

LOW VOLUME CONTRALATERAL PERIRADICULAR CONTRAST MEDIUM SPREAD DURING A LEFT L4 TRANSFORAMINAL EPIDURAL INJECTION: A CASE REPORT

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- Background:** Contralateral contrast medium spreading at very low volumes during a transforaminal epidural injection is rarely seen.
- Case Report:** A 52-year-old woman with left L4 radicular pain and an L4–L5 broad-based protrusion underwent a left L4 transforaminal epidural steroid injection. After negative aspiration, injecting 0.5 mL of nonionic contrast medium outlined the left L4 root and crossed the midline; an additional 0.5 mL reproduced bilateral periradicular contrast medium spread. A therapeutic injection (1 mL 0.5% bupivacaine, 1 mL (40 mg) triamcinolone, and 2 mL saline; 4 mL total injectate) was administered. At one month postinjection, her pain improved from a Numeric Rating Scale score of 8 to 2. There were no complications.
- Conclusion:** Bilateral opacification observed with only 1 mL may reflect patient-specific anatomical variations, including potential midline ventral epidural fenestrations related to the Hoffmann ligament or peridural membrane variability.
- Key words:** Transforaminal epidural steroid injection, lumbar radiculopathy, contralateral periradicular spread, Hoffmann ligaments

BACKGROUND

Lumbar transforaminal epidural steroid injections (TFESI) are commonly performed for radicular pain when conservative treatment is insufficient (1). Before administering steroids, it is essential to confirm periradicular spread and exclude intravascular or intradiscal injection by observing contrast medium behavior with fluoroscopy (2). Conventional teaching emphasizes ipsilateral periradicular spread at low test volumes; progression into the ventral epidural space may be seen as volumes increase (3). However, contralateral spread with low volume from a single ipsilateral needle rarely happens.

Previous fluoroscopic studies have described patterns of contrast medium spread during lumbar TFESI. Contralateral crossing has been reported to be uncommon

below approximately 2.5 mL (4), and in a prospective study using 2 mL of contrast medium, no spread beyond the midline to the contralateral foramen was observed; the spread was generally ventral and unilateral (5). Against this background, the present case describes early bilateral perineural spread with a total of 1 mL of contrast medium is instructive from both anatomical and technical perspectives.

This unusual bilateral spread, occurring with minimal injection volume, challenges the traditional understanding of epidural contrast medium dynamics and highlights the complex interaction between anatomical variations in the epidural space and injection pressure. Furthermore, the observation of this phenomenon at such a low volume suggests that factors other than

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volume—such as the position of the needle tip relative to specific anatomical structures or fine dural fenestrations—may play a greater role in determining contrast medium distribution than previously believed (3).

CASE PRESENTATION

A 52-year-old woman presented with left lower lumbar pain and radiating pain to the left leg, consistent with L4 dermatomal distribution. Her Straight Leg Raise Test was positive; no motor deficit was detected on physical examination. Sensory examination and reflexes were clinically nonfocal; there were no bowel-bladder dysfunction or other “red flag” findings. Her pain, measured by the 11-point Numeric Rating Scale (NRS-11), was 8 at rest. Her pain increased with standing and lumbar flexion. Magnetic resonance imaging showed a broad-based disc protrusion at the L4-L5 level and associated moderate canal stenosis (Fig. 1). She had insufficient pain relief despite conservative treatment, including nonsteroidal anti-inflammatory drugs and physical therapy. Therefore, an image-guided TFESI was recommended after shared decision-making. An image-guided TFESI was recommended after shared decision-making.

