Pain Physician. 2006; 9.361-366, ISSN 1533-3159

A Case Control Study

Interlaminar Versus Transforaminal Epidural Injections For The Treatment Of Symptomatic Lumbar Intervertebral Disc Herniations

Michael K. Schaufele, MD, Laura Hatch, MD, and William Jones, MD

Background: Epidural steroid injections are commonly used for the treatment of radicular symptoms associated with symptomatic lumbar intervertebral disc herniations. Transforaminal epidural injections are believed to produce better clinical outcomes than interlaminar epidural injections.

Objective: To determine a difference in short-term pain improvement and long-term surgical rates between interlaminar and transforaminal injection techniques.

Design: Case Control Study.

Methods: For each technique, 20 patients were retrospectively identified who received their first fluoroscopically guided epidural steroid injection for radicular symptoms caused by a lumbar intravertebral disc herniation over an 18 months interval. All patients had corresponding MRI findings and failed previous non-invasive therapies. The Verbal Numerical Rating Scale (VNRS, 0-10 scale) before the treatment, within one hour after the treatment and upon follow-up (average 17.1 days) were analyzed, along with the need for repeat injections and surgical interventions over a 1-year follow-up interval. The patient groups were matched for symptom duration, MRI findings and pre-injection VNRS scores.

Results: In the transforaminal group, there was a statistically significant improvement in the VNRS scores from before the injection (VNRS mean 5.9) to immediately after the injection (VNRS mean 2.9, $p<0.01$), and upon follow-up (VNRS mean 3.2, $p<0.01$, mean 18.7 days). Nine patients (45%) required 1 or 2 repeated injections, 2 patients (10%) underwent surgery.

In the interlaminar group, there was a statistically significant improvement in the VNRS scores from before the injection (VNRS mean 7.3) to immediately after the injection (VNRS mean 3.1, $p<0.01$), and upon follow-up (VNRS mean 5.9, $p<0.01$, mean 15.6 days). Eight patients (40%) required 1 or 2 repeated injection, 5 patients (25%) underwent surgery.

Fourteen patients (70%) had an improvement of 2 points or more on the VNRS scale in the transforaminal group, compared to 9 (45%) in the interlaminar group.

Conclusions: In the current study, transforaminal epidural steroid injections for the treatment of symptomatic lumbar disc herniation resulted in better short-term pain improvement and fewer long-term surgical interventions than interlaminar epidural steroid injection.

Key words: Epidural Injections, Radiculopathy, Rehabilitation, Intervertebral Disc Displacement

Epidural steroid injections (ESI) have been used for decades for the treatment of spinal pain, particularly for radicular symptoms and radiculopathy. In a review of four older randomized, controlled trials (RCT), epidural steroid injections were found to be beneficial for the treatment of acute radiculopathies compared to a control treatment, especially for short-term outcomes (OR 2.2)(1). The more recent WEST study showed that ESI offered transient benefit in symptoms at 3 weeks in patients with sciatica, but no sustained benefits in terms of pain, function or need for surgery (2). Increasing emphasis is placed on fluoroscopically guided, target specific injections to improve treatment outcomes. Therefore, modern study designs focus on fluoroscopically guided transforaminal injection techniques. They have the theoretical advantage of delivering the injectate to the site of the pathology in the anterior epidural space. Vad et al (3) showed a 84% "successful" outcome with transforaminal ESI compared to 48% in patients receiving trigger point injections. Riew et al (4) studied 55 patients with lumbar radiculopathy who were all considered surgical candidates. Seventy-one percent of the patients who received a nerve root injection with steroid cancelled surgery. Only 33% of the patients who received a local anesthetic injection without steroid cancelled surgery, indicating a significant reduction of surgical rates from the steroid component (4). In patients with chronic radicular pain, corticosteroids do not improve outcomes compared to injection of local anesthetic alone (5). This indicates that epidural steroid injections are more effective for acute radicular pain with a significant inflammatory pain component.

The goal of this study was to compare short-term improvement in pain and long-term surgical rates and the need for repeat injections between these two techniques. Our hypothesis was that transforaminal ESI provide better outcomes than interlaminar ESI.

