





Injection into the Space of Okada During Transforaminal Epidural Steroid Injections

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Abstract

Objective. Ensuring medication delivery to the epidural space is crucial for effective transforaminal epidural steroid injections. Epidural needle placement is determined by injecting a small amount of contrast at the final needle position. The purpose of this study is to illustrate the appearance of contrast flow in the retrodural retroligamentous space of Okada during computed tomography- and fluoroscopy-guided cervical and lumbar transforaminal epidural steroid injections. **Design.** This retrospective study will use a series of cases to demonstrate contrast within the space of Okada during epidural transforaminal steroid injections. **Setting.** Tertiary medical center. **Subjects.** Study subjects are adult patients who underwent transforaminal epidural steroid injection at our institution. **Methods.** Cases were identified through the use of a search engine of existing radiology reports at our institution. Epidural steroid injection procedural reports were searched for the terms “Okada” and “retrodural space.” Images from the procedure were reviewed by the authors (all proceduralists with dedicated training in spinal injections) to confirm the presence of contrast within the space of Okada. **Results.** This case series illustrates six examples of contrast injection into the retrodural space of Okada during cervical and lumbar transforaminal epidural steroid injections. **Conclusions.** Contrast uptake in the retrodural space of Okada may be seen during transforaminal epidural injections. Although relatively uncommon, it is likely underrecognized. It is extremely important that providers who perform transforaminal epidural steroid injections be familiar with this non-epidural contrast flow pattern so they can adjust needle positioning to deliver steroid to the epidural space.

Key Words: Retrodural Retroligamentous Space; Space of Okada; Transforaminal Epidural Steroid Injection

Introduction

Image-guided transforaminal epidural steroid injections are commonly performed in patients with radicular pain. A key step in these procedures is the injection of a small amount of contrast material at the final needle position to confirm that the needle tip is in the desired location [1]. To deliver steroid appropriately to the therapeutic

target, it is crucial to demonstrate contrast flow in the epidural space. As such, the proceduralist must recognize non-epidural contrast patterns and reposition the needle if necessary.

The retrodural retroligamentous space of Okada is a potential extradural space located dorsal to the ligamentum flavum in the interlaminar space (Figure 1) [2, 3]. It

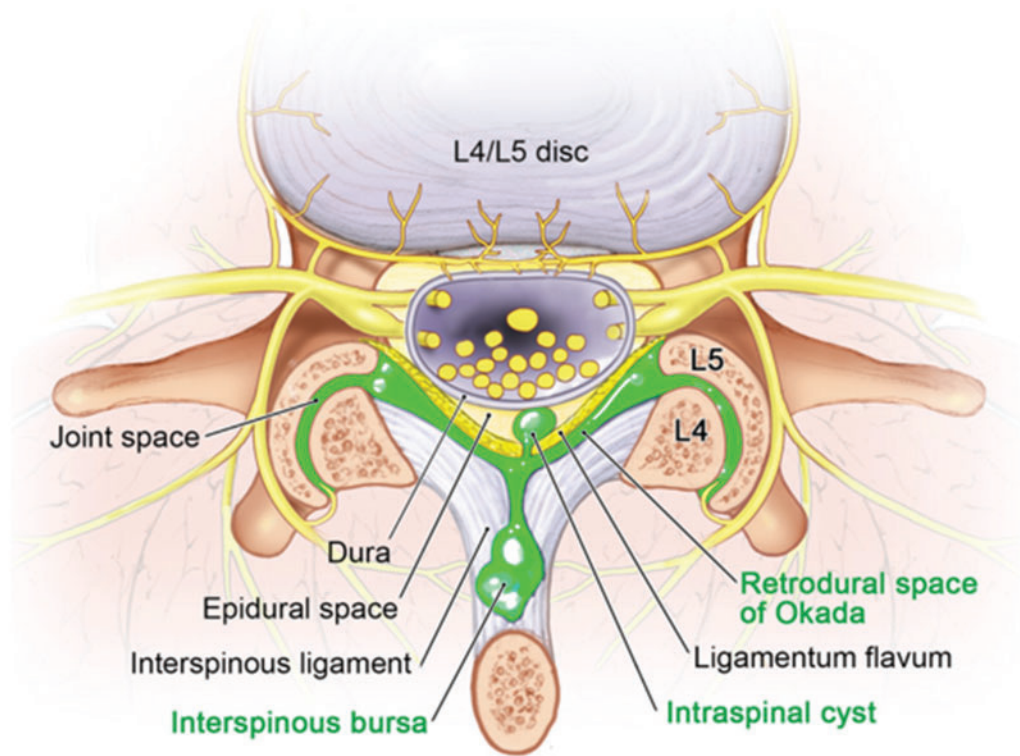


Figure 1. Artistic rendition of lumbar spine anatomy in the axial plane. The retrodural retroligamentous space of Okada is colored green, with depiction of communication with the bilateral facet joints, interspinous bursa, and through a defect in the ligamentum flavum. From: Lehman VT, Murthy NS, Diehn FS, Verdoorn JT, Maus TP. The posterior ligamentous complex inflammatory syndrome: spread of fluid and inflammation in the retrodural space of Okada. *Clin Radiol.* 2015;70(5):528–35. Used with permission of Mayo Foundation for Medical Education and Research. All rights reserved.

