

Case Report

Paraplegia Following Image-Guided Transforaminal Lumbar Spine Epidural Steroid Injection: Two Case Reports

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ABSTRACT

Objective. To present two case reports of a rare but devastating injury after image-guided, lumbar transforaminal injection of steroids, and to explore features in common with previously reported cases.

Background. Image (fluoroscopic and computed tomography [CT])-guided, lumbar transforaminal injections of corticosteroids have been adopted as a treatment for radicular pain. Complications associated with these procedures are rare, but can be severe.

Case Reports. An 83-year-old woman underwent a fluoroscopically guided, left L3–L4, transforaminal injection of betamethasone (Celestone Soluspan). A 79-year-old man underwent a CT-guided, right L3–L4, transforaminal injection of methylprednisolone (DepoMedrol). Both patients developed bilateral lower extremity paralysis, with neurogenic bowel and bladder, immediately after the procedures. Magnetic resonance imaging scans were consistent with spinal cord infarction. There was no evidence of intraspinal mass or hematoma.

Conclusion. These cases consolidate a pattern emerging in the literature. Distal cord and conus injury can occur following transforaminal injections at lumbar levels, whether injection is on the left or right. This conforms with the probability of radicular-medullary arteries forming an arteria radicularis magna at lumbar levels.

All cases used particulate corticosteroids, which promotes embolization in a radicular artery as the likely mechanism of injury. The risk of this complication can be reduced, and potentially eliminated, by the utilization of particulate free steroids, testing for intra-arterial injection with digital subtraction angiography, and a preliminary injection of local anesthetic.

Key Words. Epidural (Injection Space); Steroids

Introduction

Transforaminal injections of corticosteroids are widely used for the treatment of lumbar radicular pain. With this approach, medication can be delivered, in high concentrations, directly onto

the affected nerve, close to the site of pathology. On balance, transforaminal injections of steroids appear to be effective. Two controlled studies report negative results [1,2], but three studies report positive results [3–5], particularly with respect to avoiding surgery at 5-year follow-up [6].

These injections are not free of complications. The literature records six cases of paraplegia [7–10]. All cases involved the use of particulate corticosteroids. All patients had a rapid onset of symptoms, and postprocedure magnetic

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Figure 1 Frontal fluoroscopy view after injection of contrast medium. The needle is positioned at the exit zone of the left, L3–L4 intervertebral foramen.

resonance imaging (MRI) demonstrated changes consistent with distal spinal cord and conus infarct. The presumed cause of all the injuries was an interruption of the blood supply to the spinal cord through the *arteria radicularis magna* (the artery of Adamkiewicz). This report describes two additional cases.

Case 1

An 83-year-old, otherwise healthy female presented with sudden onset of left “hip” and lateral knee pain without preceding trauma. Her pain was severe enough to warrant the use of crutches, and was aggravated by prolonged sitting, standing, and walking. She had no lower extremity numbness or weakness. Physical examination revealed normal reflexes, strength, and sensation. She had no dural tension signs, but examination of the left hip was limited by pain. Lumbar spine MRI revealed multilevel degenerative disc disease with a left L3–L4 disc extrusion that filled the intervertebral foramen, compromising the L3 segmental nerve.

Despite several months of conservative treatment, including nonsteroidal anti-inflammatory drugs (NSAIDs), gabapentin, hydrocodone, and physical therapy, her symptoms persisted. She underwent a fluoroscopically guided left L3 transforaminal corticosteroid injection with initial pain

relief. After 2 weeks, her pain returned and she elected to undergo a second, left L3–L4 transforaminal injection.

Using a posterior approach, a 26-gauge, 3.5-inch spinal needle was advanced toward the left L3–L4 intervertebral foramen. On coronal view, the needle was projected just lateral to the inferior margin of the left L3 pedicle, over the “exit zone of the L3 root canal.” When subtle radicular symptoms were elicited, contrast medium (Isovue-300) was instilled. The injection was observed with real-time fluoroscopy. Digital subtraction angiography was not performed. No arterial or venous uptake and no subarachnoid spread were observed (Figure 1).

