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SCIENTIFIC ARTICLE

Comparison of transforaminal and interlaminar epidural steroid injections for the treatment of chronic lumbar pain

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KEYWORDS
Transforaminal;
Interlaminar;
Low back pain;
Spinal injection;
Complication

Abstract
Study design: A cross-sectional study.
Objective: We compared the 12 month outcomes of fluoroscopically guided transforaminal epidural steroid injections with interlaminar epidural steroid injections for the treatment of chronic lumbar spinal pain. Chronic lower back pain is a multifactorial disorder with many possible etiologies. The lifetime prevalence of spinal pain is reportedly 65–80% in the neck and lower back. Epidural injection of corticosteroids is a commonly used intervention for managing chronic spinal pain.
Methods: Patients who did not benefit from previous treatments were included in this study. Injections were performed according to magnetic resonance imaging findings at the nearest level of lumbar pathology; 173 patients received interlaminar epidural steroid injections and 126 patients received transforaminal epidural steroid injections. All of the patients were regularly followed up for 12 months using a verbal numeric rating scale. Magnetic resonance imaging findings, complications, verbal numeric rating scale, and satisfaction scores were recorded.
Results: Lumbar disk pathology was the most frequently encountered problem. The interlaminar epidural steroid injections were preferred at the L4–L5 intervertebral level. Verbal numeric rating scale scores significantly decreased during the 12-month period compared to basal scores ($p < 0.001$). Significant differences between the two groups according to verbal numeric rating scale and satisfaction scores were not observed ($p > 0.05$). There were no major complications; however, the interlaminar epidural steroid injections group had 22 (12.7%) minor complications, and the transforaminal epidural steroid injections group had 12 (9.5%) minor complications.
Conclusions: This study showed that interlaminar epidural steroid injections can be as effective as transforaminal epidural steroid injections when performed at the nearest level of lumbar pathology using fluoroscopy in 12-month intervals.

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PALAVRAS-CHAVE
Transforaminal;
Interlaminar;
Dor lombar;
Injeção espinhal;
Complicação

Comparação das técnicas transforaminal e interlaminar de injeções epidurais de esteroides para o tratamento de dor lombar crônica

Resumo
Desenho do estudo: Estudo transversal.
Objetivo: Comparamos os desfechos de 12 meses de injeções peridurais de esteroides usando a técnica transforaminal (IPETF) guiada por fluoroscopia com as injeções peridurais de esteroides usando a técnica interlaminar (IPEIL) para o tratamento da dor lombar crônica. A dor lombar crônica é uma doença multifatorial com muitas etiologias possíveis. Relata-se que a prevalência de dor na coluna durante a vida é de 65%-80% no pescoço e parte inferior das costas. A injeção peridural de corticosteroides é uma intervenção comumente usada para controlar a dor crônica da coluna vertebral.
Métodos: Pacientes que não obtiveram benefício de tratamentos anteriores foram incluídos neste estudo. As injeções foram realizadas de acordo com os achados em Ressonância Magnética (RM) ao nível mais próximo da patologia lombar; 173 pacientes receberam IPEIL e 126 pacientes receberam IPETF. Todos os pacientes foram acompanhados regularmente por 12 meses, usando uma escala numérica verbal (ENV) para a classificação. Achados em RM, complicações, escores ENV e índices de satisfação foram registrados.
Resultados: Patologia em disco lombar foi o problema mais frequentemente encontrado. IPEIL foi preferido ao nível intervertebral de L4-L5. Os escores da ENV diminuíram significativamente durante o período de 12 meses em comparação com os valores basais ($p < 0,001$). Não houve diferenças significativas entre os dois grupos de acordo com a ENV e os índices de satisfação ($p > 0,05$). Não houve grandes complicações, mas houve complicações menores em 22 (12,7%) no grupo IPEIL e 12 (9,5%) no grupo IPETF.
Conclusões: Este estudo mostrou que IPEIL pode ser tão eficaz como IPETF quando realizadas ao nível mais próximo da patologia lombar usando a fluoroscopia em intervalos de 12 meses.