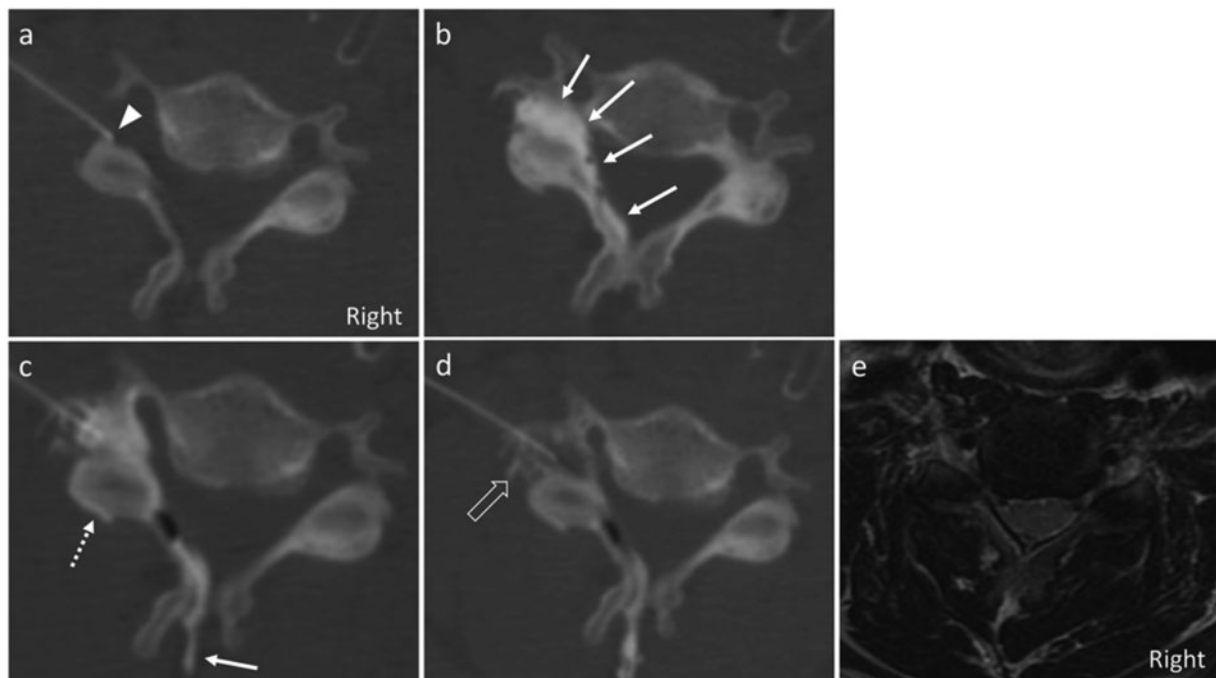


Figure 2. Patient 1. CT-guided left C5–C6 transforaminal epidural steroid injection in a 44-year-old male with left C6 radiculopathy. Precontrast axial image (a) shows the needle tip in the posterolateral left C5–C6 neural foramen (arrowhead). After injection of about 2 mL of diluted iohexol 300 mgI/mL, contrast appears to fill the foramen with central epidural flow (b, arrows). However, a more inferior image shows that most of this flow is actually within the retrodural space of Okada posterior to the ligamentum flavum and extending into the interspinous region (c, arrow) and partially filling the C5–C6 facet (c, dashed arrow). The needle tip was repositioned, and subsequent contrast injection shows peripheral and foraminal epidural flow (d, open arrow). Corresponding axial T2-weighted magnetic resonance image at the level of the injection (e).