A mixture of 1 cc of bupivacaine (0.75%) and 1 cc Celestone Soluspan (6 mg/cc) was slowly infused. When the needle was withdrawn, the patient noted immediate onset of bilateral lower extremity numbness and weakness.

A lumbar MRI was performed 2 hours after injection. There was no evidence of an epidural hematoma or cord compression. There was no intrinsic abnormal cord signal. A repeat MRI 2 days later revealed a focal area of increased T2 signal within the gray matter of the conus and distal thoracic cord, consistent with acute spinal cord infarction (Figure 2). The patient was found to have an ASIA grade C, L1 spinal cord injury that necessitated admission to an inpatient rehabilitation hospital.

Eighteen months after the incident, she still had neurogenic bowel and bladder, as well as impaired sensation in both lower extremities. She had partial motor recovery, and progressed to an ASIA grade D L1 spinal cord injury, with all muscles having at least a 4/5 strength on manual muscle testing. Unfortunately, her weakness necessitated the use of a walker for household ambulation and she was unable to live independently.

Case 2

A 79-year-old man with a history of multilevel instrumented lower lumbar fusion developed right anterior thigh pain. He had no history of recent trauma.

He underwent a right L3–L4 transforaminal corticosteroid injection under computed axial tomography (CT) guidance. Using an oblique, paraspinous approach, a 100-mm, 22-g needle was advanced toward the intervertebral foramen. The needle was too short to reach the required target point: to maintain its position in the root canal, the skin and subcutaneous tissues were “indented” as the needle was pushed to its full length. Prior to



Figure 2 Sagittal magnetic resonance imaging taken 2 days after a left, L3 transforaminal injection of particulate corticosteroids, showing infarction (black arrow) of the lower thoracic spinal cord.

injection, CT axial images demonstrated the tip of the needle at the extreme anterior, superior aspect of the left L3–L4 intervertebral foramen, against the posterior surface of the L3 vertebral body (Figure 3A).

Into a large single syringe, 2 cc of contrast medium (Omnipaque, 200 mg/cc), 2 cc of Depomedrol (160 mg) and 6 cc of Marcaine (0.375%) were drawn and delivered in two 5-cc aliquots, for a total volume of 10 cc. Postinjection CT images were obtained (Figure 3B). The patient developed sudden lower extremity paralysis, with a neurogenic bowel and bladder at completion of the injections. The operator initially felt the “paralysis” was the result of an “anesthetic block.” The symptoms did not resolve over night.

MRI scans 2 days after injection revealed a pathological increased T2 signal in the cord from T9 to the tip of the conus, consistent with a distal cord and conus infarction (Figure 4).

Discussion

These cases share features in common with those already reported in the literature. The injections

were performed at lumbar levels with a transforaminal approach, using particulate steroids, and the patients developed distal thoracic cord and conus infarcts.

Of the six cases reported in the literature, to date, one was performed on the right at L3–L4 and L4–L5 levels, but the other five were on the left, one at T12–L1, one at L1–L2, one at L2–L3, one at L3–L4, and one at S1 [7–10]. The present cases add two injections at L3–L4, one on the left and one on the right.

