

Comparison of the Effectiveness of Interlaminar and Bilateral Transforaminal Epidural Steroid Injections in Treatment of Patients With Lumbosacral Disc Herniation and Spinal Stenosis

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Objectives: The purpose of this study is to compare the effectiveness of interlaminar (IL) and bilateral transforaminal (TF) epidural steroid injections (ESIs) for pain reduction in patients with axial back pain resulting from herniated intervertebral disc (HIVD) and spinal stenosis (SS).

Methods: Patients reporting axial back pain without radiation continuing over 3 months, which resulted from lumbosacral SS or HIVD were recruited and assigned to either the IL or TF technique group. The degree of pain and patient satisfaction were evaluated by the Numerical Rating Scale (NRS), the Patient Satisfaction Index (PSI), and the Roland 5-point pain score, which were administered at pretreatment, 2 weeks, 2 months, and 4 months after ESI.

Results: Both the TF and IL ESIs accomplished significant pain reduction in HIVD and SS from 2 weeks to 4 months after treatment. SS showed a more significant reduction in the Roland 5-point pain score and obtained more successful NRS results using the TF technique as compared with the IL technique. HIVD did not show any differences between the techniques.

Discussion: Bilateral TF epidural injection allowed the higher concentration of injectates to be delivered into ventral epidural space bilaterally. The IL approach can be more affected by tissue fibrosis, scarring, or hypertrophy, which is more prominently featured in SS than in HIVD; these prevent the injectate delivered via the posterior route from spreading to the ventral epidural space. Consequently, in patients with SS, bilateral TF produces better results than IL.

Key Words: epidural steroid injection, transforaminal, interlaminar, disc herniation, spinal stenosis

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Lumbar epidural steroid injections (ESIs) have been used for decades to treat back pain or radicular pain from herniated intervertebral discs (HIVD) or spinal stenosis (SS).^{1–3} Interlaminar (IL), caudal, and transforaminal (TF) techniques have been used for fulfilling this purpose. As pain from disc disease is usually generated anteriorly in the epidural space, the ventral epidural spread is the logical target for placement of anti-inflammatory medications.

Thus, many physicians have made an effort to place injection fluid into the ventral epidural space.^{1,2} The IL technique delivers the injection fluid into the posterior epidural compartment with the needle placed directly between adjacent spinous processes or between adjacent lamina so that the injectate ideally spreads the bilateral epidural space. Alternatively, the TF technique delivers the injection fluid directly into the ventral epidural space but is frequently localized in the ipsilateral periradicular space and did not cross the midline and therefore does not cover the contralateral space.^{1,4}

Axial back pain is caused by disc end plate inflammatory changes, or dural and posterior longitudinal ligamentous irritation, whereas mechanical compression or chemical irritation around the root sheath contribute to radicular leg pain.^{2,5,6} The IL technique has been performed more often than the TF technique in patients with axial back pain because the spread of injected fluids into the bilateral epidural space is required. But it is hypothesized that the TF technique can cover the bilateral epidural space if it is conducted via both sides simultaneously. Additionally, the bilateral TF technique is expected to deliver the injectate into the ventral and the bilateral epidural space with higher concentrations than the IL technique. But to our knowledge, there is no literature to compare the effectiveness of the 2 techniques. This study was designed to identify which technique is more effective in treating HIVD and SS, in terms of pain reduction and patient satisfaction.

MATERIALS AND METHODS

Materials

Patients visiting the department of physical medicine and rehabilitation at our hospital, with axial back pain but without radiation continuing over 3 months, which resulted from lumbosacral HIVD or SS, were selected. This diagnosis was based on the clinical manifestations and the magnetic resonance image findings. Patients with unilateral or bilateral leg pain, arterial vascular disease, previous lumbar ESI (within 2 mo), previous lumbar spine surgery, or neurologic deficits were excluded.

Ethics approval was obtained from the Institutes of Review Board of our hospital. After all patients were provided with the procedure and objectives of this study and the possible complications, the patients who gave informed consent were selected. One hundred HIVD and 102 SS patients participated in this study. They were randomly allocated to either the IL or TF technique group using a randomization table. The patients not showing significant relief from injections or hoping to receive

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surgery were transferred to the surgical department. Some patients did not revisit the clinic after treatments and consequently were excluded from this study. Finally, the data of 93 HIVD and 99 SS participants were analyzed. No significant difference was found in distribution of age, sex, and initial scores before intervention between the IL and TF groups in HIVD and SS (Table 1).