From: Emory University School of Medicine, Atlanta, GA
Address Correspondence: Michael K. Schaufele, MD, The Emory Spine Center, 59 Executive Park South, Atlanta GA 30329
e-mail: Michael.Schaufele@emoryhealthcare.org
Disclaimer: There was no external funding in the preparation of this manuscript.
Conflict of Interest: None.
Manuscript received on: 08/06/2006
Revisions accepted: 09/05/2006
Accepted for publication on: 09/12/2006

Methods

The study was conducted at a large academic spine center and was approved by the University's Institutional Review Board. The study received no external funding. Inclusion criteria for the study were: 1) low back and uni- or bilateral leg pain of radicular nature caused by a lumbar intervertebral disc herniation 2) single level disc herniation on recent MRI corresponding with the patient's clinical symptoms 3) failure to respond to non-invasive treatments. Exclusion criteria were: 1) known contraindications for epidural steroid injections as described elsewhere (6) 2) previous lumbar epidural steroid injections 3) previous lumbar spine surgery 4) unstable neurological deficits and cauda equina syndrome and 5) patients with on-going workers compensation and personal injury claims.

Between the fall of 2000 and the spring of 2002, a total of 1,257 patients were treated by the lead author with spinal injections. Twenty consecutive patients were retrospectively identified who had undergone an interlaminar epidural steroid injection for a symptomatic single level lumbar disc herniation and fulfilled the above inclusion and exclusion criteria. These patients were then matched with the first 20 consecutive patients during this 18-month interval who fulfilled the inclusion and exclusion criteria and had received a transforaminal epidural injection for the same diagnosis. VNRS scores are prospectively collected on all our spinal injection patients. Only patients with complete sets of VNRS scores (pre-injection, post-injection and follow-up) were included in the study.

All patients were examined and imaging studies were reviewed prior to the injection by the first author. The choice as to whether to use the transforaminal or the interlaminar technique was made by the first author in no predetermined order. At the time of the procedures, the author had no personal preference for either technique.

All injections were performed by the first author in an injection suite affiliated with the teaching institution. All injections using either technique were performed at or below the level of the disc herniation. A Siemens Iso-C C-arm was used for the procedures and anterior-posterior (AP) and lateral spot films were obtained for documentation purposes (Figures 1, 2). Within one hour before the procedure, the patients were asked to rate their pain on the Verbal Numerical Rating Scale (VNRS, 0-10 scale) by a nurse not involved in the performance of the procedure.

For the transforaminal approach, a 25 or 22-gauge, 3½-inch or 5-inch spinal needle was used. The needle was placed in the superior and anterior aspect of the corresponding neuroforamen under frequent fluoroscopic guidance, using the standard technique described elsewhere (6,7). After the needle was determined radiographically to be in the appropriate position, 0.5-1 ml of non-ionic contrast material (Omnipaque 300) was injected to document appropriate contrast spread along the spinal nerve into the epidural space without intravascular uptake (Fig. 1). Next, a combination of 80 mg of methylprednisolone acetate with 1 to 2 ml of lidocaine 2% was injected. Diabetic patients with unstable blood glucose levels received 40 mg of methylprenisolone acetate.

For the interlaminar epidural steroid injections, we modified the traditional midline approach: An 18-gauge, 3½-inch or 5-inch Tuohy needle was advanced into the posterolateral epidural

