

COMPARABLE EFFECTIVENESS OF CAUDAL VS. TRANS-FORAMINAL EPIDURAL STEROID INJECTIONS

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ABSTRACT

Study Design: Retrospective case-control study.

Objective: To compare the effectiveness between caudal and trans-foraminal epidural steroid injections for the treatment of primary lumbar radiculopathy.

Summary of Background Data: Spinal injections with steroids play an important role in non-operative care of lumbar radiculopathy. The trans-foraminal epidural steroid injection (TESI) theoretically has a higher success rate based on targeted delivery to the symptomatic nerve root. To our knowledge, these results have not been compared with other techniques of epidural steroid injection.

Methods: 93 patients diagnosed with primary lumbar radiculopathy of L4, L5, or S1 were recruited for this study: 39 received caudal epidural steroid injections (ESI) and 54 received trans-foraminal epidural steroid injections (TESI). Outcomes scores included the SF-36, Oswestry disability index (ODI) and pain visual analogue scale (VAS), and were recorded at baseline, post-treatment (<6 months), long-term (>1 year). The average follow-up was 2 years, and 16 patients were lost to follow-up. The endpoint "surgical intervention" was a patient-driven decision, and considered failure of treatment. Intent-to-treat analysis, and comparisons included t-test, Chi-square, and Wilcoxon rank-sum test.

Results: Baseline demographics and outcomes scores were comparable for both treatment groups (ESI vs. TESI): (SF-36 PCS (32.3 ± 7.5 vs. 29.5

± 8.9 respectively; $p = 0.173$), MCS (41.2 ± 12.7 vs. 41.1 ± 10.9, respectively; $p = 0.971$), and VAS (7.4 ± 2.1 vs. 7.9 ± 1.2, respectively; $p = 0.228$). Surgery was indicated for failure of treatment at a similar rate for both groups (41.0% vs. 44.4%, $p=0.743$). Symptom improvement was comparable between both treatment groups (ESI vs. TESI): SF-36 PCS improved to 42.0±11.8 and 37.7±12.3, respectively; $p=0.49$; ODI improved from 50.0±21.2 to 15.6±17.9 and from 62.1±17.9 to 26.1±20.3, respectively ($p=0.407$).

Conclusions: The effectiveness of TESI is comparable to that of ESI (approximately 60%) for the treatment of primary lumbar radiculopathy. The increased complexity of TESI is not justified for primary cases, and may have a more specific role in recurrent disease or for diagnostic purposes.

INTRODUCTION

To understand the effects of therapeutic measures for the treatment of lumbar radiculopathy, it is important to recognize the natural history of this disease. To our knowledge, there are no recent descriptions of the natural history. However, this can be inferred from the placebo controls of 3 prospective randomized controlled trials. These control groups show us that between 23% and 48% of the patients present significant relief of their symptoms at 1 to 2 years^{11,13,14} without any specific treatment measure. Multiple conservative care options have been studied, with the goal of modifying the natural history of this disease.

Radicular pain has been attributed to both mechanical deformation as well as to the action of inflammatory cytokines on the dorsal root ganglion.^{23,24} For this reason, the local delivery of steroids seems to be a rational option. This can be delivered in multiple forms. Clinical results of epidural steroid injections (ESI) have been extensively studied, and have demonstrated to provide significant relief of symptoms at 1 year follow-up in 36%–43% in two prospective cohort studies.^{4,5,6,7,8,10,17} This does not seem to be very different from the natural history of this disease. In an attempt to improve these results, trans-foraminal epidural steroid injections (TESI) have been devised to provide a more specific and targeted delivery of the steroids to the dorsal root ganglion. Previous results have been described, and vary between 65%–84%

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This project was partially supported by NIH T35 #HL007485-26

Human subjects research approved by the University of Iowa Institutional Review Board #200505762.