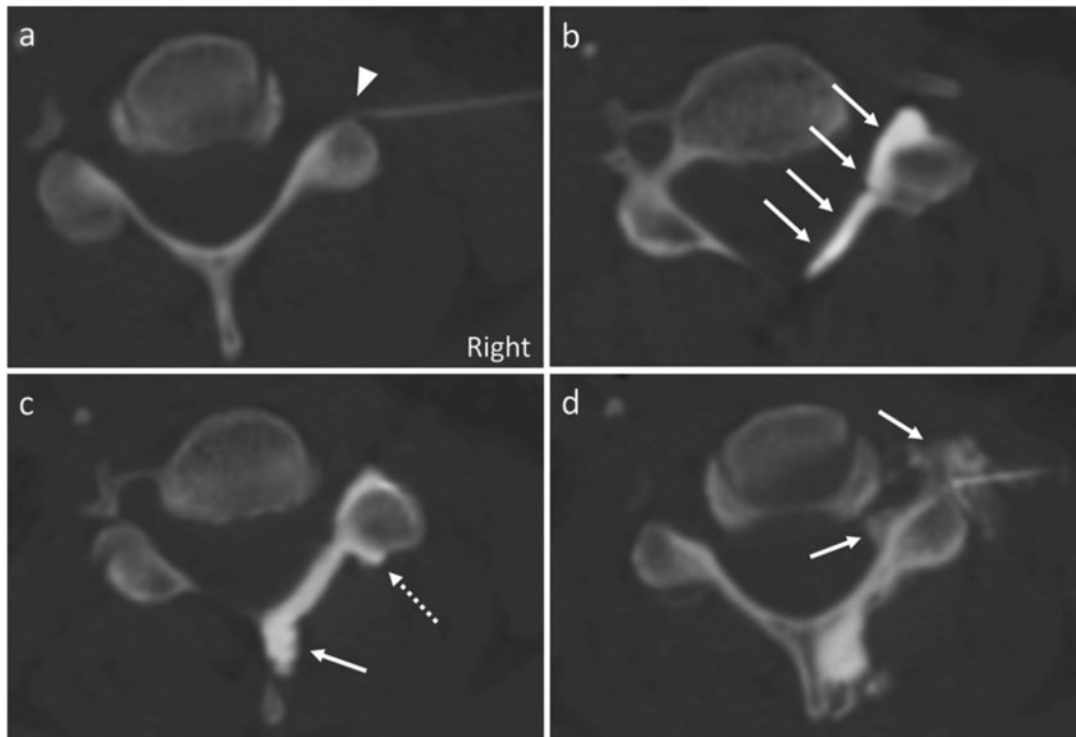


Figure 3. Patient 2. CT-guided right C4–C5 transforaminal epidural steroid injection in a 48-year-old female with right C5 radiculopathy. Precontrast axial image (a) shows the needle tip in the posterolateral right C4–C5 neural foramen (arrowhead). After injection of dilute iohexol 300 mgI/mL, contrast appears to be within the dorsal epidural space (b, arrows). However, a more inferior image shows that contrast is actually within the retrodural space of Okada extending posterior to the ligamentum flavum into the interspinous region (c, solid arrow) and partially filling the right C5–C6 facet (dashed arrow). The needle tip was repositioned, and subsequent contrast injection shows central and peripheral epidural flow (d, arrows).

allows communication between contralateral facet joints at the same level, as well as the interspinous ligament and/or interspinous bursae [2]. It was originally identified in 80% of cervical facet arthrograms [4]. Communication from lumbar facet joints to the retrodural space is less commonly observed and can vary by facet joint configuration [2].

The facet joint capsule attaches to the superior articular process laterally and the lamina medially [5]. The superior articular recess has been reported to communicate with the neural foramen and to have an opening at its lateral aspect [6]. The inferior articular recess of facet joints has a normal opening at its inferomedial aspect that communicates with the extracapsular fat [7]. In some facet joints, the ventral facet joint capsule may extend dorsal to the ligamentum flavum [3]. Further communication to the retrodural space may be seen in patients with severe spondylotic changes or interspinous adventitial bursa formation [3].

It has been suggested that fluid within a facet joint may result in an enlarged anterior facet joint recess, which theoretically could be accessed during a

transforaminal epidural steroid injection [2]. Because the space of Okada is in close proximity to the central epidural space, retrodural contrast flow could be mistaken for central epidural flow, both on computed tomography (CT) and conventional fluoroscopy. The purpose of the present study is to illustrate contrast flow in the retrodural space of Okada during CT- and fluoroscopy-guided cervical and lumbar epidural steroid injections.

Case Series

Institutional review board approval was obtained for the retrospective case series, and the requirement for informed consent was waived. A comprehensive search of PubMed was performed to identify relevant prior publications.

Cases were identified through the use of a search engine for existing radiology reports at our institution. Epidural steroid injection procedural reports were searched for the terms “Okada” and “retrodural space.” No date limits were set for this search.

