Randomized Trial

Preliminary Results of a Randomized, Equivalence Trial of Fluoroscopic Caudal Epidural Injections in Managing Chronic Low Back Pain: Part 4 — Spinal Stenosis

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Background: Spinal stenosis is one of the 3 most common diagnoses of low back and leg symptoms which also include disc herniation and degenerative spondylolisthesis. Spinal stenosis is a narrowing of the spinal canal with encroachment on the neural structures by surrounding the bone and soft tissue. In the United States, one of the most commonly performed interventions for managing chronic low back pain are epidural injections, including their use for spinal stenosis. However, there have not been any randomized trials and evidence is limited with regards to the effectiveness of epidural injections in managing chronic function-limiting low back and lower extremity pain secondary to lumbar spinal stenosis.

Study Design: A randomized, double-blind, equivalence trial.

Setting: An interventional pain management practice, a specialty referral center, a private practice setting in the United States.

Objectives: To evaluate the effectiveness of caudal epidural injections with or without steroids in providing effective and long-lasting pain relief in the management of chronic low back pain in spinal stenosis and to evaluate the differences between local anesthetic with or without steroids.

Methods: Patients were randomly assigned to one of 2 groups, with Group I patients receiving caudal epidural injections of local anesthetic (lidocaine 0.5%), whereas Group II patients received caudal epidural injections with 0.5% lidocaine 9 mL mixed with 1 mL of steroid. Randomization is being performed by computer-generated random allocation sequence by simple randomization.

Outcomes Assessment: Multiple outcome measures were utilized which included the Numeric Rating Scale (NRS), the Oswestry Disability Index 2.0 (ODI), employment status, and opioid intake with assessment at 3 months, 6 months, and 12 months post-treatment.

Significant pain relief was defined as 50% or more, whereas significant improvement in disability score was defined as reduction of 40% or more.

Results: Significant pain relief (≥ 50%) was demonstrated in 55% to 65% of the patients and functional status improvement with 40% reduction in ODI scores in 55% to 80% of the patients. The overall average procedures per year were 3.4 ± 1.27 in Group I and 2.6 ± 1.35 in Group II with an average total relief per year of 30.3 ± 19.49 weeks in Group I and 23.1 ± 21.36 weeks in Group II over a period of 52 weeks.

Limitations: The results of this study are limited by the lack of a placebo group and a preliminary report of 20 patients in each group, even though sample was justified.

Conclusion: Caudal epidural injections with or without steroids may be effective in patients with chronic function-limiting low back and lower extremity pain with spinal stenosis in approximately 60% of the patients.

Key words: Low back pain, lower extremity pain, spinal stenosis, epidural injections, steroids, local anesthetics
CLINICAL TRIAL: NCT00370799

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Intervertebral disc herniation, spinal stenosis, and degenerative spondylolisthesis with stenosis are the 3 most common diagnoses of low back and leg symptoms for which surgery is performed (1,2). Spinal stenosis is a narrowing of the spinal canal with encroachment on the neural structures by surrounding bone and soft tissue, with patients typically presenting with radicular leg pain or with neurogenic claudication (pain in the buttocks or legs with walking or standing that resolves with sitting down or lumbar flexion) (3). Although the incidence and prevalence of symptomatic lumbar spinal stenosis have not been established, it is the most frequent indication for spinal surgery in patients older than 65 years of age (4-7), and a report from the U.S. Agency for Healthcare Research and Quality (AHRQ) suggested that 13% to 14% of patients who see a spine specialist for low back complaints may have severe enough bony stenosis requiring surgical decompression (8). Further, very little is known about patients with lesser degrees of symptomatic stenosis and the natural history and prognosis of lumbar spinal stenosis. However, radiographic evidence of stenosis is frequently asymptomatic; thus, careful clinical correlation between symptoms and imaging is critical (9,10). No doubt the diagnosis of spinal stenosis has improved with modern imaging modalities, but providing the best and most appropriate care for each patient is based on symptoms and functional disability. There are also studies which support that pain and function of patients with lumbar spinal stenosis remain unchanged in a majority of patients (11-14).