While she was prone and under standard monitoring, the fluoroscopy C-arm was positioned for an oblique (“tunnel view”) projection in order to profile the left

L4–L5 foramen. Following sterile preparation/drape and local anesthesia, a 20G, 10 cm needle was advanced into the superior part of the foramen via a subpedicular approach. The needle position was confirmed on oblique and anteroposterior AP views. Aspiration was negative. Next, 0.5 mL of nonionic contrast medium was injected. On the AP view, the contrast medium outlined the ipsilateral L4 exit root and showed early contralateral spread. Due to the atypical nature of this pattern at such a low volume, we decided to proceed with caution. An additional 0.5 mL injection reproduced the same finding and revealed synchronous bilateral periradicular opacification (Fig. 2).

Since the needle position was stable and the periradicular pattern was confirmed without any vascular or intradiscal findings, a therapeutic mixture was slowly injected at low pressure: 1 mL 0.5% bupivacaine, 1 mL (40 mg) triamcinolone acetonide, and 2 mL saline (4 mL total injectate). On the postinjection AP image (without additional contrast medium), a mild symmetrical periradicular contrast medium spread consistent with residual contrast medium from the test doses was observed; the needle position had not changed (Fig. 3). No early complications occurred. She was monitored and discharged with routine precautions. At the one-month follow-up, her NRS-11 pain score had decreased to 2, and her activities of daily living had improved. There

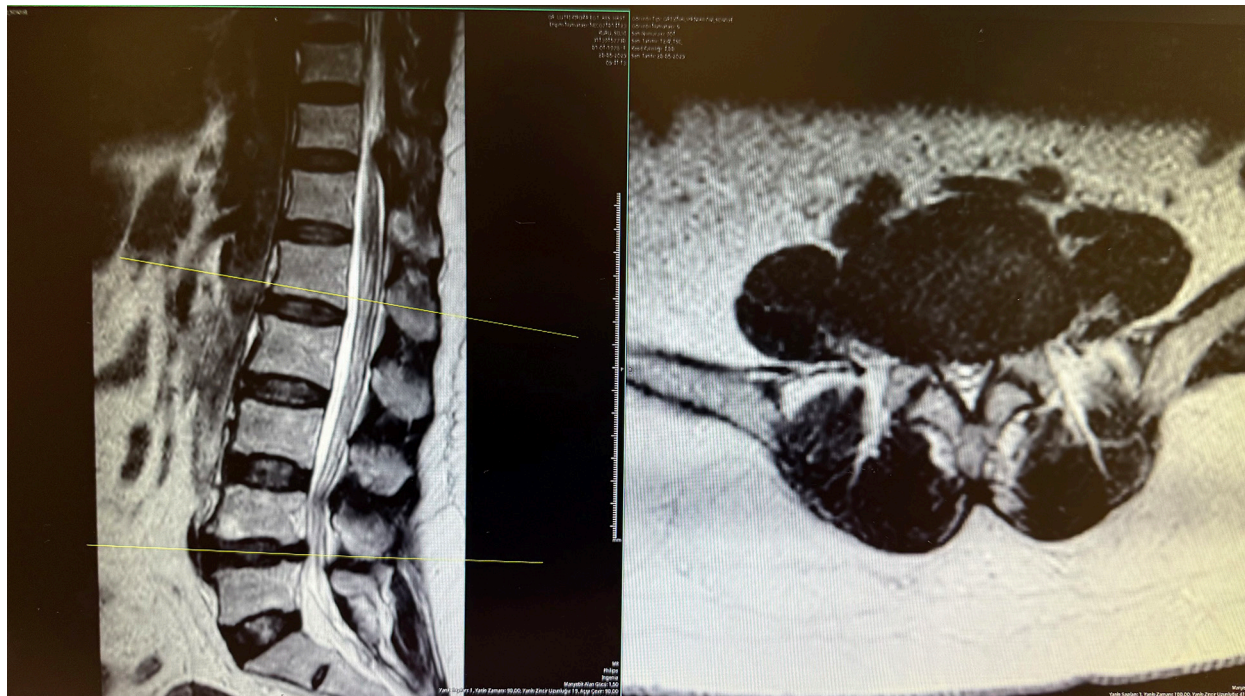


Fig. 1. Preprocedural sagittal and axial lumbar MRI images showing a broad-based posterior L4–5 disc bulge.

were no new neurological deficits and no delayed adverse events were reported.