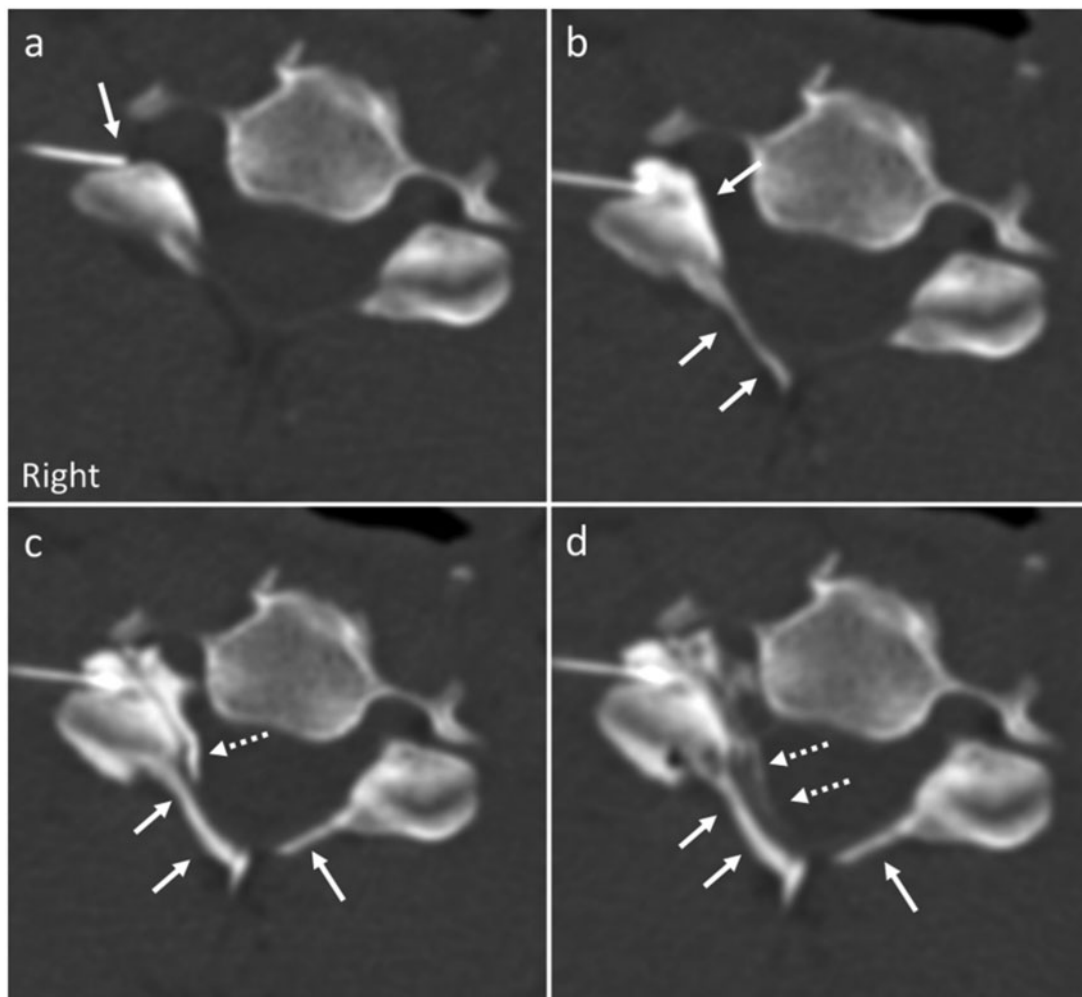


Figure 4. Patient 3. CT-guided right C5–C6 transforaminal epidural steroid injection in a 28-year-old male. Precontrast axial image (a) shows the needle tip in the posterolateral right C5–C6 neural foramen (arrow). After injection of about 2 mL of dilute iohexol 300 mgI/mL, contrast appears to fill the foramen but also clearly flows dorsal to the ligamentum flavum in the retrodural space of Okada (b, arrows), extending into the interspinous region. After repositioning of the needle and additional contrast injection, there was mostly central epidural flow (c, dashed arrow), clearly distinct from the more dorsal retrodural contrast (c, solid arrows). Washout image after dexamethasone injection showed that medication flowed in the epidural space (d, dashed arrows), with unchanged retrodural contrast (d, solid arrows).

Patient 1 was a 44-year-old male with acute left C6 radiculopathy. A CT-guided left C5–C6 transforaminal epidural steroid injection was requested and performed, as seen in Figure 2.

Patient 2 was a 48-year-old female with chronic right C5 radiculopathy. Images from a CT-guided right C4–C5 transforaminal epidural steroid injection are shown in Figure 3.

Patient 3 was a 28-year-old male with subacute right C5 and C6 radiculopathies. Figure 4 shows images from his CT-guided right C5–C6 transforaminal epidural steroid injection.

Patient 4 was a 78-year-old male with chronic right L5 radiculopathy and bilateral L5 pars defects. Images from a fluoroscopically guided right L5 transforaminal epidural steroid injection are shown in Figure 5.

Patient 5 was a 72-year-old female with chronic right L4 and L5 radiculopathies who underwent a fluoroscopically guided right L4 transforaminal epidural steroid injection (Figure 6). Imaging demonstrates anterolisthesis of L4 without pars interarticularis defects.

Patient 6 was a 72-year-old male with chronic right L4 radiculopathy. Images from a fluoroscopically guided right L4 epidural steroid injection are shown in Figure 7. There was anterolisthesis of L4 without pars interarticularis defects.