Most studies evaluating the treatment of spinal stenosis are related to surgery. A 2005 Cochrane review found that the paucity and heterogenicity of evidence limited the conclusions regarding surgical efficacy for spinal stenosis (15). The trials comparing surgical with non-surgical treatments were generally small and involved patients, both with and without degenerative spondylolisthesis (3,11,13,16-19). Weinstein et al (3) as part of Spine Patient Outcomes Research Trial (SPORT) reported on 2-year outcomes of patients with spinal stenosis without degenerative spondylolisthesis to analyze the relative efficacy of surgical versus non-surgical treatment. They concluded that in the combined as-treated analysis, patients who underwent surgery showed significantly more improvement in all primary outcomes than did patients who were treated non-surgically. Further, a subgroup of patients with persistent, severe pain and progressive neural dysfunction have been reported to benefit from decompressive surgery even though the outcomes after surgery slowly deteriorate over time (13,14,20-24).

In the United States, one of the most commonly performed interventions for managing chronic low back pain are epidural injections, including their use for spinal stenosis (25-33). Friedly et al (28) showed lumbar epidural injections were administered in 23% of patients with spinal stenosis with an additional 11% in patients with degenerative changes. Friedly et al (29) also showed a significant proportion of epidural injections with repeat procedures in the Department of Veteran's Affairs (VA) population.

Multiple approaches are available to access the epidural space in the lumbosacral spine include caudal and interlaminar or transforaminal. Evidence for managing the pain of spinal stenosis in the lumbar spine with caudal epidural injections has been limited, even though it is somewhat superior with caudal epidural injections compared to interlaminar epidural injections (31,32). The technology assessment report in 2001 of the treatment of degenerative lumbar spinal stenosis by AHRQ (8) defined the general term spinal stenosis as being applicable to 3 root compression mechanisms or in combination including disc protrusion or herniation, osteitic overgrowth into the spinal canal or the foramina through which the roots pass laterally, and vertebral slippage or spondylolisthesis. This report showed that local anesthetic block provides temporary relief from neurogenic claudication for about one month. Further, this evaluation also showed that evidence for efficacy of other conservative treatments in lumbar spinal stenosis patients was lacking. This report also showed that there was evidence for patients to benefit more from surgery than conservative therapy if symptoms were severe. While the majority of the evidence has been derived from old studies for administering epidural steroids without fluoroscopy, several studies have been published evaluating spinal stenosis with studies performed under fluoroscopy, even though none of them have been randomized (34-38). Other studies without fluoroscopy also have been published (39-44). Of the several fluoroscopically directed studies, 3 included caudal (34,37,38), whereas 2 were caudal without fluoroscopy (39,44). Botwin et al (34) in a prospective evaluation evaluated 34 patients with bilateral radicular pain from lumbar spinal stenosis with

fluoroscopically guided caudal epidural injections after failure of conservative care. They administered on average 2.2 injections per patient, all within 6 weeks of evaluation; 65% of the patients at 6 weeks, 62% at 6 months, and 54% at 12 months had a successful outcome, reporting at least greater than 50% reduction between pre-injection and post-injection visual analog scale (VAS). They also reported significant improvement in multiple other scores including sitting, standing, and satisfaction. Barre et al (37) in a retrospective evaluation of long-term efficacy of fluoroscopically guided caudal epidural steroid injections for lumbar spinal stenosis evaluated 80 patients receiving at least one caudal epidural steroid injection between 1995 and 2002 with an average of 1.6 epidural steroid injections administered. They reported an improvement on the NRS of 50% or greater in 35% of patients with a functional improvement of 2 points or greater in 36 patients on a long-term basis. Delport et al (38) in a retrospective outcome study reported the results of 140 patients, at or over the age of 55 years diagnosed with lumbar spinal stenosis, treated with either fluoroscopically guided transforaminal or caudal epidural steroid injections. Overall, they reported improvement of 2 months in 32% with 39% reporting less than 2 months of relief and with improvement in functional abilities in 53%. Of these, 91 patients, or 65%, received caudal epidural injections, whereas 59% of the patients received both. However, all 3 studies suffer from multiple flaws. Botwin et al (34) and Barre et al (37) both utilized one to 3 epidural injections within a short time period and expected persistent relief. Further, Delport et al (38) combined caudal and transforaminal epidural injections in multiple patients with a short-term follow-up. A series of 3 epidurals is an outdated procedural model, even though they utilized a contemporary approach with fluoroscopic utilization (30-32).

