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Comparing the clinical outcomes of lumbar transforaminal vs interlaminar epidural steroid injections in a registry cohort

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A B S T R A C T

Background: Transforaminal and interlaminar approaches are both common means of performing epidural steroid injection. Comparative effectiveness data on outcomes of these approaches is available but has yielded mixed results.
Objective: Compare the effect of transforaminal vs interlaminar delivery of epidural steroids on patient-reported pain severity.
Design: Retrospective Cohort Study.
Methods: A retrospective review of prospectively collected interventional spine procedure registry data between December 2011 and July 2017 from a single academic medical center. Those who received epidural steroid injections and had prospectively collected index pain data (11-point Numeric Rating Scale [NRS]) recorded in the patient's chart prior to the procedure and at a 3 month follow up appointment were included. The outcome of interest was ≥50% reduction in pain as measured using a NRS for back and/or leg pain. To evaluate true predictive odds of success, multivariable logistic regression modeling was used to determine the odds of achieving improved pain.
Results: Of the 73 patients included in the study, 61 (84%) reported radicular pain, 49 (67%) reported back pain, and eleven (15%) had symptoms consistent with claudication, pain characteristics were not mutually exclusive. Fifty-one (70%) underwent transforaminal epidural steroid injection, while 22 (30%) underwent interlaminar injection. When claudication and radicular pain groups were combined into a single “leg pain” category (n = 66), 26/46 (57% 95% CI 41–71%) patients undergoing transforaminal and 6/20 (30% 95% CI 12–54%) patients undergoing interlaminar injections achieved ≥50% leg pain reduction on NRS (p = 0.048). Transforaminal epidural steroid injections were associated with higher odds of ≥50% reduction in leg pain in both the unadjusted model (OR 3.2, p = 00.034) and after adjustment for presence of radicular pain on presentation and the type of steroid used (OR 3.6, p = 0.042).
Conclusion: In this clinical practice registry, patients treated with transforaminal epidural steroid injection were more likely to achieve ≥50% reduction in radicular or neurogenic/claudicatory leg pain compared to those treated with interlaminar epidural steroid injection.

1. Introduction

Epidural steroid injections are a safe and effective treatment for acute low back pain associated with radicular pain; the best available evidence is for acute intervertebral disc herniation pathology, though other pathology such as spondolytic stenosis or non-specific pack pain have also been studied [1–4]. Transforaminal and interlaminar epidural steroid injections work, in theory, by delivering a corticosteroid in close proximity to the site of nerve root compression and inflammation. While both approaches deliver corticosteroid to the epidural space, differences in approach may result in different medication flow patterns. Specifically, the transforaminal approach is theorized to better deliver medication to the ventral epidural space which is the most common location of certain pathology such as intervertebral disc herniation. Neural compression may also occur at or near the neural foramen, for which a transforaminal approach has also been hypothesized to be the most direct and efficacious route for medication delivery [5].

Differences in flow pattern have even been observed with either approach; with a transforaminal approach, for example, medication delivery to the ventral epidural space is partially determined by final needle positioning supero-anteriorly as opposed to a supero-posterior position [6]. Likewise, a modified or parasagittal interlaminar approach has been shown to result in ventral medication flow [7,8]. Within this theoretical discussion however, clinical outcomes are still the primary concern.

Transforaminal epidural steroid injection (TFESI) has been shown to

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be superior to Interlaminar epidural steroid injection (ILESI) as a treatment for radicular pain due to intervertebral disc herniation [9,10]. Other studies have shown equivalency of the two treatments for the same diagnosis [11,12]. Of note, we are unaware of data demonstrating ILESI is superior to TFESI as a treatment for radicular pain due to disc herniation. For neurogenic claudication and central canal stenosis, sub-group analysis of one major trial demonstrated statistical equivalence between TFESI and ILESI though there a trend in favor of ILESI [13]. Otherwise, there is less comparative data when considering TFESI vs ILESI for radicular pain in general or radicular pain due to degenerative stenosis.