Introduction

Lower back pain with or without lower limb pain is the most common problem among acute and chronic pain disorders, and has significant implications.[1–3] Chronic lower back pain is a multifactorial disorder with many possible etiologies.[4,5] The lifetime prevalence of spinal pain is reportedly 65–80% in the neck and lower back.[6] Kuslich et al.[7] identified intervertebral discs, facet joints, ligaments, fascia, muscles, and nerve root dura as the tissues capable of transmitting pain in the lower back.

Intervertebral disk herniation, spinal stenosis, intervertebral disk degeneration without disk herniation, degenerative spondylolisthesis with stenosis, and post lumbar surgery syndrome are the most common diagnoses for lower back and leg symptoms.[1]

Disk-related pain is caused by disk degeneration, disk herniation, or biochemical effects including inflammation. Degeneration of the human intervertebral disk is a major clinical problem and the leading cause of pain and disability, resulting in significant health care-related costs. The degenerative process in intervertebral discs is associated with a series of biochemical and morphological changes that combine to alter the biomechanical properties of the motion segment. Disk degeneration with or without disk herniation can lead to lower back pain.[8]

Generally, the etiology of lumbar spinal pain includes not only mechanical neural compression, but also vascular compromise, inflammation, and biochemical and neural mechanisms. Neurotoxicity has also been attributed to many agents including phospholipase A2 and tumor necrosis factor, which may play essential roles in intervertebral disk-induced nerve root damage.[9,10]

Epidural injection of corticosteroids is one of the most commonly used interventions for managing chronic spinal pain.[1–5,11,12] However, clinical data regarding epidural steroid applications in Turkey were not available. Currently, epidural injections are frequently performed interventions in the United States, and over 1 million epidural steroid injections are performed annually worldwide.[1,2,11]

Of the several approaches available to access the lumbar epidural space, the lumbar interlaminar approach is commonly used, followed by lumbar transforaminal and caudal epidural steroid injections.[3,6] Increasing emphasis is being placed on fluoroscopically guided, target-specific injections to improve treatment outcomes; therefore, modern study designs focus on fluoroscopically guided transforaminal injection techniques, which have the theoretical advantage of delivering the injectate to the site of the pathology in the anterior epidural space.[13]

In this study, we compared interlaminar epidural steroid injections (ILESI) with transforaminal epidural steroid

injections (TFESI), both fluoroscopically guided, over a 12-month period of treatment for chronic lumbar spinal pain.

Methods

This a cross-sectional study was approved by the Faculty of Medicine's Ethics Committee of Sakarya University (no 2012/45); 364 patients, treated by epidural steroid injections for chronic lumbar pain, were evaluated. All of the study patients were informed regarding interventions, and written informed consent was obtained.

The criteria for the study included a minimum of 6 months lower back pain, unilateral or bilateral leg pain symptoms, and no positive responses to medical or physical therapies. Medical therapies included non steroidal anti inflammatory drugs, and in some cases, opioids. Physical therapies included initial bed rest and passive physiotherapy, followed by an extension-based exercise program and light, and isometric core strengthening if pain was not relieved after 2 weeks of medical therapies. Patient lumbar spinal pathologies were clinically examined. An experienced radiologist confirmed the pathologies using magnetic resonance imaging (MRI). Exclusion criteria for the study included patients who refused interventions, did not receive lumbar surgery, were pregnant, had any contraindications to interventions (coagulopathy, sepsis, or allergy to drugs or contrast material), received lumbar spinal interventions in other clinics, had previously undergone lumbar surgery, and had neurological deficits or cauda equina syndrome.

All of the patients were examined, and imaging studies were reviewed prior to injection by the author. The choice of whether to use the transforaminal or the interlaminar approach was determined by the first author in no predetermined order. TFESI was performed if patients had radicular pain and positive MRI findings at one or two levels. Similarly, ILESI was performed if patients had radicular pain, lower back pain, and MRI findings at one or two levels. At the time of the procedures, the author had no personal preference for either approach.