This study is undertaken to evaluate the role of caudal epidural injections in patients with chronic intractable pain secondary to spinal stenosis, with or without steroids. The study is designed to evaluate 120 patients. This preliminary report includes 40 patients completing one-year follow-up.

Methods

The study was conducted in an interventional pain management practice, a specialty referral center, in a private practice setting in the United States. The study was performed based on Consolidated Standards of Reporting Trials (CONSORT) guidelines and an extension of the CONSORT statement reporting of non-inferiority and equivalence randomized trials (45-47). The study protocol was approved by the Institutional Review Board (IRB) and was registered on the U.S. Clinical Trial Registry with an assigned number of NCT00370799.

Participants

Patients were assigned to one of 2 groups, with Group I patients receiving caudal epidural injections with injection of local anesthetic (lidocaine 0.5%), whereas Group II patients received caudal epidural injections with 0.5% lidocaine 9 mL mixed with 1 mL of non-particulate betamethasone (Celestone). Each injection was a total volume of 10 mL (10 mL of lidocaine 0.5% or 9 mL of lidocaine with 1 mL of steroid), followed by 2 mL of 0.9% sodium chloride solution as a flush.

Interventions

All patients were provided with the IRB-approved protocol and the informed consent which described in detail all aspects of the study and withdrawal process.

Pre-Enrollment Evaluation

The pre-enrollment evaluation included demographic data, medical and surgical history with co-existing disease(s), radiologic investigations, physical examination, pain rating scores using the Numeric Rating Scale (NRS), work status, opioid intake, and functional status assessment by the Oswestry Disability Index 2.0 (ODI).

All patients with evidence of spinal stenosis and radicular pain were included. Patients without lower extremity pain were excluded.

Inclusion Criteria

Inclusion criteria were diagnosis of spinal stenosis with radicular pain, patients over the age of 50 years; patients with a history of chronic function-limiting low back pain and lower extremity pain of at least 6 months duration; and patients who were competent to understand the study protocol and provide voluntary, written informed consent and participate in outcome measurements.

Further inclusion criteria included patients who have failed to improve substantially with conservative management including, but not limited to physi-

cal therapy, chiropractic manipulation, exercises, drug therapy, and bed rest.

Exclusion criteria were history of lumbar surgery, spinal stenosis without radicular pain, uncontrollable or unstable opioid use, uncontrolled psychiatric disorders, uncontrolled medical illness either acute or chronic, any conditions that could interfere with the interpretation of the outcome assessments, pregnant or lactating women, and patients with a history or potential for adverse reaction(s) to local anesthetics or steroids.

Description of Interventions

All caudal epidural procedures were performed by one physician in an ambulatory surgery setting, in a sterile operating room, under fluoroscopy, with patients in the prone position, under appropriate monitoring with intravenous access and sedation with midazolam and fentanyl. With sterile preparation, access to the epidural space was obtained, which was confirmed by injection of non-ionic contrast. Following this, injection 6 mg of non-particulate betamethasone (either brand name or non-particulate) was carried out, followed by injection of 2 mL of 0.9% sodium chloride solution.

Repeat caudal epidural injections were provided based on the response to the prior caudal epidural injections evaluated by improvement in physical and functional status. Further, repeat caudal epidural injections were performed only when increased levels of pain were reported with deteriorating relief below 50%.