DISCUSSION

Contralateral crossing of approximately 2.5 mL of contrast medium has rarely been reported (5). To our knowledge, no image showing true contralateral exit root opacification below this threshold has been published (4-6).

The ventral meningo-vertebral (Hoffmann) ligaments are short collagen bands extending between the posterior longitudinal ligament /periosteum and the ventral dura (7,8). Comprehensive reviews emphasize interindividual and interlevel variability in number, thickness, and continuity; critically, these bands do not form a smooth, continuous midline septum. Gaps between the bands (or thinning at specific levels) can create “windows” in the midline; this may allow low-volume contrast medium to cross the midline, producing contralateral dural opacity despite using a unilateral needle. In other words, our observation is consistent with a relatively sparse/segmental Hoffmann ligament configuration at the L4-L5 level in this patient. This anatomical variation, combined with the hydrostatic pressure created by the injection, may have facilitated contralateral spread without requiring “overcoming” potential midline barriers by volume.

From another anatomical perspective, the peridural membrane is located between the vertebral canal and the dura and contributes to the anterior epidural connective tissue complex. In cadaver studies, a well-developed peridural membrane has been identified anterior to the deep posterior longitudinal ligament; in some cadavers, an additional thin and incomplete layer has been reported, emphasizing variability rather than a uniform partition (9). This arrangement, together with variable ventral meningo-vertebral (Hoffmann) ligaments, may leave gaps in the midline instead of a continuous septum; this allows for midline crossing at low volumes and may explain the contralateral periradicular spread we detected when we injected 1 mL of contrast medium.

Although central spinal stenosis generally limits epidural contrast medium dispersion, this effect may not be uniform in all patients. Asymmetric central or paracentral disc pathology can alter epidural flow pathways, allowing the contrast medium that is initially tracking along the perineural epidural sleeve to redistribute through the continuous epidural space and reach the contralateral root exit zone. Such a mecha-

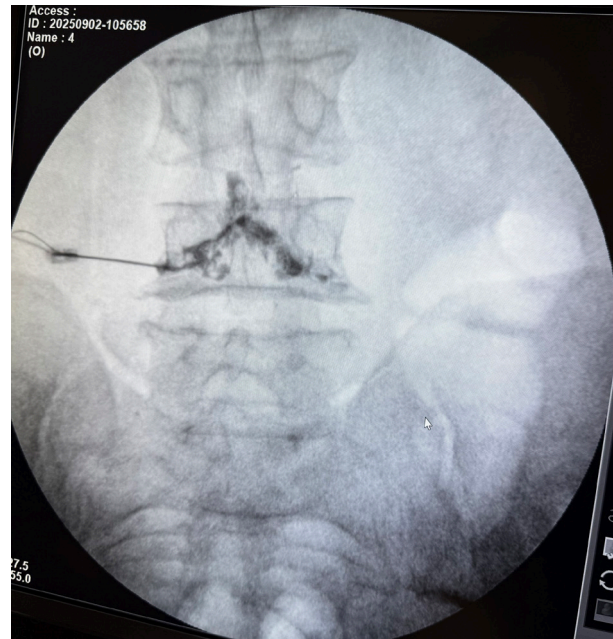


Fig. 2. Anteroposterior fluoroscopic image demonstrating bilateral L4 periradicular contrast spread after injection of 1 mL of contrast medium during left L4 transforaminal epidural injection.



Fig. 3. Anteroposterior fluoroscopic image obtained after administration of the 4 mL therapeutic injectate, showing persistent bilateral periradicular contrast distribution from the preceding contrast test injections during left L4 transforaminal epidural injection.

nism may account for early contralateral periradicular opacification in select cases and highlights the need to

interpret an epidurogram with attention to patient-specific anatomy.