All of the injections were performed in a similar manner. Routine hemograms, biochemical, and coagulation parameters were evaluated to confirm that they were within the normal range, after which the patients were taken to the operating room. All of the injections were performed by one anesthesiologist, and 6–8 h of fasting was preferred on the injection day. All of the procedures were performed under C-arm fluoroscopic guidance. Initial anteroposterior (AP) images were obtained to identify the level and interlaminar space in a prone position with a 10 cm high pillow placed under the abdomen. On the fluoroscopic table, standard anesthesia monitoring (noninvasive blood pressure, pulse oxymeter, ECG) was performed, and 0.9% NaCl was started intravenously. The injection area was cleaned with an antiseptic iodine-based solution, and anesthetized with 0.5 mL 2% prilocaine injected into the skin and subcutaneous tissue; 1–2 mg midazolam and 25–50 μg fentanyl were administered for conscious sedation.

For the TLESI approach, a 20 gauge blunt curved needle (Epimed®, Johnstown, NY, USA) was used. The target point was accessed by the subpedicular safe triangle[14,15] approach in the oblique position. In all of the TLESI applications, a mixture of 80 mg triamcinolone acetonide in 0.25% bupivacaine was used. After placing the needle into the target point, 0.5–2 mL nonionic contrast material (Iomeron 300, Patheon, Italia S.p.A.) was injected to determine whether vascular leakage or intrathecal distribution occurred. After the accurate anterior epidural flow pattern was observed on oblique, anteroposterior, and lateral images, 4 mL of the mixture was injected if TLESI was performed for a single level. If TLESI was performed for more than one level, 2 mL of the mixture per each level was injected, but the total steroid dose was maintained constant; for example, a total of 8 mL of 80 mg triamcinolone acetonide in 0.25% bupivacaine mixture was administered for all levels. In the case of vascular leakage, the needle site was slightly repositioned and recontrolled by contrast material. If vascular leakage persisted, the procedure was canceled for that level. If the intervention was performed for more than one level, the erroneous injection of the residual mixture into the subsequent level was avoided by flushing the needle with sterile isotonic after each level.

For the ILESI approach, an 18 gauge, $3^{1/2}$-in. or 5 in. Tuohy needle was advanced directly perpendicular to the skin in a posterior to anterior direction, with use of the loss-of-resistance to air technique to identify the epidural space. In cases when traditional methods failed to reach the epidural space, the parasagittal approach was preferred. After negative aspiration for cerebrospinal fluid and blood, 2 mL nonionic contrast material was injected to document the appropriate contrast spread into the epidural space. Next, a combination of 8 mL of 80 mg triamcinolone acetonide with 3 mL 0.25% bupivacaine was injected in the epidural space.

After the intervention, the patients rested on the table for 5 min, and were then transported to the recovery room where they stayed 2 h if complications did not develop. The complications that occurred during the procedure were recorded. The patients were asked to sit, stand, and walk before rating their pain using the Verbal Numerical Rating Scale (VNRS, 0-10 scale). All of the data obtained were recorded on the patient's charts. The patients discharged from the hospital were asked to immediately refer to our pain clinic if an unexpected situation occurred. On the control days (1, 3, 6, 9, and 12 months after injection), patients were interviewed at the hospital, and probable therapeutic effects, VNRS, and complications were recorded. Moreover, age, gender, and MRI findings were recorded on the patient's charts for post-interventional evaluations. Modified North

Table 1 Modified North American Spine Society Patient Satisfactory Score.

Score	
Bad	No change of complaints; even worse.
Moderate	Epidural steroid helped me but I won't let this procedure again.
Good	Most of the complaints are relieved and I would again let this procedure if my complaints reappear.
Perfect	Epidural steroid satisfied me and fulfilled my expectations.

American Spine Society (NASS) patient satisfaction score was recorded using a 4 point scale (Table 1).

Statistical analysis

All data were analyzed using the statistical package SPSS version 15.0 for Windows. Kolmogorov–Smirnov test was used to determine if the demographic data were distributed normally. Chi-Square test was used to compare the satisfaction scores and complications between the groups. Repeated measurements ANOVA parametric test for repeated measurements analysis was used to evaluate the improvements in VNRS scores before and after the procedure. Independent sample *t*-test analysis was performed for differences in pain reduction between the two groups. Data were presented as means ± standard deviation (SD).