Additional Interventions

All the patients underwent the treatments as assigned. A patient was unblinded on request or if an emergency situation existed. If a patient required additional caudal epidural injections, they were provided based on the response to the previous injections, either after unblinding or without unblinding. If the patient chose not to be unblinded, the prior treatment was repeated as assigned. However, if patients chose to be unblinded, they were offered either the assigned treatment or another treatment based on response. If the patients were non-responsive and different treatments other than caudal epidural injections were required, they were considered to be withdrawn from the study, and no subsequent data were collected. However, patients who were non-responsive and continued with conservative management were followed without further epidural injections with medical management, unless they requested unblinding. In addition, all patients who were lost to follow-up were considered withdrawn. Patients unavailable for follow-up were considered as lost-to-follow-up.

Co-Interventions

Most patients were receiving opioid and non-opioid analgesics, adjuvant analgesics, and some were involved in a therapeutic exercise program. If patients were improving significantly and the medical necessity for these drugs was lacking, medications were stopped or dosages were decreased. In addition, dosages were also increased, based on medical necessity. All patients continued previously directed exercise programs, as well as their work. Thus, in this study, there was no specific physical therapy, occupational therapy, bracing, or other interventions offered other than the study intervention.

Objectives

The study was designed to evaluate the effectiveness of caudal epidural injections with or without steroids in managing chronic low back pain with radiculitis secondary to spinal stenosis in providing effective and long-lasting pain relief and to evaluate the differences between local anesthetic with or without steroid.

Outcomes

Multiple outcome measures were utilized which included the NRS (0–10 scale) pain scale, the ODI on a 0–50 scale, employment status, and opioid intake in terms of morphine equivalents, with assessment at 3 months, 6 months, and 12 months post-treatment. The NRS represented no pain with a 0 and the worst pain imaginable with a 10. The ODI was utilized for functional assessment. The value and validity of the NRS and ODI have been reported (47,48). Thresholds for the minimum clinical important difference for the ODI varied from a 4 to 15 point change from a total score of 50. Significant pain relief was described as a 50% or more reduction in the NRS from baseline, whereas significant improvement in function was described as at least a 40% reduction in ODI (49-54).

Based on the dosage frequency and schedule of the drug, the opioid intake was converted into morphine equivalents (55).

Employment and work status were determined based on employability at the time of enrollment rather than including all of the patients participating in the study as employable. Employment and work status were classified into multiple categories such as employable, housewife with no desire to work outside the home, retired, or over the age 65. Patients who were unemployed due to pain or employed but on sick leave or laid off were considered as employable.

The epidurals were considered to be successful if a patient obtained consistent relief with the first and second procedures of at least one and 3 weeks respectively and if the relief from the second injection outlasted the first injection. All others were considered as failures.

Sample Size

Since there were no studies available for estimation of sample size for spinal stenosis with caudal epidural injections, it was calculated based on significant pain relief in lumbar disc herniation. Considering a 0.05 2-sided significance level, a power of 80%, and an allocation ratio of 1:1, 18 patients in each group were estimated (56) and allowing for a 10% attrition/non-compliance rate, 40 subjects were required.

Previous studies of interventional techniques have confirmed that 50 to 60 patients is acceptable (50-52,57).

Randomization

From a total of 120 patients, 60 patients are being randomly assigned into each group.

Sequence Generation

Randomization is being performed by computer-generated random allocations sequence by simple randomization.

Allocation Concealment

The operating room nurse assisting with the procedure randomized the patients and prepared the drugs appropriately.

Implementation

Participants were invited to enroll in the study if they met inclusion criteria. One of the 3 nurses assigned as coordinators of the study enrolled the participants and assigned participants to their respective groups.

Blinding (Masking)

Participants and those administering the interventions were blinded to the group assignment. The blinding was assured by mixing the patients with other patients receiving routine treatment and not informing the physician performing the procedure of the inclusion of the patients in the study. All the patients for one-year follow-up were selected by the statistician not participating in provision of patient care. The unblinding results were not disclosed to either the treating physician or other participants or patients. Thus, the nature of blinding was not interrupted.