Using a single center registry of epidural steroid injections, we sought to identify the effect of transforaminal vs interlaminar delivery of epidural steroids on patient-reported pain severity among patients presenting with either radicular pain, claudication, or axial back pain. Specifically, we queried the registry data to determine if TFESI or ILESI had increased effectiveness when stratifying by the type of pain the patient was reporting prior to the procedure.

2. Methods

Prospectively collected data as part of an interventional spine procedure registry data between December 2011 and July 2017 from a single academic medical center was considered. We retrospectively reviewed charts to collect additional data such as whether pain was either predominantly radicular or claudicatory. The registry includes patient-, symptom-, and intervention-specific data from a random sample of patients referred for an interventional spine procedure from a surgeon. Patients were randomly enrolled at a rate of approximately one patient per day but were not consecutive. Available resources precluded all patients at the institution being part of the registry. As a clinical registry, there was no pre-specified inclusion criteria that determined why an epidural steroid injection was ordered. Additional details of enrollment in the registry have been published in other studies utilizing this data set [14]. Epidural steroid injections were mostly performed by the anesthesiology interventional pain clinic at the institution, the type of injection performed was at the discretion of the referring and/or performing physician. Of note, the primary authors of this manuscript had registry data availed to them for the purpose of this manuscript but were not involved in enrollment of patients nor primarily responsible for the performance of the injections. For this study, only patients who received epidural steroid injections and had prospectively collected index pain data (11-point Numeric Rating Scale [NRS]) recorded in the registry within 7 days prior to the procedure and at the 3 month follow up time point after the initial injection were included. Both back pain and leg pain were recorded and independently evaluated accordingly. Repeat injections did occur in some patients within the 3 month period, but did not re-start the data collection window. For analysis, the type of injection considered was the initial epidural steroid injection. The primary outcome of interest was ≥50% reduction in leg pain as measured using a NRS for leg pain. Axial back pain was considered and is reported independently. Other data, such as which symptoms were predominant and type of epidural and steroid, were included as covariates in modeling. When individuals reported more than one type of pain (i.e., radicular and claudicatory pain, n = 6), both complaints were included in relevant analyses.

Chi square tests were used to determine correlations between the pain- and intervention-related covariates described above and the pain outcome. In order to evaluate true predictive odds of success, multivariable logistic regression modeling was used to determine the odds of achieving improved pain. This study was approved by the Vanderbilt University Medical Center Institutional Review Board (IRB 170906).

3. Results

Pain characteristics were not mutually exclusive, and all presenting symptoms were recorded. Of the 73 patients included in the study, 61 (84%) reported radicular pain, 49 (67%) reported back pain, and eleven (15%) had symptoms consistent with claudication. Fifty-one (70%) underwent transforaminal epidural steroid injection, while 22 (30%) underwent interlaminar injection. (Table 1). 52 patients had baseline data collection on the day of or the day prior to the injection. Only 6 patients had baseline data collected between 3 and 7 days prior to the injection. All ILESI were performed with a particulate steroid. 17 TFESI were performed with dexamethasone while the remainder were done with particulate steroid. Of note, the beginning of in the registry predated multi-society recommendations that dexamethasone should be used as the first-line agent in the performance of lumbar TFESI [15].

Of the 43 patients complaining of radicular pain and undergoing transforaminal injection, 25 (58%, 95%CI: 42–72%) achieved the primary outcome of at least a 50% improvement in leg pain; of the 18 patients with radicular pain who underwent interlaminar injection, six (33%, 95% CI 13–58%) reported at least 50% leg pain reduction (p = 0.128). Among the eight individuals reporting claudication, 5 (62.5%, 95% CI 29–96%) receiving transforaminal injections achieved ≥50% leg pain reduction, whereas one of the three (33.3%, 95% CI 0–87%) individuals with claudication undergoing interlaminar injection met the primary outcome (p = 0.387). When claudication and radicular pain groups were combined into a single "leg pain" category (n = 66), 26/46 (57% 95% CI 41–71%) patients undergoing transforaminal and 6/20 (30% 95% CI 12–54%) patients undergoing interlaminar injections achieved ≥50% leg pain reduction on NRS (p = 0.048) (Table 2).