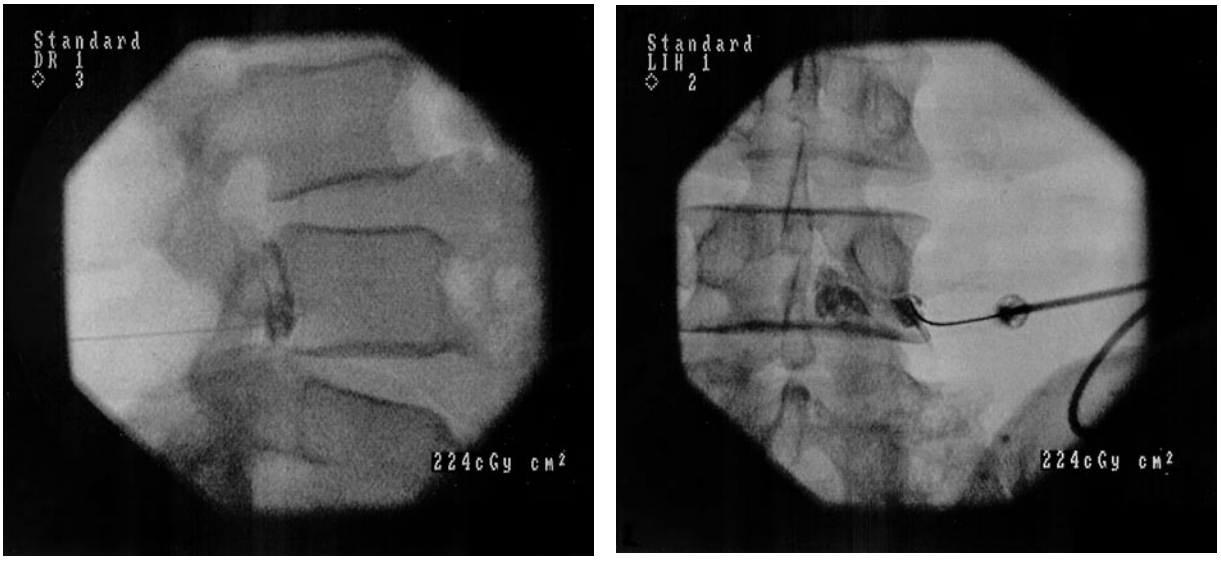

Fig. 1: *Transforaminal Epidural Steroid Injection L4-5*

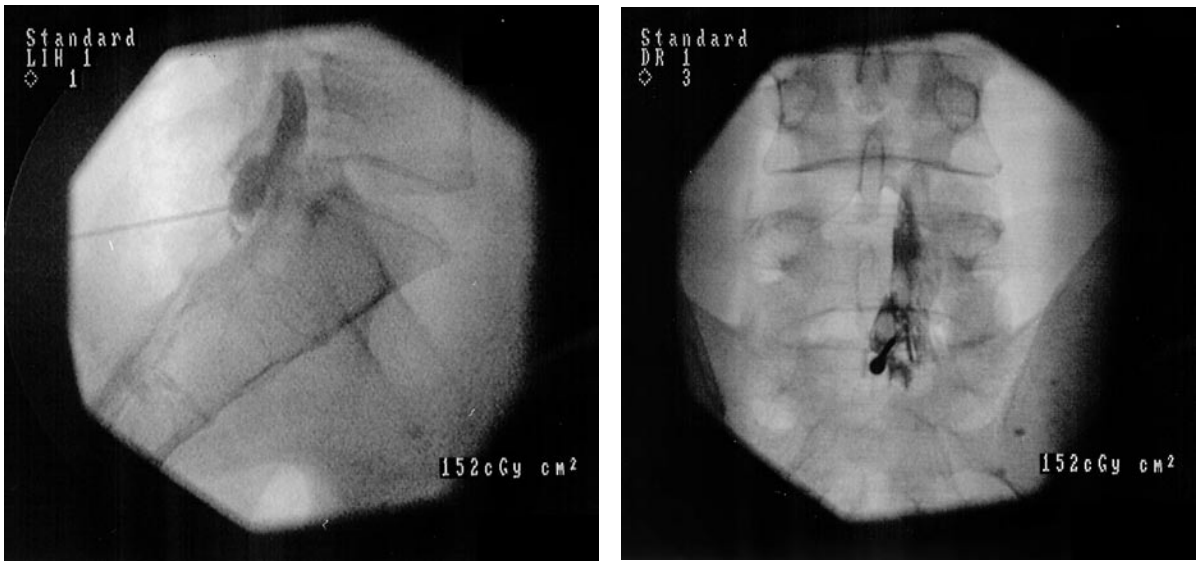

Fig. 2: *Directed Lateral Interlaminar Epidural Steroid Injection L5-S1*

space of the affected leg with radicular symptoms, using the loss-of-resistance technique. This "directed lateral interlaminar approach" may improve the delivery of the injectate to the site of the pathology without increasing the technical difficulty or side effects of the procedure. After negative aspiration for cerebrospinal fluid and heme, 0.5 -1 ml of non-ionic contrast material (Omnipaque 300) was injected to document appropriate contrast spread into the epidural space on the patient's symptomatic side (Fig. 2). Next, a combination of 80 mg of methylprednisolone acetate with 2 to 3 ml of lidocaine 1% was injected in the epidural space. Diabetic patients with unstable blood glucose levels received 40 mg of methylprednisolone acetate.