Methods

All patients were evaluated individually using the Numerical Rating Scale (NRS), the Patient Satisfaction Index (PSI), and the Roland 5-point pain score at pretreatment, 2 weeks, 2 months, and 4 months after the last treatment.^{3,7} All patients were evaluated by 1 physiatrist who did not perform epidural injection and did not know which technique was used in individual patient. NRS measured experienced pain with 0 representing no pain and 10 representing the worst pain imaginable. Patients were also given the PSI adapted from the North American Spine Society's low back pain outcome instrument in which they were asked to choose from one of the 4 possible responses based on their satisfaction with treatment (Table 1). We defined a successful outcome as a patient who was both satisfied with her results (PSI = 1 or 2) and experienced at least a 2-point improvement in NRS.³ All patients were asked to give their answers considering the average severity of their symptoms over a recent 1-week period of time.³ These measurement scores were compared between the IL and TF technique groups in SS and HIVD, respectively.

All ESIs were conducted under biplane fluoroscopic guidance. Patients were not informed of the technique with which ESI was performed. Injections were performed at the level that best matched the patient's clinical presentation.⁷ For the TF technique, with the patient lying prone, the fluoroscopic tube was rotated obliquely to an ipsilateral oblique angle with respect to the suspected nerve root. The goal of positioning was to allow a perpendicular needle track toward the classic injection site underneath the pedicle in the so-called safe triangle, which is defined by the pedicle superiorly, the lateral border of the vertebral body laterally, and the outer margin of the spinal nerve medially. The patient's skin was disinfected and a local anesthetic was administered to the area where the needle would be inserted. With fluoroscopic guidance, a 12-cm, 21-gauge spinal needle was then advanced into the safety triangle. The needle position was checked using anterior-posterior and lateral views of fluoroscopy, and this was

followed by an injection of approximately 1 mL of contrast material. Anterior-posterior and lateral views were obtained to identify contrast material distribution. Combination of 4 mL of lidocaine (0.5%) and 0.5 mL of triamcinolone acetonide (20 mg) were slowly injected per side. This procedure was performed at the right and left neural foramina sequentially.

For the IL approach, with the patient lying prone, the fluoroscopic tube was placed vertically to the lesion. An 18-gauge, 3.5-inch or 5-inch Tuohy needle tip was placed on the IL space under guidance of fluoroscopy. After the patient's skin was disinfected and a local anesthetic was administered to the area where the needle would be inserted. The needle was advanced into the middle or posterior-lateral epidural space using the loss-of-resistance technique. After we confirmed that the needle tip had been placed in the dorsal epidural space through obtaining anterior-posterior and lateral views and using negative aspiration for cerebrospinal fluid, 1 mL of nonionic contrast material was injected to document appropriate contrast spread into the epidural space. Next, a combination of 8 mL of lidocaine (0.5%) and 1 mL of triamcinolone acetonide (40 mg) was slowly injected. All patients returned to the outpatient clinic at 2-week intervals. If the patient's pain was level 5 or greater on the NRS, they were reinjected at an interval of 2 weeks.^{8,9} The maximum number of injections was limited to three.

The SPSS Version 12.0 statistical package was used for statistical analysis. χ^2 was used to compare sex proportion and proportion of successful results in NRS and PSI between the 2 technique groups. T test was used to test the difference in age, symptom duration, and number of injections. Repeated measures analysis of variance was used to compare the efficacy of the 2 techniques measured by the Roland 5-point pain score. Results were considered statistically significant if the *P* value was less than 0.05.

RESULTS

Before steroid injection, the NRS and the Roland 5-point pain score were not significantly different between the IL and TF technique groups in patients with disc herniation or SS (Table 2). Both the TF and IL technique groups had significant improvement of the Roland 5-point pain score after treatment for both HIVD and SS cases. Although the HIVD patients did not show any difference between the TF and IL techniques after treatment, the SS patients showed a more significant reduction of the Roland 5-point pain score in the TF technique as compared with the IL technique from 2 weeks to 4 months (Figs. 1, 2). Significant difference between successful and unsuccessful results was found only in 4 months of NRS. No significant difference was found in the proportion of successful and unsuccessful results in PSI between the IL and TF technique groups in patients with HIVD (Fig. 3). However, the TF technique obtained a higher proportion of successful results in NRS from 2 weeks to 4 months in patients with SS as compared with the IL technique (Fig. 4).