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at 1-year follow-up, and compare favorably to control groups in 3 prospective randomized controlled trials.^{9,11,14}

When choosing a therapeutic technique, we must not only consider efficacy, but also safety and reproducibility. The delivery of steroids by inter-laminar or caudal techniques fails to reach the epidural space in 25%–40% of cases.¹⁷ This could be one of the reasons to account for the low efficacy of previous studies. Alternatively, trans-foraminal epidural steroid injections (TESI) present with intra-vascular injection of the steroid crystals in 13.1% of the cases.²⁵ This may not only compromise its efficacy, but may also induce serious neurologic complications.²² Furthermore, this procedure requires increased radiation exposure from longer fluoroscopy usage.

It then becomes necessary to compare the clinical efficacy of both procedures, to support further cost-benefit analysis. For this reason, the aim of this study is to directly compare the effectiveness of trans-foraminal and caudal epidural steroid injections in the treatment of primary lumbar radiculopathy.

MATERIALS AND METHODS

This study was designed as a retrospective case control (Class III-A evidence). During the period between June 2002 and July 2004, 132 patients were diagnosed for primary lumbar radiculopathy of L4, L5, or S1. Patients with previous surgeries at the same motion segment, those with unclear topographical diagnosis, those with major neurological dysfunction, and those under 18 years of age were excluded, as well as those patients without a thorough understanding of the English language.

The treatment plans were analogous for all patients: Surgical and non-surgical care was discussed, including all risks and potential benefits. The dialogue was aimed to be as unbiased as possible. The concept of failure of medical care was emphasized, and particularly, the fact that the patient is the protagonist of the decision-making process, based on complete and unbiased medical information. All patients in the study group elected to undergo conservative care options as their initial treatment method. In subsequent follow-up visits, this was again reviewed with the patients. At every point in time, patients were free to elect between continuing conservative care and surgery.

Conservative care consisted of activity modifications, physical therapy and epidural steroid injections. Physical therapy included extension-based exercise program and light, isometric core strengthening. Medications were also used, and included non-steroidal anti-inflammatory agents, muscle relaxants, and in some cases, narcotics. These patients were subject to two different types of epidural steroid injections as part of their treatment plan. Treatment groups were allocated according with

randomly assigned appointments to the clinics of either of the two senior authors. In each of these clinics, a different preference of epidural injection technique was maintained.

All procedures were performed by the same group of interventional musculo-skeletal radiologists, with a standardized technique. The caudal epidural steroid injections (ESI) were performed under fluoroscopic guidance with a 22g needle, and either 2cc of Depo-Medrol (40mg/ml), or 3cc Celestone (6mg/ml) were injected. The trans-foraminal epidural steroid injections (TESI) were also performed under fluoroscopic guidance for the L4 and L5 nerve roots, and under CT-guidance for the S1 nerve roots. A 20/25 coaxial system was utilized, and 1.5–2cc 1:1 solution of Marcaine 0.25% with Depo-Medrol (40mg/ml) or Celestone (6mg/ml) were injected.

Patients who consented to participate in the study included 39 of 58 patients (67.2%) treated with caudal Epidural Steroid Injections (ESI) and 54 of 74 (72.9%) treated with Trans-Foraminal Epidural Steroid Injections (TESI). Of the 93 patients, 16 were lost to follow up. Thus, we were able to account for 87.9% of the patients. This human subject research was approved by The University of Iowa Institutional Review Board (#200505762).

Baseline data collection included demographics, comorbidities, BMI, and imaging studies confirming the etiology of the lumbar radiculopathy. Information was collected at baseline, during the early post-treatment period (<6 months), and at a long-term post-treatment (24 months).

Primary outcomes include: Visual Analog Scale (VAS), the disease specific Oswestry Disability Index (ODI) and generic SF-36. Data was obtained from the University of Iowa Hospitals and Clinics electronic medical records. Long-term follow-up information required contact with patients by telephone or by mail-in questionnaires. The average follow-up was 24 months (12–36 months).