Among the 51 individuals reporting back pain, 10/32 (31%, 95% CI 15–47%) of patients undergoing transforaminal and 6/17 (35%, 95% CI 14–61%) patients undergoing interlaminar injections achieved ≥50% back pain reduction on NRS (p = 0.774).

Regression modeling showed that when compared with interlaminar epidural steroid injections, transforaminal epidural steroid injections were associated with higher odds of ≥50% reduction in leg pain in both the unadjusted model (OR 3.2, p = 00.034) and after adjustment for presence of radicular pain on presentation and the type of steroid used (OR 3.6, p = 0.042). There was no statistically significant association between injection approach (transforaminal vs interlaminar) and ≥50% reduction in back pain among those with a primary back pain complaint in either univariate (OR = 0.73, p = 0.558) or multivariable models (OR = 0.74, p = 0.584).

No association was found between type of steroid used (dexamethasone vs particulate steroids) and the odds of meeting the primary outcome in multivariable analysis for leg pain (OR = 0.9, p = 0.669) or back pain (OR = 0.8, p = 00.271).

8 of the 22 patients (36.4%) that initially received ILESI had repeat injection vs 17 of 51 patients (33.3%) of those that initially received TFESI. Of the 6 patients who initially received an ILESI and has a single repeat injection, 3 of the repeat injections were ILESI and 3 were TFESI. Of the 16 patients who initially had a TFESI and had a single repeat injection, 14 had a repeated TFESI and 2 had ILESI. Only 3 patients received 3 epidural steroid injections during the 3 month window, 1

Table 1
Characteristics of individuals undergoing epidural steroid injection.

	TFESI (n = 51, 70%)	ILESI (n = 22, 30%)	p
Gender (Male)	19	4	0.11
Race (Caucasian)	41	18	0.89
Age (Years)	61.6	56.0	
Back pain only	5	2	0.775
Radicular pain only	18	5	
Claudication only	0	0	
Back pain + radicular pain	20	12	
Back pain + claudication	3	2	
Radicular pain + claudication	1	0	
Back pain, radicular pain, + claudication	4	1	

Table 2
Percentage of patients with leg pain achieving at least 50% reduction in pain at 3 months.

	Yes	No
TFESI	26	20
ILESI	6	14

Unadjusted OR 3.2 (p = 0.034) in favor of TFESI.

patient had 3 ILESI, 1 patient had 3 TFESI, 1 patient had an initial ILESI followed by 2 TFESI. Repeat injections were performed at the following time intervals after the index injection: 2 weeks (n = 5), 4 weeks (n = 1), 6 weeks (n = 11), 8 weeks (n = 4), 10 weeks (n = 1). Of the patients who had 3 injections, they were performed at 1 and 5 weeks, 2 and 8 weeks, and 6 and 11 weeks after the initial injection.

4. Discussion

This study sought to identify the effects of interlaminar vs transforaminal epidural steroids on patient-reported pain using a single-center registry.

Our results suggest that epidural steroid injections are most successful when performed in the presence of leg pain rather than back pain, and that a transforaminal approach may be more successful when used for this indication. Specifically, we found that a transforaminal approach yielded significantly higher odds of ≥50% pain reduction in radicular or claudicatory leg pain than an interlaminar approach. Prior studies investigating outcomes between the two approaches have yielded mixed results; while many have found greater symptom improvement with a transforaminal approach, others have found no difference at all [7,8,16–21]. Many of these studies have primarily been limited by small sample size, often including 30 or fewer total patients. A 2016 systematic review and meta-analysis of the studies available at that time found that while a transforaminal approach was more effective at pain reduction, no meaningful difference existed between the two in terms of functional recovery, progression to surgery, or time to next injection [22]. While the study benefited from a combined *n* of 246 patients, the authors noted a substantial level of heterogeneity between studies that threatened the external validity of their results. A single large (n = 140) study compared each of the two approaches with a caudal approach on the basis of Japanese Orthopedic Association (JOA) score, and found that a transforaminal approach had a significantly greater effect on JOA score at six and twelve months post-procedure than either interlaminar or caudal approach [23]. The study did not address analgesic effect. Our study adds to the body of literature by contributing a larger *n* data point with analysis that benefited from multivariable regression to control for potential confounding variables.