Discussion

In this case series, we illustrated several examples of contrast material within the retrodural space of Okada during CT-guided cervical and fluoroscopically guided

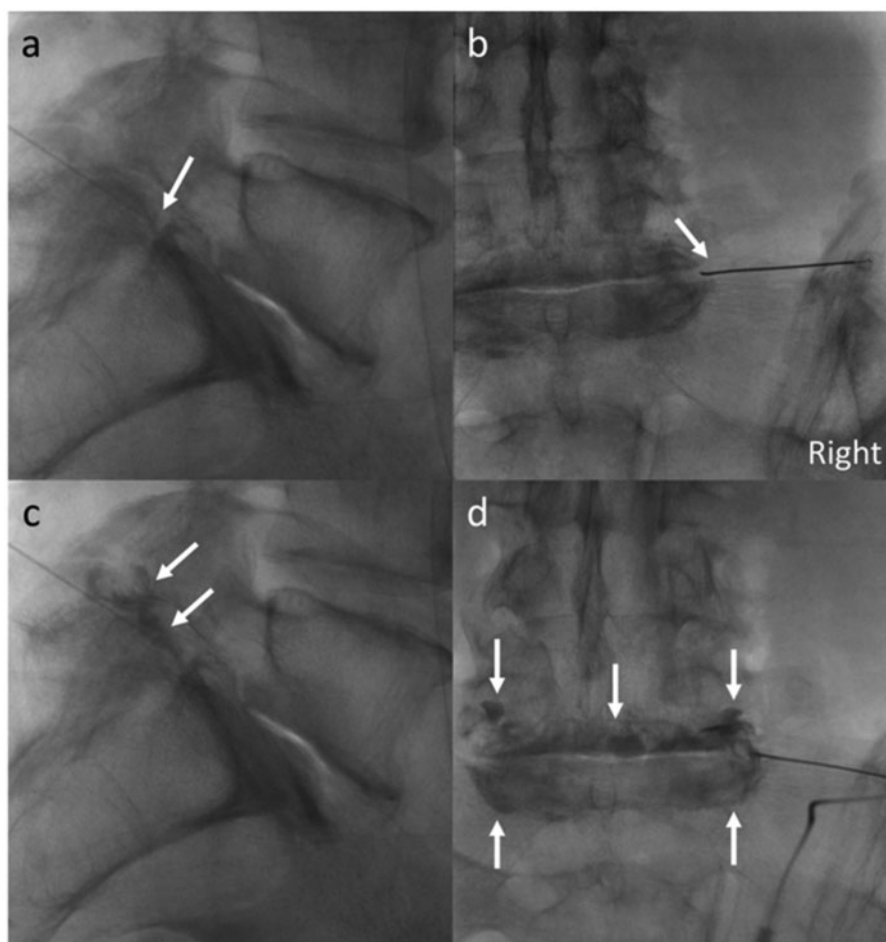


Figure 5. Patient 4. Fluoroscopically guided right L5 transforaminal epidural steroid injection in a 78-year-old male with chronic right L5 radiculopathy and known bilateral L5 pars defects. Intra-procedural lateral (**a, c**) and frontal (**b, d**) images from his transforaminal injection show the needle tip projecting over the right L5 neural foramen (**precontrast images a and b, arrows**). A small volume of contrast was injected and accumulates dorsal to the L5 foramen in a nonspecific pattern (**c, arrows**). Continued injection of contrast in the frontal projection shows filling of the right L5–S1 facet joint with flow to the contralateral left facet through the retrodural space of Okada (**d, arrows**). Epidural flow could not be achieved at this level; therefore, a right S1 transforaminal injection was performed instead (images not shown).

lumbar transforaminal epidural steroid injections. In each of these cases, there was also contrast present within the ipsilateral facet joint immediately below the targeted neural foramen. Although this is a relatively uncommon occurrence, it is important that proceduralists be familiar with the appearance of facet joint and retrodural contrast flow, both on CT and conventional fluoroscopy. As is well illustrated in [Figure 3](#), the retrodural space is in close proximity to the epidural space and may demonstrate similar morphology, particularly during early contrast injection if the interlaminar space has not filled with contrast.

Prior studies have reported contrast uptake within the retrodural space during a variety of other image-guided procedures. For example, lumbar spondylotic defects have been shown to communicate with adjacent and

contralateral facet joints through the retrodural space of Okada [7]. This could have contributed to the inadvertent injection into the space of Okada seen in Patient 4 of our series. Furthermore, a number of case reports and series have highlighted the risk of false loss of resistance within the retrodural space during both cervical and lumbar interlaminar epidural injections [8, 9]. A larger study examined the pattern of contrast distribution in post-intervention images of patients who underwent CT-guided intra-articular facet joint ($n = 29$) or transforaminal epidural ($n = 27$) steroid injections [10]. In that study, 19 patients who received intra-articular facet joint injection had contrast within the retrodural space, but contrast was not seen in the retrodural space in any patients in the transforaminal epidural steroid injection group. In a prior review article, a figure showed an example of

