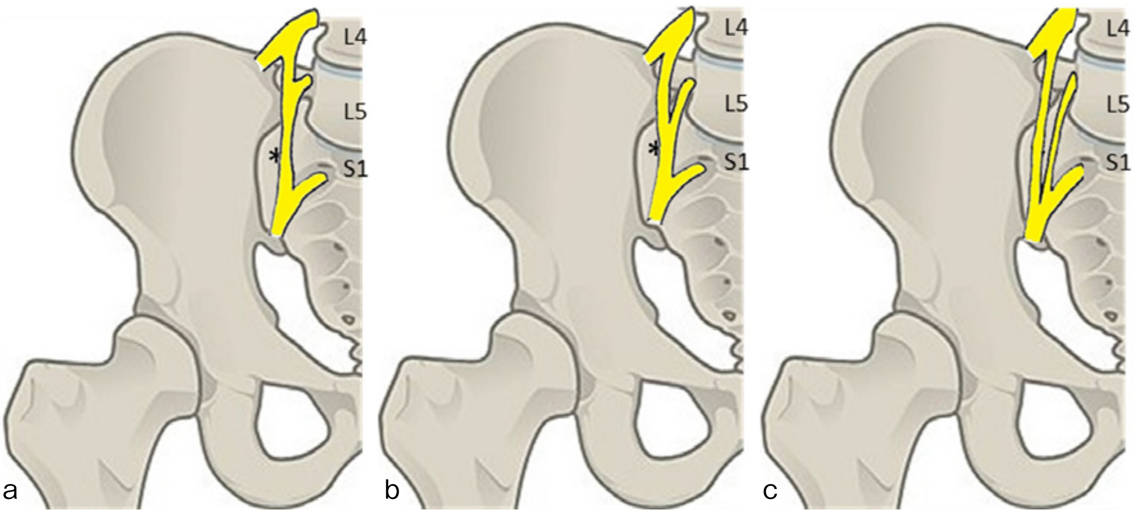

Figure 4. There is considerable variability in the course of the L4 and L5 nerve roots, which can merge to form the lumbosacral trunk (a) at the level above, (b) on, and (c) below the most anterior part (shown as *) of the sacrum (adapted from Waikakul S, Chandraphak S, Sangthongsil P. Anatomy of L4 to S3 nerve roots. J Orthop Surg (Hong Kong). 2010 Dec;18 (3):352-5).

ability in the neuroanatomy that cannot be predicted from preoperative imaging (Fig. 4). One anatomic study found that the L4 nerve root may join the L5 nerve root to form the lumbosacral trunk above or below the most anterior portion of the sacral ala in roughly equal proportions[15]. The lumbosacral trunk has been measured to be 11 mm wide and 4 mm thick[16], but there can be considerable variability in the size and length of the L4 and L5 nerve roots[15]. The

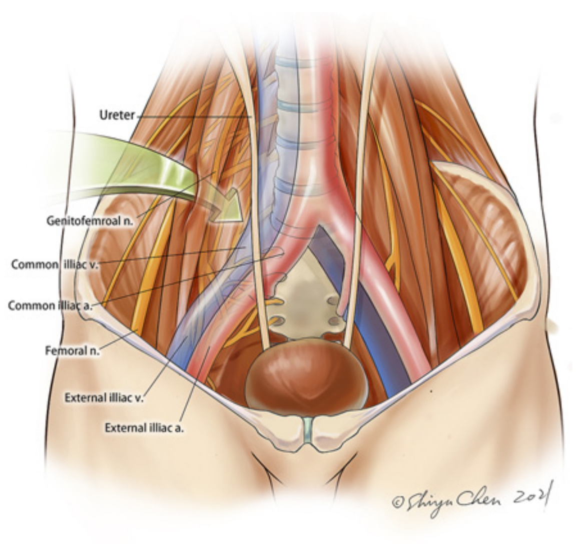

Figure 5. Schematic illustration showing the transpsoas approach to the sacral ala, lateral to the common iliac vein, in close proximity to the elements of the lumbar plexus. Copyright 2021, Shiyu Chen. Used under permission.

L5 nerve root was found to be duplicated or plexiform in a quarter of the specimens in another anatomic study[17]. Other neurologic structures that will be encountered include the genitofemoral nerve, femoral nerve within the posterior portion of the psoas, and obturator nerve, which also lies within the posterior portion of the psoas and emerges from the posteromedial border of the muscle opposite the L5 vertebral body (Fig. 5)[18,19].

Previous authors have described decompression of the L5 nerve root via an anterior approach for various pathologies. Bureta presented a case report describing the decompression of an L5 nerve root compressed by a large osteophyte in a transitional segment. The common iliac artery and vein were retracted medially, and the occurrence of a vascular injury in their case report highlights the risks of manipulating blood vessels[20]. Jones described a case of an osteophyte arising anterolaterally from the L5-S1 disc space compressing the L5 nerve root against the sacral ala. Their initial approach was between the bifurcation of the aorta, followed by exposure and removal of the osteophyte[10]. Kikuchi, reporting resection of large anterior osteophytes arising from the L5 transverse process due to transitional anatomy, performed ligation of the iliolumbar vein, medial retraction of the iliac vessels, and lateral retraction of the psoas muscle[11]. A similar technique was described by Hackel in four cases of high-energy vertical sacral fractures in which the L4 and L5 nerve roots were compressed by the fracture site or comminution. Contrary to the above, most cases of sacroplasty cement leakage occur laterally, which allows for an approach that avoids retraction of the psoas muscle or common iliac vessels[9].

An anterior retroperitoneal transpsoas approach provided rapid and excellent visualization of the cement and affected nerves. Although the cement had interdigitated among the elements of the lumbar plexus, it was not adherent to any of the structures that were mobilized with blunt dissection. Removal was facilitated by the morphology of the cement, which exited the sacrum via a thin stalk. It was not necessary to use a high-speed bur, which would have been a daunting proposition because of the proximity of the web-like elements of the lumbar plexus. We recommend that surgery be considered in a timely fashion, to utilize neuromonitoring, and that surgeons be aware of the variability of the plethora of neurologic structures that will be encountered.

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Author Contributions:

Concept, design, acquisition, analysis, and interpretation: J. Mok

Concept, design, analysis: J. Strelzow

Acquisition: V. Vallina

Analysis, interpretation: L. Zebala

Drafting and revising critically: J. Mok

Revising critically: J. Strelzow, V. Vallina, L. Zebala

Final approval: J. Mok, J. Strelzow, V. Vallina, L. Zebala

Ethical Approval: IRB approval was not necessary for this technical note, which is being considered equivalent to a case report. The patient provided informed consent for the publication of this case.

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