Statistical Methods

Statistical analysis included chi-squared statistic, Fisher's exact test, t-test, and paired t-test. Results were considered statistically significant if the *P* value was less than 0.05.

Chi-squared statistic was used to test the differences in proportions. Fisher's exact test was used wherever the expected value was less than 5; a paired t-test was used to compare the pre- and post-treatment results of average pain scores and ODI measurements at baseline versus 3 months, 6 months, and 12 months. For comparison of mean scores between groups, t-test was performed.

Intent-to-Treat-Analysis

An intent-to-treat-analysis was performed. Either the last follow-up data or initial data were utilized in the patients who dropped out of the study and no other data were available.

Results

Participant Flow

Figure 1 illustrates the participant flow.

Recruitment

The recruitment period lasted from January 2007 to August 2008.

Baseline Data

Baseline demographic and clinical characteristics of each group are illustrated in Table 1. There were no significant differences noted between the groups.

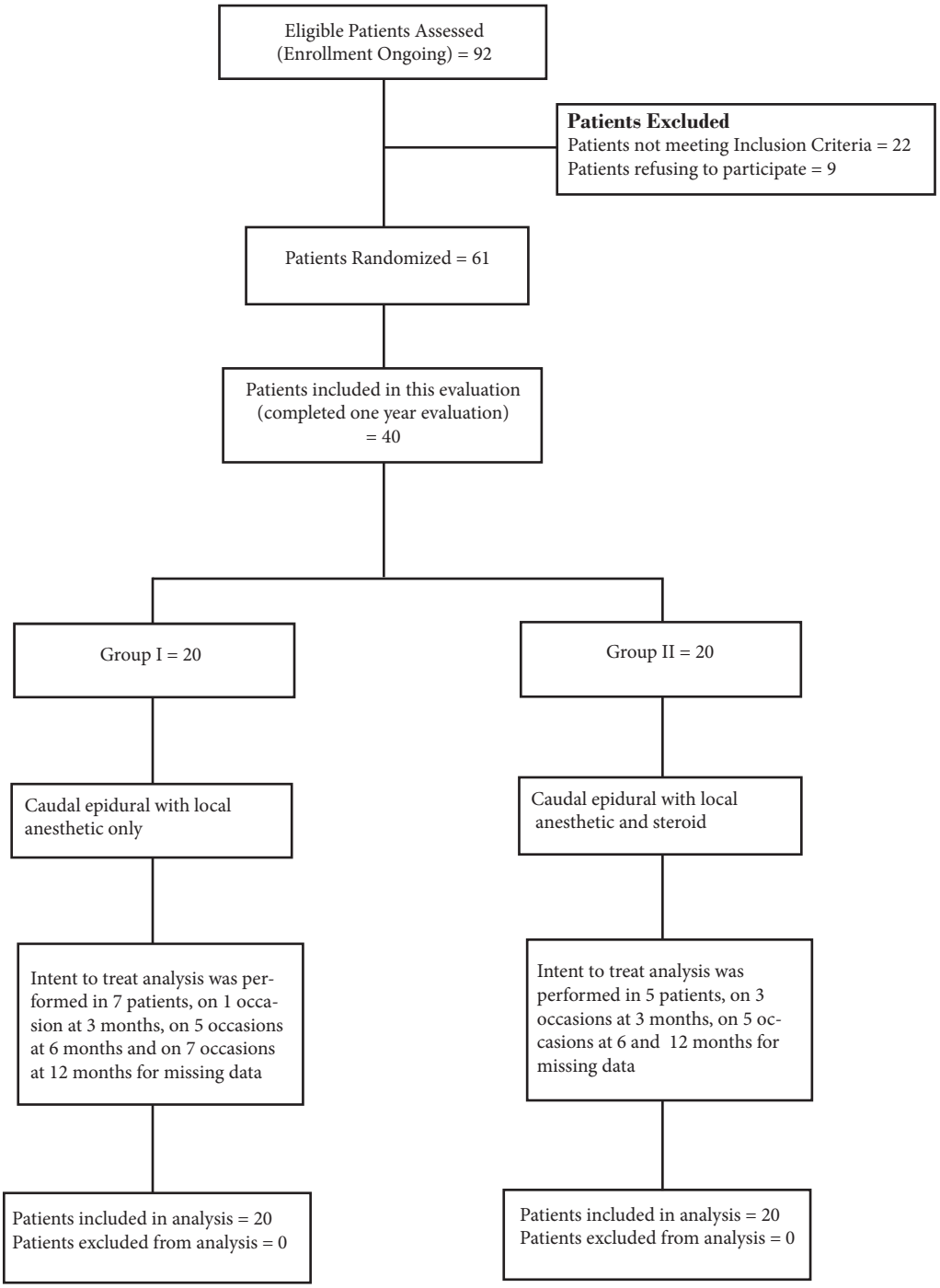


Fig. 1. *Schematic presentation of patient flow at one-year follow-up.*

Table 1. *Baseline demographic and clinical characteristics of participants.*

		Group 1 (n = 20)	Group II (n = 20)	*P* value
Gender	Male	35% (7)	25% (5)	0.490
	Female	65% (13)	75% (15)	
Age	Mean ± SD	60.3 ± 17.37	60.4 ± 14.08	0.976
Weight	Mean ± SD	186 ± 55.15	192 ± 58.95	0.741
Height	Mean ± SD	65.9 ± 3.75	66.1 ± 3.41	0.859
Duration of Pain (months)	Mean ± SD	84.5 ± 66.23	75.4 ± 69.39	0.672
Onset of the Pain	Gradual	75% (15)	90% (18)	1.000