The patients were then brought to the recovery area. They were asked to rate their back and leg pain on the VNRS scale within 1 hour after the injection prior to departure from the injection suite. They were asked to sit, stand and walk before rating their pain. The patients were then seen in follow-up in our spine clinic typically two to three weeks after the injection. They were asked again to rate their average back and leg pain using the VNRS scale. All VNRS scores were documented by nursing personnel not involved in the procedure.

The patients' charts were then reviewed for one year after the initial procedure to determine if further epidural steroid injections or surgery for the presenting problem were required in our institution. Repeated epidural steroid injections were carried out by the lead author at the same level using the same approach as the initial procedure. Only patients with complete data for all time points were included in the analysis.

Microsoft Excel/ Analyze-It software (Version 2003) was used for statistical analysis. A paired, two-tailed t-test was used to determine a statistical difference for pre-injection, post-injection and follow-up VNRS scores between the interlaminar and transforaminal groups (Table 2). Statistical significance was accepted at an alpha level of .05.

Results

There was no statistically significant difference in the duration of symptoms prior to the injection in either group (5.6 months in the transforaminal group, 5.4 months in the interlaminar group). Pre-injection VNRS scores were higher in the interlaminar group (VNRS mean 7.3) compared to the transforaminal group (VNRS mean 5.9), but the difference did not reach statistical significance ($p=0.08$). All MRI reports were performed by radiologists not involved in the study and the information was reviewed. The radiologists' readings indicated a similar distribution of protrusions and extrusions/ sequestrations in the two study groups. The majority of injections were performed in both groups at the L5-S1 level. In the transforaminal group, there were three bilateral injections (for patients with bilateral leg symptoms) and 2 two-level injections (for patients with nerve root compressions of the exiting and descending nerve roots caused by the same disc herniation) (Table 1).

In the transforaminal group, there was a statistically significant improvement in the VNRS scores from before the injection (VNRS mean 5.9) to immediately after the injection (VNRS mean 2.9, $p<0.01$, 95% CI 1.63-4.42), and upon follow-up (VNRS mean 3.2, $p<0.01$, 95% CI 1.53-3.84, mean 18.7 days). Nine patients (45%) required one or two repeated injections, and 2 patients (10%) underwent surgery.

Table 1: *Patients Summary of MRI findings, pain duration and injection levels*

MRI FINDINGS	N
IL-ESI	
Protrusion	11
Extrusion	8
Sequestration	1
TF-ESI	
Protrusion	11
Extrusion	9
Sequestration	0
PAIN DURATION (months)	
IL-ESI	5.4 (0.5 to 12)
TF-ESI	5.6 (0.5-12)
INJECTION LEVEL	
IL-ESI	
L4-5	5
L5-S1	15
TF-ESI	
L2-3	2
L3-4	1
L4-5	15
S1	1

numbers in parenthesis indicate range

In the interlaminar group, there was a statistically significant improvement in the VNRS scores from before the injection (VNRS mean 7.3) to immediately after the injection (VNRS mean 3.1, $p<0.01$, 95% CI 2.80-5.50), and upon follow-up (VNRS mean 5.9, $p<0.01$, 95% CI 0.52-2.26, mean 15.6 days). Eight patients (40%) required 1 or 2 repeated injection, 5 patients (25%) underwent surgery.

The post-injection VNRS scores showed no statistical difference between the groups at post-injection, i.e. immediately after the injection. However, at follow-up there was a statistically significant difference between the two groups in the improvement in the VNRS scores ($p<0.01$, 95% CI 1.08-4.21) in favor of the transforaminal group: The interlaminar group had an average improvement of 1.4 points of the VNRS score, the transforaminal group had an average improvement of 2.7 points of the VNRS score. Fourteen patients (70%) had an improvement of 2 points or more on the VNRS scale in the transforaminal group, compared to 9 (45%) in the interlaminar group. The average VNRS improvement at follow-up was 46% in the transforaminal group and 19% in the interlaminar group.