STATISTICAL ANALYSIS

The data was interpreted on an intent-to-treat basis. The SF-36 Physical (PCS) and Mental (MCS) Summary Scales were used as our primary outcome measures for generic health-related quality of life. To account for the effects of age and gender, the SF-36 summary scale scores were adjusted to corresponding age and sex normative data. Since the SF-36 summary scale scores are not only affected by back pain and sciatica, but also by other co-morbid conditions, these were also considered for the purpose of our analysis.

Co-morbid conditions were identified and annotated at baseline. These were stratified according to Charlson's criteria, and divided into the categories of 0, 1 or ≥ 2 co-morbid conditions. Other confounding variables that

were controlled for included BMI, and the etiology of the radiculopathy.

Once collected, the data was exported to Statistical Analyzing System (SAS Institute Inc., Cary, N.C.) for statistical analysis. Repeated ANOVA was used to study the effectiveness of treatment, and independent sample mean comparisons to compare treatments. The LOCF (Last Observation Carried Forward) method was used to replace missing values on individual patients. Kaplan-Meier disease-free survival curves were constructed, and for this study, represents the number of patients that had not requested surgery for the management of their symptoms at a specific time point.

Results are expressed as mean ± standard deviation. An alpha (p-value) < 0.05 was accepted for statistical significance.

RESULTS

Baseline Demographics and Treatment Group Allocation

The two treatment groups included 39 patients subject to caudal epidural steroid injections and 54 patients subject to trans-foraminal epidural steroid injections. Both treatment groups (ESI vs. TESI) were comparable, at baseline, in age (38.9±12.8 vs. 39.0±13.3, respectively; p = 0.9596), Body Mass Index (BMI) (29.1 ± 5.6 vs. 28.8 ± 7.3, respectively; p = 0.814), duration of symptoms (25.9 ± 27.4 vs. 35.5 ± 40.5, respectively; p = 0.181), and co-morbidities (0 co-morbid conditions: 27(69.2%) vs. 43 (79.6%), respectively and ≥1 co-morbid condition 5 (12.8%) vs. 4 (7.5%) respectively; Wilcoxon rank-sum test p=0.2435). Finally, the etiology of the radiculopathy was attributed to disc herniation in 38(97.4%) vs. 49(97.4%) respectively, spondylolysthesis in 0 vs. 2(3.7%) respectively, and stenosis in 1(2.6%) vs. 3(5.5%) respectively; p=0.203.

The baseline health-related quality of life measures were also comparable between treatment groups (ESI vs. TESI): The SF-36 physical compound scores (PCS) was 32.3 ± 7.5 vs. 29.5 ± 8.9 respectively; p = 0.173. The SF-36 mental compound score (MCS) was 41.2 ± 12.7 vs. 41.1 ± 10.9, respectively; p = 0.971. The visual analogue pain scale was 7.4 ± 2.1 vs. 7.9 ± 1.2, respectively; p = 0.228. Finally, the Oswestry disability index was 54.8 ± 15.5 vs. 62.1 ± 17.9, respectively; p = 0.128.

Additional Therapeutic Interventions

Subsequently to the index procedure, a number of patients required additional interventions for the management of their symptoms (Table 1). This included a similar number of repeat injections for both treatment groups (ESI 25.6% vs. TESI 18.5%; p=0.5183), as well as surgical interventions, which were also requested by

TABLE 1

Variable	ESI (n=39)	TESI (n=54)	p-value
Surgery (% operated)	16 (41.03%)	24(44.4%)	Chi-square test p = 0.7425
Repeat Injections			Wilcoxon rank-sum test p = 0.5183
0	29	44	
1	10	7	
2	0	3	

Comparison of additional therapeutic interventions following the index procedure between the caudal epidural steroid (ESI) and trans-foraminal epidural steroid (TESI) groups, throughout the study period.

patients in similar proportion for both groups (ESI 41.0% vs. TESI 44.4%; p = 0.743). A Kaplan-Meier surgery-free survival curve illustrates that the rate of surgical end-point was similar between groups over time (Figure 1), and surgery was requested and executed mostly within 3-6 months following the initial visit to our institution. This did not vary between treatment groups (p = 0.91).