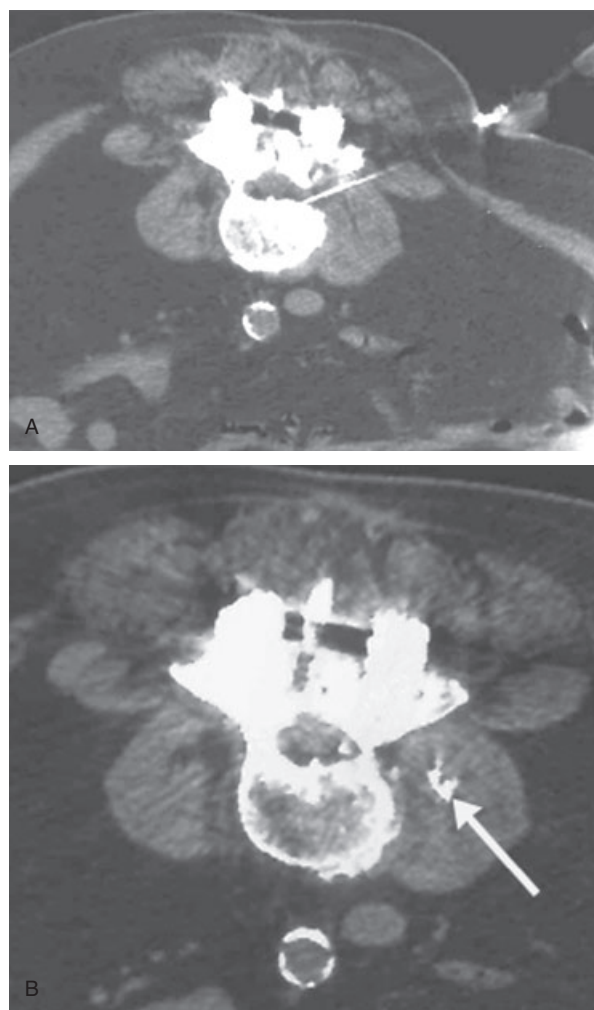


Figure 3 Prone Axial CT views of right L3 transforaminal injection. (A) The needle tip lies against the vertebral body in the midzone of right L3–L4 intervertebral foramen prior to injection. The next section documented that the needle tip was immediately below the pedicle, in the anterior superior aspect of the root canal. (B) After injection, some contrast medium is seen in the lateral recess or entrance zone of L3 root canal. Contrast medium is also seen in the extraforaminal zone and in the surrounding neurovascular structures (white arrow) in the right psoas muscle.



Figure 4 Thoracic magnetic resonance imaging, midsagittal section acquired 2 days after an L3 transforaminal steroid injection of particulate corticosteroids. Bright signal in the central cord represents part of a long distal thoracic cord and conus infarct.

The midlumbar to high lumbar sites of injection resonate with the distribution of the anterior reinforcing artery of the lower spinal cord (arteria radicularis magna; artery of Adamkiewicz). Arising from a thoracic or lumbar spinal artery, this artery enters an intervertebral foramen, where it lies close to the anterior—superior aspect of the dural root sleeve of the spinal nerve and its roots, before accompanying the nerve roots to the spinal cord. The artery arises on the left side in 69–85% of cases [11], anywhere between the T5 and L5 vertebral levels [12–14]. In one cadaver study, the artery arose between T9 to T12 in 75% of cases, between T5 and T8 in 15%, and between L1 and L2 in 10% [13]. In another cadaver study, it was located between T12 and L3 in 84% of cases, most commonly on the left at L1 [12]. In an angiography study, the artery was found at T8–L2 in 95.4% of cases, usually from the left T11 level [14].

The juxtapositioning of the reinforcing artery to a spinal nerve renders the artery susceptible to puncture during the conduct of a transforaminal injection. More disconcerting is the fact that arterial puncture can occur even with correct placement of the needle at recommended target points. This is due to the close proximity of the radicular artery to the spinal nerve. The relatively frequent location of the artery at upper lumbar levels increases the risk of injury when injections are performed at L3 or above. Heeding this anatomy, operators should be especially alert to the risk of misadventure when they perform transforaminal epidural corticosteroid injections at upper lumbar levels.

Commensurate with the less frequent location of the artery at lower lumbar levels, the risk may be less for procedures performed at L4 or below. However, arterial branches follow each of the roots of the cauda equina, from lower lumbar and sacral levels [13]. Lazorthes et al. [15] reported that if colloid is injected into the abdominal aorta below the origin of the artery of Adamkiewicz, the colloid material will appear in the conus. They postulated that it arrives there by way of aorta, to lumbar and sacral radicular arteries to ansa communications in the conus to the distal anterior spinal artery. Corticosteroid particulate matter would act as the colloid if injected into a lumbar or sacral radicular artery. Given reports of severe complications, even at lower lumbar levels, precautions should be taken at all levels to avoid intra-arterial injection. No lumbar level or side is immune to arterial puncture.