Discussion

Analysis of our pre-procedure patient information did not show any significant difference in symptom duration between the two groups. There was also no significant difference in MRI findings (Table 1), indicating comparable baseline data in both groups. Of note, the interlaminar group had a higher VNRS score compared to the transforaminal group prior to the procedure, but the difference did not reach statistical significance. Therefore, the patients in this trial were matched for pre-injection VNRS scores, MRI finding and symptom duration.

The interlaminar group on average felt significantly better immediately after the procedure. However, the pain improvement was less pronounced at follow-up, indicating a short-term treatment effect mainly due to the local anesthetic injection. On the other hand, the transforaminal group had significant improvement of VNRS scores directly after the injection, which was largely maintained at follow-up. We agree with others that the more targeted delivery of the injectate along the inflamed spinal nerve is the most likely explanation for these better outcomes (8) (Table 2). We have changed our interlaminar technique to a "directed lateral interlaminar approach" by targeting the epidural needle toward the side of the pathology. This technique may improve outcomes of the interlaminar approach, but these findings are anecdotal. However, the effect of improved interlaminar injection techniques on treatment outcomes may warrant further scientific study.

Our study supports the findings of Riew et al (4) that transforaminal ESIs decrease the need for discectomies for lumbar disc herniations. Our surgical

Table 2. *Comparative responses from VNRS pre- and post-injection for both interlaminar and transforaminal injections*

	Pre-injection VNRS Mean± SD	*Post-injection VNRS Mean± SD*	*Follow-up VNRS Mean± SD*	*Change VNRS (pre-injection to F-U) Mean± SD*	*Repeated Injection*	*Surgery*
Interlaminar (n=20)	*7.3±2.3*	*3.1*±2.3*	*5.9*±2.7*	*1.4 ±1.9*	*8 (40%)*	*5 (25%)*
Transforaminal (n=20)	*5.9 ±2.4*	*2.9* ±2.5*	*3.2*# ±2.0*	*2.7 ±2.5*	*9 (45%)*	*2(10%)*

* statistically significant at $p<0.01$ within groups

statistically significant at $p<0.01$ with interlaminar group

rates (10%) were lower than those reported in that study (29%).

Our results are very similar to previous studies looking at the outcomes from interlaminar and transforaminal epidural steroid injections independently. Buttermann reported a 42-56% "effective treatment" in patients undergoing interlaminar epidural steroid injections for a large lumbar of intervertebral disc herniations compared to 45% in our study as defined by an improvement of the VNRS score of two or more points (9). Vad et al (3) reported a 84% "success" in patients with lumbosacral radiculopathy who underwent transforaminal ESI, compared to 70% in our group. Although these studies looked at different outcome endpoints, the results seemed to be quite comparable to the ones reported in our study, supporting the validity of our study.

The transforaminal approach has been the favorite approach by most interventional pain physicians for the treatment of lumbar radicular symptoms over the last several years. This is supported by two RCTs (3-4). Karpinnen's trial, however, demonstrated fewer positive results (10). On the other hand, interlaminar ESIs have been used for many years, but current science provides only limited support for the efficacy of this treatment for lumbar radicular symptoms (2,11,12). However, all currently available studies on interlaminar ESIs have significant methodological flaws, mainly due to unreliable utilization of fluoroscopic control and contrast injection and the lack of correlation of pathological findings on advanced imaging studies with the precise localization of the ESI.

The currently published standards indicate that ESIs should be performed under fluoroscopic guidance with contrast injection to ensure appropriate localization of the needle and confirmation of the appropriate delivery of the injectate to the target area (6,8,13). To our knowledge, there has been no study to date directly comparing the transforaminal with the interlaminar approach for symptomatic lumbar radiculopathies with corresponding MRI findings utilizing these recommended standards.