DISCUSSION

ESIs have been used to treat lumbosacral radicular or axial pain syndromes caused by herniated discs or SS. Epidural injections of steroid and local anesthetics benefit patients by inhibiting prostaglandin synthesis, stabilizing cellular membranes, suppressing immune responses, enhancing

TABLE 1. Roland 5-point Pain Scale and Patient Satisfaction Index

Roland 5-point pain scale
0 Absence of pain
1 Little pain
2 Moderate pain
3 Bad pain
4 Very bad pain
5 Almost unbearable pain
Patient Satisfaction Index (North American Spine Society Score)
1. The treatment met my expectations
2. I did not improve as much as I had hoped, but I would undergo the same treatment for the same outcome
3. I did not improve as much as I had hoped, and I would not undergo the same treatment for the same outcome
4. I am the same or worse than before treatment

TABLE 2 General Features, NRS, and Roland Pain Score at Pretreatment in HIVD and SS

	HIVD		P	SS		P
	IL (34)	TF (59)		IL (42)	TF (57)	
Sex (M/F)	17/17	36/23	0.385	11/31	20/37	0.387
Age(y)	42.86 ± 11.3	42.02 ± 12.1	0.729	62.02 ± 11.6	62.22 ± 10.1	0.929
Duration of symptoms (mo)	3.71 ± 6.0	4.51 ± 6.0	0.633	16.5 ± 13.3	14.31 ± 18.7	0.822
No. injections	1.3 ± 0.5	1.35 ± 0.5	0.64	1.62 ± 0.6	1.5 ± 0.7	0.389
NRS-pretreatment	6.84 ± 1.6	6.49 ± 1.6	0.295	6.64 ± 1.6	6.62 ± 1.5	0.933
Roland score-pretreatment	3.25 ± 0.6	3.34 ± 0.7	0.957	3.31 ± 0.6	3.39 ± 0.8	0.451

HIVD indicates herniation of intervertebral disc; IL, interlaminar approach; NRS, Numeric Rating Scale; SS, spinal stenosis; TF, transforaminal approach.

neuronal blood flow, and washing out inflammatory mediators, in addition to blocking nociceptive C fiber conduction.^{8,10–12}

Because the effect of ESIs is short-lived and the therapeutic benefits disappear between 3 weeks and 6 months after treatment,^{1,8,13,14} we followed-up the patients for a relatively short period to identify the differences in therapeutic effects between 2 ESI techniques. Four months should be long enough to evaluate the effect of 1 to 3 steroid injections.

Because inflammatory and mechanical reactions between the intervertebral disc, posterior longitudinal ligament, and nerve roots have been suggested as playing an important role in provoking back pain, it is very important that the injectate is administered in the appropriate concentration to the ventral epidural space to accomplish therapeutic goals.^{8,15} According to 1 study comparing TF and IL injections for the treatment of symptomatic lumbar disc herniation, the TF injection resulted in better short-term pain improvement and fewer long-term surgical interventions than the IL injection.¹ This can be explained by the fact that the TF technique allows a high concentration of corticosteroid to be delivered precisely to the ventral

aspect of the lumbar nerve root sleeve and the dorsal aspect of the disc herniation where mechanical and chemical irritation to the nerve root usually occur.^{7,11,16,17} IL approaches deliver the injection fluid into the posterior epidural compartment with the needle placed directly between adjacent spinous processes or between adjacent laminae. This procedure does not guarantee that the fluid will flow to the anterior epidural compartment because this technique is influenced by epidural anatomy such as stenosis, epidural scarring, or a midline raphe; frequently, the injection fluid does not reach the ventral epidural space.^{16–19}

The TF technique is frequently conducted in cases of radiating pain in 1 limb because it delivers the injectate mainly to unilateral side of the ventral epidural space. Axial back pain has been attributed to inflammatory changes of the dura, postlongitudinal ligaments, or disc end plate.² Therefore, the IL technique has been more frequently performed because it has the advantage of delivering injectate to the bilateral epidural space, unlike the TF technique. One study about contrast spread pattern after lumbar TF epidural injection demonstrated that although the contrast fluid spread into the ventral epidural space, it