Results

In the present study, 364 patients were enrolled between April 2013 and October 2014 for epidural injections. Of these, 23 patients did not come to the hospital, 1 refused intervention on the operation table, 6 could not be reached by telephone, and 36 had a previous history of lumbar surgery. The number of patients with complete data was 299. The distribution of these patients according to the month was 299 (100%), 238 (79.6%), 211 (70.6%), 171 (57.2%), and 114 (38.1%), respectively.

A total of 299 patients received 485 interventions. The patients were divided into two groups according to the steroid injection approach used. The transforaminal approach group (the TFESI group) consisted of 126 patients with 266 injections including repeated injections, and the interlaminar approach group (the ILESI group) consisted of 173 patients with 219 injections including repeated injections. The average age was 54.66 (11.69) years (range 23–85 years). Demographic data revealed no significant differences between the groups (Table 2).

When MRI images were evaluated, numerous pathologies were detected, such as disk herniation, spinal degeneration, spondilolisthesis, facet hypertrophy, and spinal stenosis. Disk pathologies were divided into 4 types; namely, bulging, protrusion, extrudation, and sequestration. The most affected level was L4–L5 (Table 3). Bulging was the most common pathology, and no sequestration was detected; 144 patients had only disk pathologies. In addition to disk pathologies, 64 patients had degenerative changes, 125 patients had diffuse degeneration, 73 patients had spinal stenoses of various types, and 27 patients had facet joint hypertrophy.

Table 2 Demographic features of groups.

	ILESI ($n = 173$)	TFESI ($n = 126$)	p[a]
Years	58.08 (13.49)	51.45 (12.50)	0.001
Gender M/F	50/123	41/85	0.623
Weight	69.38 (10.25)	66.48 (11.84)	0.527
Height	161 (8.7)	164 (11.6)	0.376
Number of injections	173	219	0.001
Pain duration, years	2.2	1.9	0.172

ILESI, interlaminar epidural steroid injections; TFESI, transforaminal epidural steroid injections.
[a] Chi-square test.

Table 3 The MRI findings of 299 patients the LESI.

	ILESI, *n* (%)	TFESI, *n* (%)	p[a]
L1-L2			0.526
Bulging	10 (71.4)	10 (55.5)	
Protrusion	4 (28.6)	8 (44.5)	
Extrusion	0	0	
L2-L3			0.445
Bulging	27 (71.05)	29 (60.41)	
Protrusion	11 (28.95)	18 (37.51)	
Extrusion	0	1 (2.08)	
L3-L4			0.234
Bulging	48 (71.64)	44 (58.66)	
Protrusion	18 (28.36)	28 (37.33)	
Extrusion	1 (1.49)	3 (4.01)	
L4-L5			0.085
Bulging	50 (58.14)	45 (42.45)	
Protrusion	35 (40.69)	58 (54.71)	
Extrusion	1 (1.17)	3 (2.84)	
L5-S1			0.200
Bulging	41 (50.61)	33 (37.08)	
Protrusion	37 (45.68)	51 (57.30)	
Extrusion	3 (3.71)	5 (5.62)	

Data are presented as *n* (%). LESI, lumbar epidural steroid injection.
[a] Chi-square test.

L4–L5 was the most injected level in both groups (Table 4). The average pre-injection VNRS score in the ILESI group was 7.8 (1.9) and in the TFESI group was 7.6 (2.2). The post-injection VNRS scores in both groups at 1, 3, 6, 9, and 12 months also decreased ($p < 0.001$, Fig. 1). Although the VNRS scores gradually increased after the first month, no significant difference could be detected. The VNRS and satisfaction scores were not significantly different between the groups ($p > 0.05$ for both scores).

No catastrophic complications were observed in either the ILESI or TFESI group. The ILESI group had 22 (12.7%) minor complications, and the TFESI group had 12 (9.5%) minor complications (Table 5). During the therapy period,

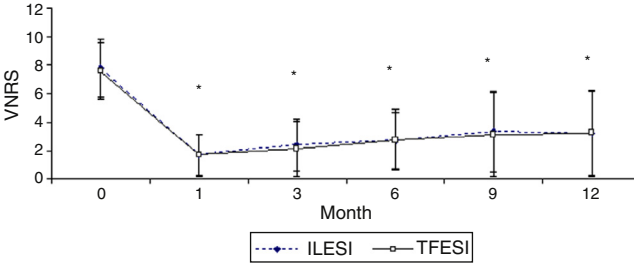

Figure 1 Post-injection VNRS scores in both groups at 1, 3, 6, 9, and 12 months.