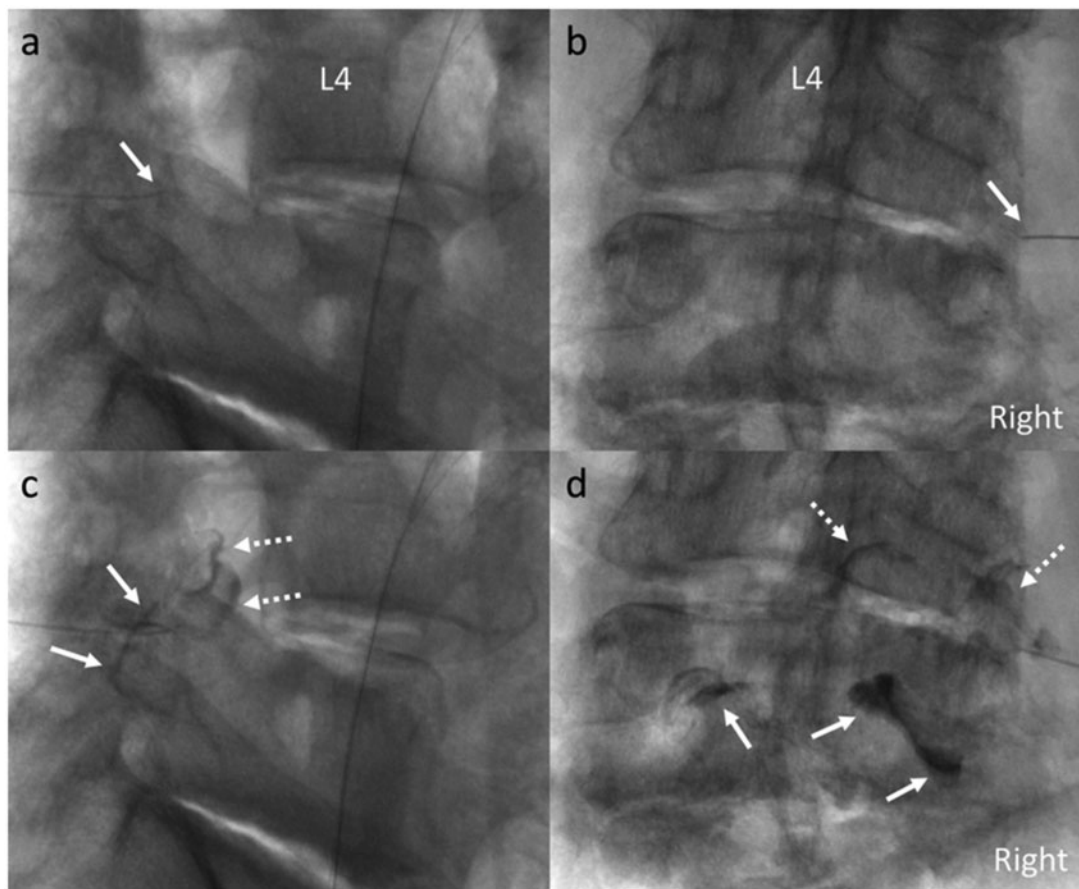


Figure 6. Patient 5. Fluoroscopically guided right L4 transforaminal epidural steroid injection in a 72-year-old female with L4 and L5 radiculopathies. Lateral (**a**) and frontal (**b**) images show the needle tip projecting over the L4 neural foramen (**precontrast images a and b, arrows**). Initial contrast injection filled the right L4–L5 facet joint (**c, solid arrows**), as well as the central and peripheral epidural space (**c, dashed arrows**). Continued injection of contrast demonstrated continued central and peripheral epidural flow (**d, dashed arrows**), and well as flow from the right L4–L5 facet joint into the retrodural space of Okada, crossing midline from right to left (**d, solid arrows**).

contrast flowing into the ipsilateral facet joint and retrodural space during a supraneural transforaminal lumbar epidural steroid injection [3]. In a pictorial essay on CT-guided transforaminal epidural steroid injection, one illustration demonstrated “subperiosteal” contrast accumulation, which appears that it may in fact be within the space of Okada and ipsilateral facet joint [11]. To our knowledge, there are no other reports of contrast flow within the retrodural space of Okada during cervical or lumbar transforaminal epidural steroid injections. Given the paucity literature on the topic, this finding is likely underrecognized.

The epidural and retrodural spaces do not normally communicate. During the transforaminal epidural injections described in the present article, the authors postulate that the needle was likely positioned within the facet joint capsule during contrast injection. A distended or patulous anterior facet joint capsule or superior or inferior recess could be inadvertently accessed in the

foraminal zone. As mentioned previously, in each case of retrodural contrast flow, contrast within the ipsilateral facet joint was also seen. It is possible to access the facet joint during transforaminal epidural steroid injection without demonstrating communication to the retrodural space of Okada, as is illustrated in Figure 8.