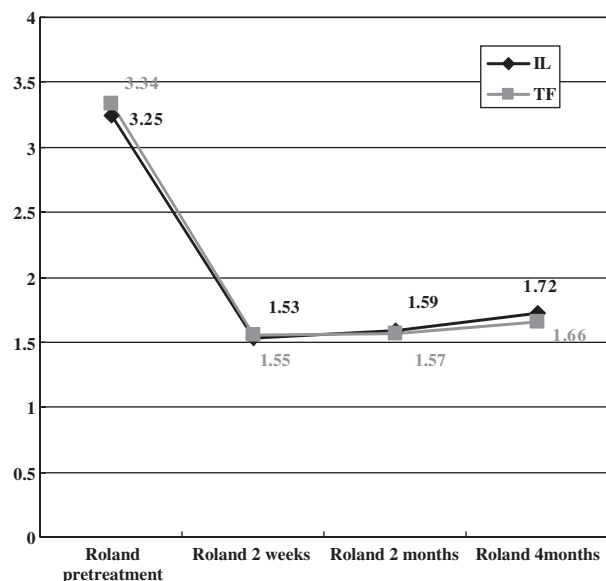


FIGURE 1. Roland pain score was not significantly different at pretreatment, 2 weeks, 2 months, and 4 months after treatment in patients with herniated disc. IL indicates interlaminar approach; TF, transforaminal approach.

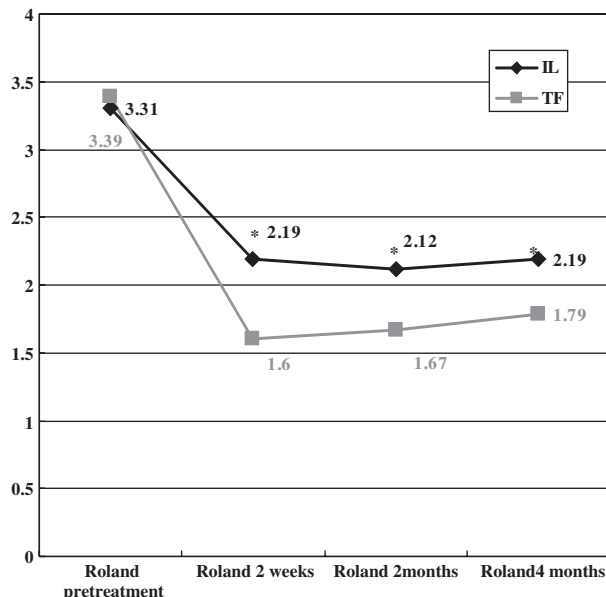


FIGURE 2. Roland pain score was significantly different at 2 weeks, 2 months, and 4 months after treatment in patients with spinal stenosis. IL indicates interlaminar approach; TF, transforaminal approach. *P<0.05.

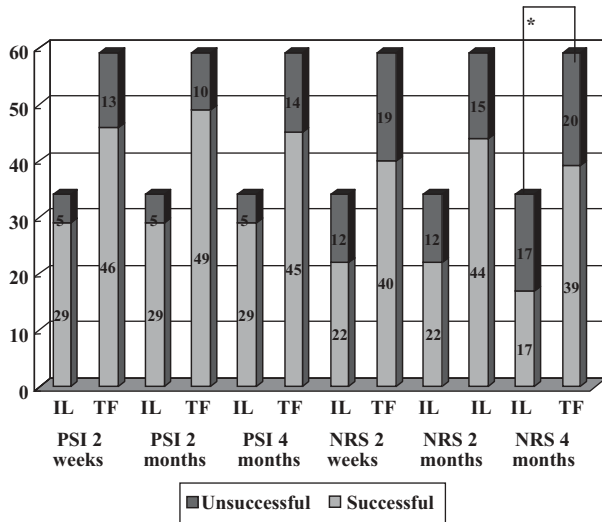


FIGURE 3. No significant difference was found between IL (interlaminar approach) and TF (transforaminal) group as to successful results measured by PSI and NRS after treatment in patients with HIVD. HIVD indicates herniated intervertebral disc; PSI, Patient Satisfaction Index; NRS, Numerical Rating Scale.

only spread unilaterally and did not cross the midline.⁴ Using the TF technique, injectate was more easily delivered to the anterior epidural space but was frequently localized in the ipsilateral periradicular space and did not cross the midline; therefore, it did not cover the contralateral space.^{1,4} However, bilateral TF epidural injection conducted in this study let the higher concentration of injectates to be delivered into ventral epidural space bilaterally. Consequently, in SS cases, the bilateral TF technique led to better results than the IL technique in terms of pain reduction and patient satisfaction.