Table 4 Repeated injections for lumbar epidural steroid injections.

	Single injection	First repeated injections	Second repeated injections	Total injections
TFESI				
One level	26/26	16/32	–	42/58
Two level	70/140	11/44	4/24	85/208
ILESI				
One level	130/130	40/80	3/9	173/219

Data are presented as patient number/injection number.
ILESI, interlaminar epidural steroid injections; TFESI, transforaminal epidural steroid injections.

Table 5 Distribution of complications for ILESI and TFESI.

	ILESI ($n = 173$)	TFESI ($n = 126$)
Dural puncture	4 (2.31%)	3 (2.38%)[a]
Post dural puncture headache	1 (0.57%)	–
Subdural block	3 (1.73%)	3 (1.59%)
Transient increased pain	3 (1.73%)	3 (2.38%)
Transient paresthesia	8 (4.62%)	3 (2.38%)
Hiccup	1 (0.57%)	–
Menstrual irregularities	1 (0.57%)	–
Vasovagal reaction	1 (0.57%)	–
Total	22 (12.7%)	12 (9.5%)

ILESI, interlaminar lumbar epidural steroid injection; TFESI, transforaminal epidural steroid injection.
Data are given *n* (%).
[a] The contrast agent were intrathecal spread in three patients who dural puncture.

three patients in the ILESI group (1.73%) and eight patients in the TFESI group (6.35%) underwent lumbar surgery.

Discussion

This study was conducted to evaluate and compare the effects of two different lumbar steroid injection approaches. The length of the study period was 12 months, and the study population included chronic lumbar pain patients.

Pre-procedural analysis of patient information did not show any significant difference in symptom duration between the two groups. The average age in the ILESI group was significantly higher than that in the TFESI group. Pre-intervention VNRS scores in the ILESI group were higher than those in the TFESI group, although without statistical significance. In terms of comparable parameters, the MRI findings were not significantly different between the two groups (Table 3).

At the 12 month follow-up, the VNRS scores significantly decreased after epidural steroid injections in both groups. This decrease was reflected clinically as increased satisfaction scores. Most of the patients (85.1%) improved after injection, and expressed improved well-being. However, the symptoms worsened in 13.9% of the patients who rated their condition as bad.

In another recent study, interlaminar injection provided superior pain relief in up to 92% of patients, whereas transforaminal injection provided pain relief in up to 90.5% of patients; however, in 9.5% of patients the condition worsened after TFESI, indicating that both steroid injections largely provided pain relief.[16] The decreased VNRS scores in the TFESI group were not significantly different from the ILESI group. High satisfaction scores could be explained by the injectate material being administered close to the pathology sites. Conversely, the ILESI group consisted of older patients with multi-level pathologies and more complex conditions, which might have contributed to the differences.

The current study is important because both groups had similarly high satisfaction scores (85.1%), which might be due to effective fluoroscopy or injection site proximity. In 2002, Wang et al.[17] conducted a study on 69 patients with symptomatic lumbar disk hernia. On follow-ups after the epidural steroid injections, radicular pain was decreased for 20–27 months, and surgical intervention was avoided during this period.

In 2007, Acherman et al.[18] conducted a study on 90 patients comparing the transforaminal, interlaminar, and caudal approaches, and concluded that the transforaminal approach was the most effective. However, the results were similar in all three groups (TFESI, ILESI, caudal epidural steroid injection groups). Each group consisted of 30 patients; 13 patients in the TFESI group and 12 in the ILESI group were not satisfied and only 1 patient experienced improvement. The pathology site level in ILESI was the same for all patients, which might have caused the differences.

In the current study, there were no significant differences between TFESI and ILESI levels as shown in the Table 5.