The imaging data in all cases indicate a spinal cord infarct. The exact mechanism of injury has not been proven. Embolization of the cord as a result of intra-arterial injection of particulate matter is the most likely mechanism of injury. In all cases, particulate steroids have been used. It has been shown that betamethasone (Celestone), methylprednisolone (Depo-medrol), and triamcinolone (Kenalog) have particles, or form aggregates, that are larger than red blood cells [16]. This means that they could act as emboli in arterioles, metarterioles, or some arteries, if injected into a radicular artery. Only dexamethasone sodium phosphate has particles smaller than red blood cells, and does not aggregate [16]. When particulate or nonparticulate steroids were injected into the vertebral arteries of pigs, all animals injected with particulate steroids failed to regain consciousness, and showed clinical, MRI, and histopathologic findings consistent with a cere-

brovascular insult. Those animals receiving non-particulate steroids expressed no evidence of neurologic injury, clinically, on imaging, or at postmortem [17].

These data suggest that operators would be prudent to avoid particulate steroids as a measure to reduce risk. Beliefs prevail that soluble steroids are less effective because they are rapidly cleared from the spinal canal [18], but no prospective studies have been published that compare the effectiveness of particulate and nonparticulate steroids for lumbar transforaminal injections. One abstract has been presented that prospectively compared triamcinolone with dexamethasone in the treatment of low back and radicular pain via lumbar transforaminal epidural steroid injections in 50 subjects [19]. The study showed a statistically significant greater reduction in pain at the 2-week follow-up in those receiving triamcinolone. The study, however, had methodological flaws including nonequivalent steroid doses and standard two-level injections. Additionally, one comparative study has been conducted of cervical transforaminal injections. It found no statistically significant difference, at 4 weeks, between outcomes achieved using dexamethasone or triamcinolone [20].

More fundamental to avoiding spinal cord injury is the recognition of intra-arterial injection at the time of the procedure, before corticosteroids are injected. Although not established as definitive, real-time fluoroscopy and digital subtraction angiography are the best means of obtaining this goal.

Aspiration is not a sufficient test. Intravascular injection despite negative aspiration has been documented in 11.2% of 761 consecutive transforaminal injections [21]. A positive flash or aspiration, during lumbosacral transforaminal injections, has a sensitivity of only 45% [21], and three of the known case reports of paraplegia following lumbosacral transforaminal injections reported a negative aspiration [7].

Proponents of CT guidance claim that in a single view, CT can depict both the medio-lateral and antero-posterior location of the tip of the needle. CT also demonstrates the soft tissue anatomy of the neural canals. Dispersal of contrast medium in the intervertebral foramen can be documented, but CT does not reveal arterial flow.

During the process of injecting, intermittent fluoroscopic spot filming is inadequate for visualizing vascular uptake [22]. Arterial flow can flush contrast medium out of view before an exposure is taken. Continuous fluoroscopy, during and

throughout the injection of contrast medium, is the only available means of demonstrating, intra-arterial flow away from the site of injection [23]. Digital subtraction angiography renders them more evident [23].

A further precaution is to precede the injection of corticosteroids with an injection of local anesthetic, and assess the patient for neurologic impairment. If intra-arterial injection is present and has not been recognized, the consequences of intra-arterial local anesthetic injection are likely to be only temporary. This was possibly demonstrated in a case of a cervical transforaminal injection [24]. No obvious radicular artery uptake was seen upon injection of contrast medium, but after injection of local anesthetic, the patient suffered loss of anterior spinal cord function. Corticosteroids were not injected, and the patient recovered in 20 minutes. A cautious protocol for all transforaminal injections would be to inject a test dose of local anesthetic, wait for 2 minutes for the full effect of the anesthetic to manifest, and then assess the patient's neurologic status. In the absence of weakness, numbness, or loss of proprioception, the injection of corticosteroids can then be completed with greater confidence than if the assessment had not been conducted.

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