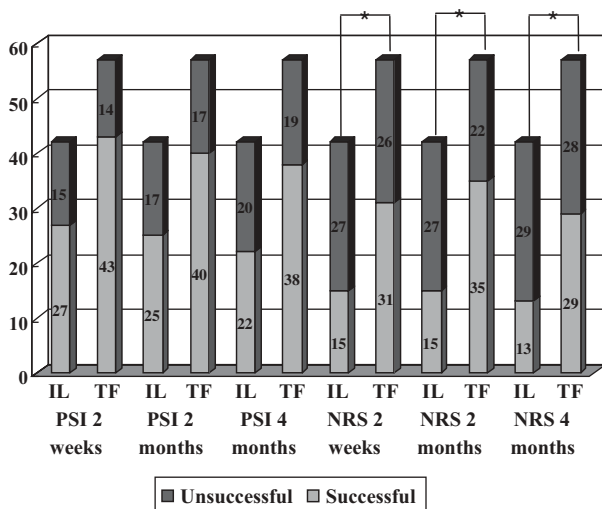


FIGURE 4. Significant difference was found between IL (interlaminar approach) and TF (transforaminal) group as to successful results measured by PSI and NRS at 2 weeks, 2 months, and 4 months after treatment in patients with SS. PSI indicates Patient Satisfaction Index; NRS, Numerical Rating Scale. * $P < 0.05$.

Our results showed that, in the SS group, the TF technique showed more significant benefits in pain reduction than the IL technique, whereas, in the HIVD group, TF technique had no significant benefits as compared with IL technique except NRS in 4 months after treatment. Fluoroscopic-guided TF ESI is known to be an effective way of treating pain in patients with SS. According to Delpont et al's²⁰ study demonstrating the effect of ESI in patients with SS, 32% reported more than 2 months of pain relief, 46% were very satisfied with their treatment, and 74% were at least somewhat satisfied with ESI among patients with SS who underwent ESI. One study found that 55.8% of patients had a successful outcome at 1 month postinjection and 37.2% of patients had a successful outcome at 1 year postinjection. They defined a successful outcome as a reduction of at least 2 points on the NRS, which was the same definition used in our study.³ Another study revealed that 64% patients with SS had a completely better or somewhat better outcome at 6 weeks.²¹ Our study showed 61.4% of TF technique had a successful outcome at 2 months, whereas only 35.7% of IL technique had a successful outcome in terms of NRS, which was comparable to the results of the previous studies. The outcomes of patients with HIVD showed that 74.6% of the TF technique group and 64.7% of the IL technique group obtained a successful outcome at 2 months; the lower successful outcome percentage of the IL technique in SS was the main contributor to the significant difference between the 2 techniques.

The IL approach can be more affected by epidural ligaments or fibrosis, scarring and hypertrophy of post-longitudinal ligaments, or hypertrophied lateral recess, which may prevent migration of the posteriorly administered injectate to the anterior epidural space.^{16–19} Tissue fibrosis, scarring, or hypertrophy that interfere with the spread of injectates into the ventral space is a more prominent feature of SS than HIVD. This explained why TF technique was found to have a better outcome as compared with the IL technique only in the SS group, not in the HIVD group. As well, tissue fibrosis, scarring or hypertrophy is also prominent features of failed back surgery syndrome. It will be very useful and meaningful study to compare the clinical effectiveness of IL and TF techniques in patients with failed back surgery syndrome.

We recruited the patients with axial pain but without radiating pain so that participants had similar clinical features such as axial pains originated from disc end plate, dura, or posterior longitudinal ligaments as possible. Considering that ESIs were also frequently indicated for reduction of radiating leg pain, study of patients having predominantly leg pain was worthy of being performed in the future.

The volumes used in this study were significantly higher than those used in other randomized studies evaluating TF ESI.^{1,11} We recruited patients with axial pain but without radiating leg pain. We regarded these patients as having the pathologic lesions in sinuvertebral nerve around annulus fibrosis, end plate, or ventral dura and afferent nerves of posterior longitudinal ligaments rather than periradicular sheath.^{5,6} Lesions of these patients are supposed to be more nonspecific and broader than focal and radicular pain.⁵ Therefore, we used higher dose of injectates to cover the broader area.

In conclusion, bilateral TF and IL ESI are useful methods to reduce pain in patients with lumbosacral HIVD

and SS. Bilateral TF ESI is a more effective treatment method than IL ESI in patients with SS.

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