In 2006, Schaufele et al.[13] conducted a study on 20 patients comparing the two approaches of epidural steroid injections, and concluded the TFESI was more effective. However, significant limitations existed in their study; the population number was very small ($n = 20$), and the age of patients was unknown. The similarity to this study is that they injected the steroid at the same level of lumbar pathology. In 2004, Butterman[19] compared surgery with ILESI using large intervertebral disk herniation (herniation > 25% of the spinal canal sectional area). ILESI provided an effective treatment in 42–56% of patients, and temporarily relieved

pain for 6 weeks before surgery. In 1995, a review by Koes et al.[20] examined eight randomized trials that evaluated the effectiveness of ILESI on disk herniation, sciatica, or radiculopathy in the lumbar spine. Of the eight randomized trials evaluating lumbar radiculitis, five were positive for short-term relief, whereas only one study was positive for long-term relief. In 2003, Boswell et al.[4] conducted a systematic review of ILESI patients, and showed an absence of long-term side-effects.

These results are supported by two randomized controlled studies,[21,22,5] but Karppinen et al.[21] reported less positive outcomes. Thus, numerous studies on TFESI and ILESI have been published, which indicate positive or negative results with over 6 months of efficacy. Recently, TFESI provided more efficient results, but ILESI studies were conducted as randomized controlled studies using a blind technique for single level injections. In an ILESI study using the blind technique, the success rate was 70%, meaning that 30%[23] of the patients were not satisfied. However in the current study, fluoroscopy was used in both TFESI and ILESI. In addition, ILESI was performed at the closest site to the pathology. Our results showed that TFESI had much lower scores than ILESI, because the patients were older and their pathologies were multi-leveled.

Hopwood and Abram[24] described 33 factors associated with the success rate of lumbar epidural steroid injections, and suggested that all factors should be considered when treating chronic lumbar pain patients with epidural steroids. However, the experience of the person performing the procedure remains a very important factor that influences the success/satisfaction rate.[2]

In a review by Parr et al.[1] evaluating disk herniation and radiculitis, none of the randomized ILESI trials were performed under fluoroscopy. Among various reviews, epidural steroid injections were not performed under fluoroscopy in any of the published, randomized controlled studies.[1,3,4,20] Recently, authors tended to prefer TFESI under fluoroscopy, because the drug was directly administered to the precise pathology site level.

Fewer complications were encountered in the TFESI group than the ILESI group (9.5% and 12.7%, respectively), and major complications requiring hospitalization were not observed. When performing TFESI, the dural may be punctured despite appropriate needle placement. Subdural and intrathecal spread of contrast is rarely observed with transforaminal injections, and thus can be easily overlooked. In the TFESI group, six patients had dural puncture during an intervention, but none of the patients had complained of headaches. However, in the ILESI group, only one patient had dural puncture, and was treated with an epidural blood patch. Accidental dural punctures may lead to spinal headaches.[15] A particularly concerning complication of a dural puncture is the instillation of anesthetic into the subdural space, which may lead to a subdural neural blockade. Prior reports have suggested an incidence of 0.82% for subdural injections during interlaminar epidural injections.[25] To recognize a potential dural puncture, interventionists need to distinguish the intrathecal, subdural, and epidural contrast flow patterns. Goodman et al.[26] reported dural puncture complications during the TFESI, particularly during the subdural injection, which is probably under-reported by practitioners.

The strength of this study was that the same person performed all of the interventions under fluoroscopy guidance, and the study population was large. However, limitations including selection bias, recall bias, and incomplete data sets existed. Patients were not randomized for inclusion in this study, because group heterogeneity was the most important limitation in this study. Assessing global and back-specific function in addition to VNRS scores would be a better method for qualifying any differences in clinical outcomes between ILESI and TFESI.

Advanced age may cause increased multiple-level pathologies that aggravate lumbar spinal pain. After a 12 month follow-up, we concluded that ILESI can be as effective as TFESI if performed under fluoroscopy at the closest level to the lumbar pathology. Nevertheless, further randomized studies comparing the two approaches performed under fluoroscopy at the closest level to the lumbar pathologies are necessary.

Conflicts of interest

The author declares no conflicts of interest.

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