Retrodural contrast may mimic central epidural contrast flow on both cervical and lumbar transforaminal epidural injections, but the flow patterns should be distinguished in a number of ways. First, the retrodural space may communicate with the interspinous region or contralateral facet joint, whereas the epidural space will not. Second, the retrodural space and facet joints are usually inferior to the expected location of epidural flow. Finally, epidural flow usually has a characteristic “feathery” appearance with possible vacuolization, or negative filling defects from fat globules, whereas flow in the facet joint or retrodural space is more commonly confluent. Once retrodural flow is identified, needle

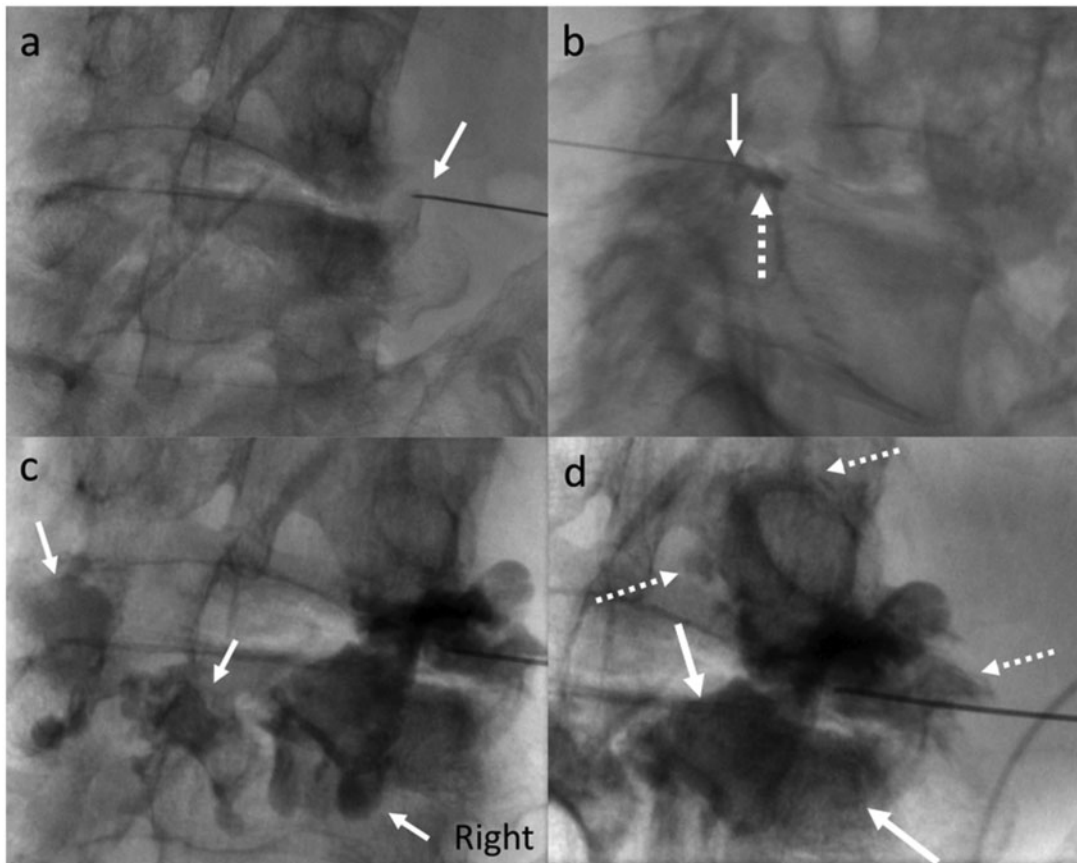


Figure 7. Patient 6. Fluoroscopically guided right L4 transforaminal epidural steroid injection in a 72-year-old male with chronic right L4 radiculopathy. Frontal and lateral images show the needle tip projecting over the right L4 neural foramen (**a and b, arrows**). Injection of a small volume of contrast demonstrates flow over the L4–L5 foramen on lateral view (**b, dashed arrow**). Continued injection of contrast in the frontal projection resulted in filling of the right L4–L5 facet joint with flow to the contralateral left facet joint through the retrodural space of Okada (**c, arrows**). After slight needle repositioning, epidural flow was achieved, including cephalad spread, with contrast now seen around the L4 pedicle (**d, dashed arrows**) and unchanged appearance of the contrast in the facet joints and space of Okada (**d, solid arrows**).

positioning must be adjusted to obtain epidural access. In the authors' experience, a small advancement, if possible, and repositioning craniocaudally within the foramen are useful techniques to achieve epidural flow.

It is the practice at our institution that cervical transforaminal epidural steroid injections are guided by CT. In our experience, CT guidance is helpful to precisely visualize contrast material posterior to the ligamentum flavum. We recognize that many institutions perform cervical transforaminal epidural steroid injections with fluoroscopic guidance. We have therefore included an example of contrast within the space of Okada during fluoroscopically guided cervical facet injection (Figure 9). Regardless of guidance modality, the retrodural space of Okada could still be encountered, and the same findings are expected to apply. It is also noteworthy that the infraneural approach is preferred by most proceduralists at

our institution, which is reflected in the cases shown. We have seen, however, that the ipsilateral facet joint and retrodural space of Okada may be accessed by either an infraneural or a supraneural approach.