Previously, Jin et al. (10) suggested that, in the setting of severe central or foraminal stenosis, certain transforaminal approaches, such as the retrodiscal approach, may facilitate broader epidural contrast medium spread at lower injection volumes. While this provides an important anatomical context, the present case differs in that severe stenosis was not present, so a standard transforaminal approach was used. Therefore, the early contralateral periradicular opacification observed here may be better understood in relation to patient-specific anatomical factors, including individual epidural space configuration and perineural epidural sleeve continuity, rather than stenosis severity alone. Several technical considerations should be acknowledged. First, although the subsequent 4-mL therapeutic injectate was administered as part of a therapeutic TFESI, not as a diagnostic selective nerve root block, the observation of bilateral spread after only 1 mL of contrast medium suggests that the therapeutic volume may have contributed to

broader epidural distribution. Therefore, when early contralateral spread is observed with a low contrast volume, the planned therapeutic injectate volume should be reconsidered. Second, triamcinolone was used according to local routine practice at the time of the procedure. No vascular or intradiscal uptake was observed during contrast injection; however, because the procedure was performed using a subpedicular/supraneural approach rather than an infraneural or Kambin triangle approach, the use of a particulate steroid should be acknowledged as an important safety consideration

CONCLUSION

This case highlights that individual anatomical variations, such as ventral meningo-vertebral ligaments and gaps in the peridural membrane, may affect contralateral contrast medium spread at unexpectedly low injection volumes. This awareness provides valuable insight into clinical practice for interpreting contrast medium spread patterns and evaluating injection safety.

REFERENCES

1. Shrestha P, Subba L, Agrawal P, Lohani S. Outcome of transforaminal epidural steroid injection for lumbar radiculopathy: Initial three-year experience at Upendra Devkota Memorial-National Institute of Neurological and Allied Sciences, Nepal. *Chin Neurosurg J* 2020; 6:6.
2. Shamov T, Al-Hashel J, Rousseff RT. Fluoroscopic epidural steroid injection: Pain relief in discogenic sciatica versus lumbar spinal stenosis. A study on Middle Eastern patients. *Acta Medica (Hradec Kralove)* 2020; 63:73-78.
3. Jeong YC, Lee CH, Kang S, Yoon JS. Contrast spread in the superoposterior approach of transforaminal epidural steroid injections for lumbosacral radiculopathy. *Ann Rehabil Med* 2017; 41:413-420.
4. Furman MB, Mehta AR, Kim RE, et al. Injectate volumes needed to reach specific landmarks in lumbar transforaminal epidural injections. *PM R* 2010; 2:625-635.
5. Botwin KP, Natalicchio J, Brown LA. Epidurography contrast patterns with fluoroscopic guided lumbar transforaminal epidural injections: A prospective evaluation. *Pain Physician* 2004; 7:211-215.
6. Furman MB, Lee TS, Mehta A, Simon JI, Cano WG. Contrast flow selectivity during transforaminal lumbosacral epidural steroid injections. *Pain Physician* 2008; 11:855-861.
7. Tardieu GG, Fisahn C, Loukas M, et al. The epidural ligaments (of Hofmann): A comprehensive review of the literature. *Cureus* 2016; 8:e770.
8. Krystkiewicz K, Maślanka M, Skadorwa T, Cizek B, Tosik M, Furtak J. Meningovertebral ligaments could be a barrier for migration of a herniated intervertebral disc: An anatomical study. *Front Surg* 2022; 9:969244.
9. Bosscher HA, Grozdanov PN, Warraich I, MacDonald CC, Day M. The anatomy of the peridural membrane of the human spine. *Anat Rec (Hoboken)* 2020; 304:677-691.
10. Jin HS, Bae GH, Choi EJ, Lee JW, Lee PB. Comparison of effect and contrast spreading in transforaminal epidural injection using the retrodiscal versus subpedicular approach: A prospective, randomized trial. *Pain Physician* 2022; 25:E1379-E1388.