	Injury	25% (5)	10% (2)	
Low Back Pain Distribution	Bilateral	70% (14)	70% (14)	1.00
	Left or right	30% (6)	30% (6)	
Leg pain Distribution	Bilateral	35% (7)	25% (5)	0.392
	Left or right	65% (13)	75% (15)	
Numeric Pain Rating Score	Mean ± SD	8.1 ± 1.00	7.5 ± 1.05	0.098
Oswestry Disability Index	Mean ± SD	28.4 ± 4.50	26.1 ± 4.63	0.112

Analysis of Data

Numbers Analyzed

A schematic illustration of patient flow is provided in Fig. 1. The study period for one-year follow-up lasted from January 2007 to August 2008 with completion of one-year follow-up of 40 patients with 20 patients in each group. Intent-to-treat analysis was performed due to non-available data on 13 occasions in Group I on a total of 7 patients, and on 13 occasions on 5 patients in Group II. Based on the number of follow-up periods, lack of follow-up was found in 13 of 60 occasions (9.3%) in Group I or 7 of 20 patients; whereas it was 13 of 60 occasions in Group II with 5 of 20 patients at least one time.

Outcomes

Pain Relief

Figure 2 illustrates the NRS scores. Pain scores changed significantly from baseline, at 3 months, 6 months, and 12 months in all groups, with no significant differences between the groups or follow-up periods.

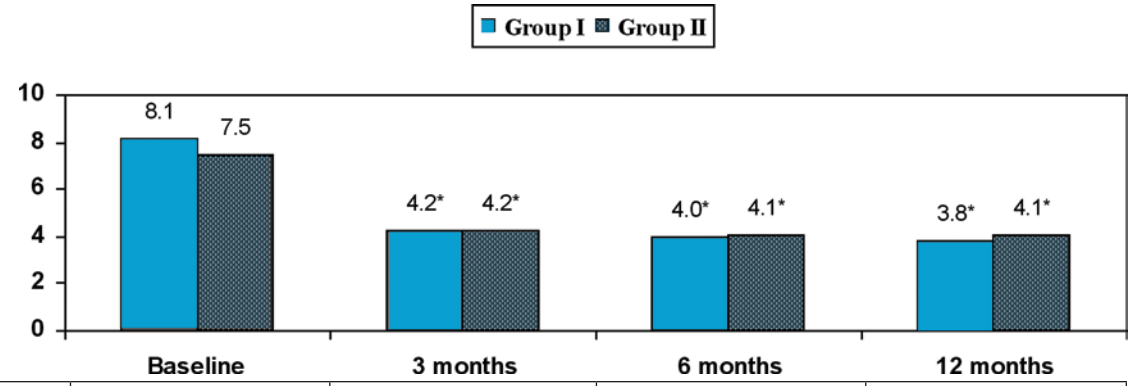
Figure 3 illustrates the proportion of patients with significant pain relief of 50% or greater at 3 months, 6 months, and 12 months, with 65% in Group I and 50% in Group II at 3 months, 70% in Group I and 60% in Group II at 6 months, and 65% in Group I and 55% in Group II at 12 months respectively. There were no significant differences between the groups or from the 3-month to 6-month to 12-month outcomes.