Our findings, in terms of proportion of successful outcomes, are overall consistent with other published outcomes of TFESI as a treatment for lumbar radicular pain, which confer some external validity to the findings in the absence of there being strict inclusion criteria for enrollment [24]. Outcomes for ILESI are arguably lower than may be expected, though the broad confidence interval due to overall low n in this group still captures other published outcomes [4]. Successful outcomes for claudicatory pain (6 out of 11 (54.5% 95% CI 23–83%)) are higher than that reported elsewhere, but again the confidence interval is broad due to overall low n [13].

Admittedly, there are many other variables that may also affect outcomes after epidural steroid injections. While outcomes for epidural steroid injections may be best for radicular pain due to intervertebral disc herniation, there are many studies that show positive outcome for degenerative conditions as well [2,3,25,26]. Indeed, other factors such as steroid type may also be implicated, though prospective and large cohort studies do suggest equivalency between dexamethasone and particulate steroids [25,27]. Our study showed no correlation between the type of steroid used (dexamethasone vs particulate) and odds of meeting the primary endpoint, further supporting the parity of these classes of medication.

Notably, there was no correlation between either transforaminal approach or interlaminar approach and reduction in back pain. This is consistent with most current guidelines that do not recommend epidural steroid injections for the treatment of low back pain [28]. That said, these data show that there is a small portion of patients (31%, 95% CI 20–47%) who receive greater than 50% improvement in low back pain. After chart review, it was apparent that 7 patients underwent epidural steroid injection in whom the only complaint was low back pain, of whom only 3 demonstrated >50% improvement in low back pain. This is consistent with the overall proportion achieving relief from back pain, reaffirming that axial pain in isolation is not an indication for epidural steroid injection. Given the prolonged period of enrollment and multiple treating physicians with patients enrolled in the registry, it is unclear as to why these patients did in fact receive an epidural steroid injection.

34% of patients did receive a repeat injection within the 3 month data collection, without a significant difference in repeat injection rate between the TFESI and ILESI group, nor was there a meaningful difference seen in the number of patients who received a different approach with their repeat injection. If anything, the slightly higher proportion of patients who received an initial ILESI that subsequently received a TFESI compared to the alternative would have biased against our findings that TFESI was more effective than ILESI. While the durability of treatment effect at 3 months may be confounded by some of the repeat injections performed within the 3 month window, the majority of repeat injections were done within the first 6 weeks and are unlikely to effect the primary outcome in the difference between ILESI and TFESI we measured at 3 month follow up.

This study has several limitations. First, injection approach was not randomized, and choice of approach may have been impacted by anatomic or pathologic findings (indication bias), which were not specified in the registry, and which may have shown collinearity with the outcomes of interest. While this registry data is larger than many previous studies that have reported on this, the overall 'n' was still too small to adequately power further sub-group analysis such as stratifying by injection type, symptom, and underlying pathology. Referral patterns such as which patients were referred to Anesthesiology Pain clinics versus Physical Medicine and Rehabilitation clinics were also not considered. While registry data can be very helpful when addressing questions such as ours, retrospective data analysis, including registry data, suffers from common limitations [29]. While patients were enrolled into the registry at a consistent interval, patients were not consecutive which may introduce selection bias. The use of either proportional or absolute thresholds for success can show skewed results, particularly among individuals with lower baseline pain scores.

5. Conclusions

In this clinical practice registry, patients treated with transforaminal epidural steroid injection were more likely to achieve ≥50% reduction in radicular or neurogenic/claudicatory leg pain compared to those treated with interlaminar epidural steroid injection.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Byron J. Schneider reports a relationship with Spine Intervention Society that includes: board membership. Byron J. Schneider reports a relationship with State Farm Insurance Companies that includes: consulting or advisory. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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