Health-related Quality of Life

Both patient groups displayed comparable improvement with treatment, by all measures of outcome. The visual analogue scale for pain (VAS) improved from 7.4±2.1 at baseline to 4.4±3.2 at 24-month follow-up (p<0.0001) in the group treated with caudal ESI. This was comparable to the improvement seen in the patients treated with foraminal epidural steroid injections (TESI), where the baseline VAS of 7.9±1.8 improved to 5.7±3.0, p<0.0001). This improvement was statistically equivalent for both groups (p=0.933). Similar results were found for Oswestry disability index: The caudal ESI group improved from a baseline of 50.0±21.2 to 15.6±17.9 at 24-month follow-up, p<0.0001. Similarly, the TESI treated group improved from a baseline of 62.1±17.9 to 26.1±20.3 at follow-up. This improvement was also comparable between both groups (p=0.407).

Finally, both groups displayed comparable improvement with treatment as measured by their SF-36 scores. The physical compound score was 32.3±7.5 at baseline and improved to 42.0±11.8 at follow-up for the ESI group (p=0.0004), which compared to the TESI group (29.5±8.9 at baseline and 37.7±12.3 at 24-month follow-up, p=0.0003). This improvement was comparable between both treatment groups (p=0.49). The mental compound score was 41.2±12.7 at baseline and improved to 48.8±13.1 at follow-up for the ESI group (p=0.0032), which compared to the TESI group (41.1±10.9 at baseline and 51.1±9.9 at 24-month follow-up, p<0.0001). This improvement was comparable between both treatment groups (p=0.83).

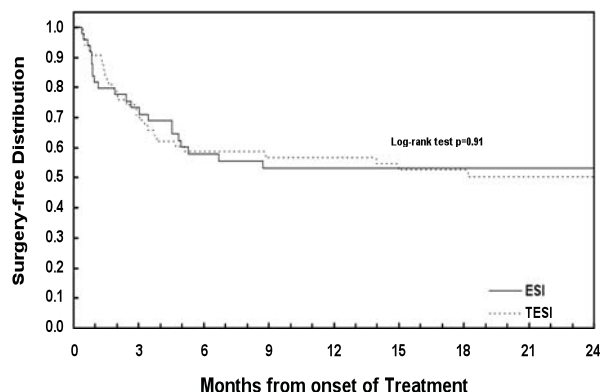


Figure 1. Kaplan-Meier curve demonstrating the surgery-free distribution as a function of time following initial treatment. This was comparable for the caudal epidural steroid (ESI) group as well as the trans-foraminal epidural steroid group (TESI); Log-rank test $p=0.91$.

DISCUSSION

In order to assess the effectiveness of epidural steroid injections for the treatment of lumbar radiculopathy, we must first recognize the natural history of the disorder. Hakelius¹² described a favorable prognosis for patients with sciatica, and after treating a group of patients with bed rest and brace, 70% were clinically improved in 3 months time. This study lacks the rigorous evaluation criteria used in modern clinical trials, but gives us a broad idea that not all patients require surgery to obtain relief of their symptoms within a reasonable timeframe. From 4 prospective randomized studies, we may use the control groups as a source of information for natural history. The study by Vad¹⁴ compares trans-foraminal epidural injections with steroids versus saline trigger-point injections, and after a 1.4 year follow-up, the trans-foraminal steroid group had a significantly higher success rate of 84% as compared with 48% for the control group ($p<0.005$). Fraser¹³ reports on the results of intradiscal injections with chymopapain versus normal saline solution, and at final follow-up, 57% of the chymopapain group was free of pain, compared to only 23% of the saline group. Of these, 20% of the chymopapain group, and 47% of the saline group requested surgery during the observation period of 2 years. Karppinen¹¹ found that periradicular infiltrations of Methylprednisolone + Bupivacaine had only short-term clinically meaningful benefits over periradicular infiltrations with normal saline solution. At 1 year, 22.5% of the steroid group, and 18.8% of the saline group had requested surgery. These results have been attributed to a possible “wash-out” effect of the saline injection, altering the concentrations of inflammatory cytokines. Finally, Riew⁹ found that selective nerve-root injections of corticosteroids were significantly more effective in obviating the need for surgical intervention,