Functional Assessment

Functional assessment results assessed by the ODI are illustrated in Fig. 4. Significant improvement of functional status was seen in both groups from baseline to one year. Reduction of Oswestry scores of at least 40% was seen in 80% (Group I) and 55% Group II) at one-year as shown in Fig. 5 with no significant differences noted between the groups or during follow-up periods.

Employment Characteristics

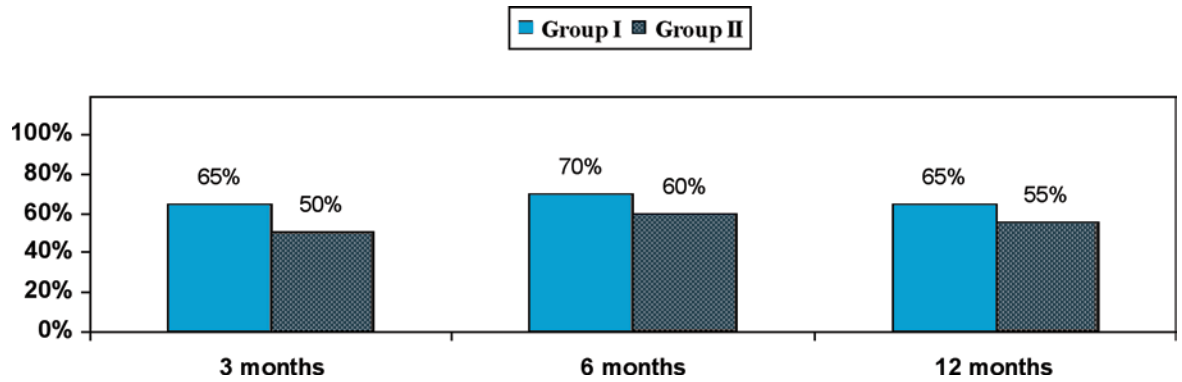
Table 2 demonstrates employment characteristics in both groups. The number of eligible patients for employment at baseline remained the same at 12 months for both groups. The total employment was higher in both groups at 12 months; however, the differences were insignificant.



Group I (n = 20)	8.1 ± 1.00	4.2* ± 2.17	4.0* ± 2.16	3.8* ± 1.96
Group II (n = 20)	7.5 ± 1.05	4.2* ± 2.37	4.1* ± 2.16	4.1* ± 2.47
P value	0.098	1.000	0.885	0.673

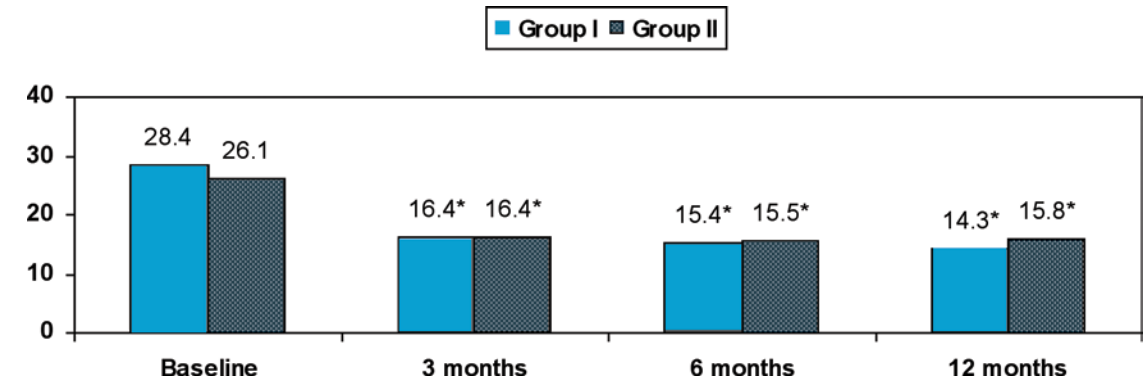
* indicates significant difference with baseline values ($P < 0.001$)