The study has obvious limitations: First, the follow-up interval for pain improvement is short. However, it is commonly agreed that epidural steroid injections are particularly helpful for pain control in the first weeks after the injection (2). We therefore focused our long-term outcomes on surgical rates as well as the need for repeat injections. Second, the sample size is small. For the purpose of the study, only patients with the previously stated, fairly strict inclusion/exclusion criteria were enrolled. This eliminates a large proportion of patients typically seen by pain interventionalists. ESIs are commonly performed for radicular symptoms after previous lumbar surgery, multilevel disc herniations, chronic symptoms, previous blind epidural steroid injections and for diagnostic reasons in cases of an unclear diagnosis. It was our goal to limit the study to a well-defined patient population to increase the validity of our results. Third, all procedures were performed by the same physician. The results of this study therefore reflect the experience of one practitioner and may not be generalized. Fourth, the study was not randomized. Our goal was to use a case-control design to determine the feasibility of a future trial. The data of this study will allow us to perform a power analysis for an RCT, which is ultimately needed to more definitely answer our initial hypothesis.

Therefore, the study should be considered an initial attempt to answer the question about the most efficacious technique for ESI.

Conclusions

Patients who received a transforaminal epidural steroid injection for the treatment of symptomatic lumbar disc herniation had significantly better short-term pain improvement and required fewer long-term surgical interventions than patients who were treated with an interlaminar epidural steroid injection. The results of this study assist in formulating an appropriate RCT.

Author Affiliation:

Michael K. Schaufele, MD
Attending Physiatrist
The Emory Spine Center
Assistant Professor
Emory University
School of Medicine
Atlanta, Georgia 30329
michael.schaufele@emoryhealthcare.org

Laura Hatch, MD
Physiatrist
Emory University
School of Medicine
Atlanta, Georgia 30329

William Jones, MD
Physiatrist
Emory University
School of Medicine
Atlanta, Georgia 30329

References

1. Vroomen PC, de Krom MT, Slofstra PD, Knottnerus AJ. Conservative treatment of sciatica: A systematic review. *J.Spinal Disord* 2000; 13: 463-469.
2. Arden NK, Price C, Reading I, Stubbing J, Hazelgrove J, Dunne C et al. A multicentre randomized controlled trial of epidural corticosteroid injections for sciatica: the WEST study. *Rheumatology* (Oxford) 2005; 44:1399-1406.
3. Vad VB, Bhat AL, Lutz GE, Cammisa F. Transforaminal epidural steroid injections in lumbosacral radiculopathy: a prospective randomized study. *Spine* 2002; 27:11-16.
4. Riew KD, Yin Y, Gilula L, Bridwell KH, Lenke LG, Lauryssen C (need to list all authors - Bert). The effect of nerve-root injections on the need for operative treatment of lumbar radicular pain. A prospective, randomized, controlled, double-blind study. *J Bone Joint Surg Am* 2000; 82-A:1589-1593.
5. Ng L, Chaudhary N, Sell P. The efficacy of corticosteroids in periradicular infiltration for chronic radicular pain: a randomized, double-blind, controlled trial. *Spine* 2005; 30:857-862.

6. International Spine Intervention Society. *Practice Guidelines - Spinal Diagnostic Treatment Procedures*. 1 ed. 2005.
7. Fenton DS CL. *Image-Guided Spine Intervention*. 1st ed. Saunders, 2002.
8. Manchikanti L. Transforaminal lumbar epidural steroid injections. *Pain Physician* 2000; 3:374-398.
9. Buttermann GR. Treatment of lumbar disc herniation: epidural steroid injection compared with discectomy. A prospective, randomized study. *J Bone Joint Surg Am* 2004; 86-A:670-679.
10. Karppinen J, Malmivaara A, Kurunlahti M, Kyllonen E, Pienimaki T, Nieminen P et al. Periradicular infiltration for sciatica: a randomized controlled trial. *Spine* 2001; 26:1059-1067.
11. Nelemans PJ, deBie RA, deVet HC, Sturmans F. Injection therapy for subacute and chronic benign low back pain. *Spine* 2001; 26:501-515.
12. Boswell MV, Hansen HC, Trescot AM, Hirsch JA. Epidural steroids in the management of chronic spinal pain and radiculopathy. *Pain Physician* 2003; 6:319-334.
13. Boswell MV, Shah RV, Everett CR, Sehgal N, McKenzie Brown AM, Abdi S, Bowman II RC, Deer TR, Datta S, Colson JD, Spillane WF, Smith HS, Levin LF, Burton AW, Chopra P, Staats PS, Wasserman RA, and Manchikanti L. Interventional techniques in the management of chronic spinal pain: evidence-based practice guidelines. *Pain Physician* 2005; 8:1-47.