than a control group with similar injections of Bupivacaine alone (28.6% vs. 66.7% requested surgery during the follow-up period of 13–28 months). In general, the control groups of the previously described trials show that within 1–2 year follow-up periods, a range between 33.3%–81.5% of the patients had not requested surgery for the management of their sciatic pain. If we exclude the “wash-out” results from saline- or Bupivacaine-only nerve root injections, the placebo control groups may have a success rate of only 23%–48%. Treatments that provide benefit to a larger percentage of patients can be called clinically effective.

Three of the previously described trials^{9,11,14} describe the efficacy of trans-foraminal injections with steroids to lie within the range between 65%–84%, expressed as improved quality of life outcomes scores and decreased surgical rates. On the other hand, there are adverse events related to intra-vascular uptake,^{18,25} which occurs in up to 11.2 % of the cases, not observed with either caudal or inter-laminar application of epidural steroids. Both caudal and inter-laminar epidural injections may fail to reach the epidural space in 25%–40% of the cases.¹⁷ In a recent review of the literature^{16,20} based on 12 controlled clinical trials, only 4/5 caudal ESI studies, and 2/7 inter-laminar ESI studies demonstrated increased effectiveness over controls. In 2 prospective cohort studies^{1,2,3,19} comparing conservative care with surgical treatment for lumbar radiculopathy, patients reported significant symptomatic improvement with conservative care in 36%–43% at 1-year follow-up, and 51%–56% at 5 years. Conservative care included physical therapy, bed rest, spinal manipulation, narcotic analgesics and epidural steroids. Finally, McDonald²¹ presents a 31% failure rate in patients treated for lumbar radiculopathy with interlaminar epidural steroids and local anesthetic, which is not different from the 41% failure rate of a control group treated with an intramuscular injection of local anesthetic and steroid.

The current study was designed to assess the relative effectiveness of caudal and foraminal epidural steroid injections, performed with a standardized technique by a constant group of interventional musculo-skeletal radiologists. Both techniques successfully provided relief from the major complaint of radiculopathy to similar proportions of patients. A comparable number of patients elected to have surgery after the index procedure was considered to have failed (37.93% of the TESI and in 39.19% of the caudal ESI treated patients ($p=0.883$)). Most of the patients that elected to have surgery did so within 3 to 6 months of treatment. Treatment was considered successful by all other patients, and this was quantified by significant changes in VAS, ODI and SF-36 scores. As described in other clinical trials, a decline in VAS to 50%

of baseline, as well as a decrease in ODI of at least 15 points is considered as a standard of clinically relevant difference. These goals were obtained for both the TESI as well as the caudal ESI treated groups. However, the end result was that there was no statistical difference in outcomes between treatment groups, demonstrating that there is no outcomes benefit to performing one injection technique instead of the other.

LIMITATIONS OF THE STUDY

This is a retrospective study, and patients were not randomized to be included into this study. Two carefully selected cohorts were chosen from the clinics of the two senior authors, following rigorous entry criteria. They were not randomized, but they were comparable in their baseline characteristics. The choice of the steroid injection technique was determined by the individual preferences of the senior authors. Although there is no randomization, the two matched cohorts give us the opportunity to compare effectiveness of two variations of epidural steroid injections.

The technical aspects of the epidural injection techniques include standardized technique by the same group of interventional radiologists, with minimal differences in dosage and drugs, which similarly affects both cohorts.

CONCLUSION

The effectiveness of caudal and trans-foraminal epidural steroid injections for the treatment of primary lumbar radiculopathy were compared in a retrospective case control study. They were found to be equivalent, and allowed patients to decline surgery in approximately 60% of the cases.

Regardless of the technique, 24%–28% of the patients required 1 or 2 repeat injections for the management of their primary complaint—radiculopathy.

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