Ensuring medication delivery to the epidural space is a key step during transforaminal epidural injections. This is done by injecting a small amount of contrast material at the intended final needle tip position to confirm the appropriate location. The proceduralist must be able to accurately recognize both epidural and non-epidural contrast flow patterns. Contrast uptake in the facet joints and/or retrodural retrodural space of Okada will not deliver medication to the epidural space, precluding a successful injection. It is therefore extremely important that providers who perform transforaminal epidural injections be familiar with the appearance of contrast in the facet joints and retrodural space.

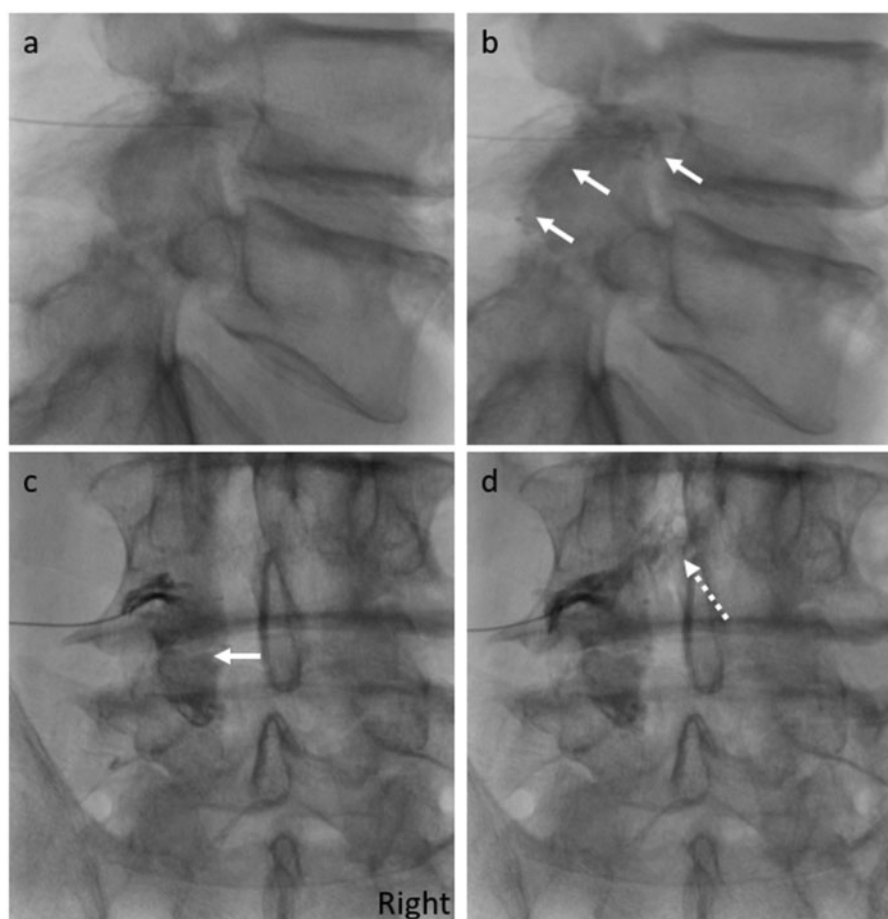


Figure 8. Fluoroscopically guided left L4 transforaminal epidural steroid injection in a 78-year-old male patient. Lateral precontrast image (a) demonstrates a supraneural approach. After the injection of a small amount of contrast material, there is uptake into the facet joint and its superior recess (b, arrows). Frontal image (c) again demonstrates contrast material within the left L4–L5 facet joint (arrow). The needle was advanced slightly, and subsequent contrast injection demonstrated central epidural flow with characteristic vacuolization (d, dashed arrow).

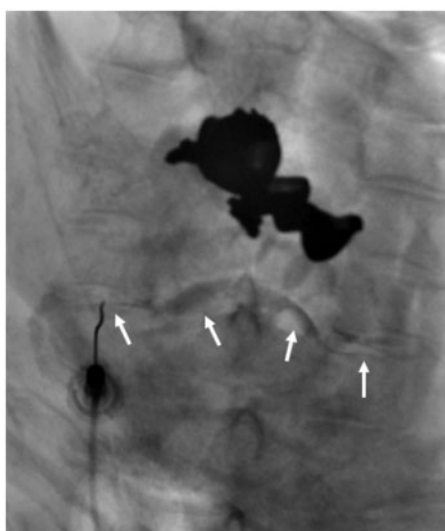


Figure 9. Fluoroscopically guided left C6–C7 facet injection in an 81-year-old woman with chronic axial neck pain. Frontal image after intra-articular contrast injection into the left C6–C7 facet joint also shows prominent flow of contrast extending through the retrodural space of Okada into the right C6–C7 facet joint (arrows).

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