Fig. 2. *Illustration of pain relief characteristics (mean ± SD)*



Group I (n = 20)	65% (13)	70% (14)	65% (13)
Group II (n = 20)	50% (10)	60% (12)	55% (11)
P value	0.337	0.507	0.519

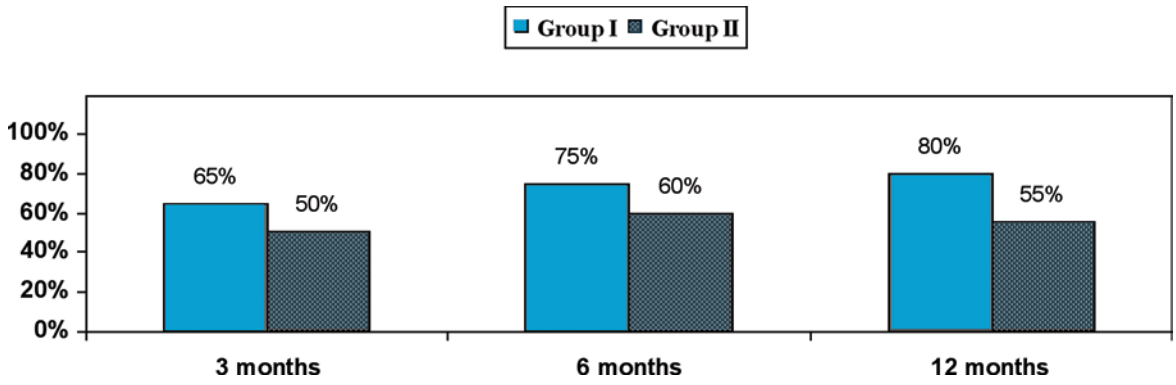
Fig. 3. *Illustration of significant pain relief (≥ 50% reduction in Numeric Rating Score from baseline).*



Group I (20)	28.4 ± 4.50	16.4* ± 7.53	15.4* ± 7.80	14.3* ± 8.52
Group II (20)	26.1 ± 4.63	16.4* ± 8.27	15.5* ± 8.43	15.8* ± 8.55
P value	0.112	1.000	0.985	0..594

* indicates significant difference with baseline values ($P < 0.001$)

Fig. 4. *Illustration of average Oswestry Disability Index for functional assessment (scale 0–50%).*



Group I (n = 20)	65% (13)	75% (15)	80% (16)
Group II (n = 20)	50% (10)	60% (12)	55% (11)
P value	0.337	0.311	0.091

Fig. 5. *Illustration of reduction (≥40%) of Oswestry Disability Index from baseline.*

Table 2. *Employment characteristics.*

Employment status	Group I		Group II	
	Baseline	12 months	Baseline	12 months
Employed part-time	0	0	0	0
Employed full-time	1	2	2	3
Unemployed/laid off/sick	2	1	3	2
Total Employed	1 (33%)	2 (67%)	2 (40%)	3 (60%)
Eligible for employment	**3**	**3**	**5**	**5**
Housewife with no desire to work outside	2	2	5	5
Disabled	8	8	4	4
Over 65 year of age	7	7	6	6
Total Number of Patients	**20**	**20**	**20**	**20**

Table 3. *Daily opioid intake in morphine equivalents in milligrams.*

Opioid intake	Group I (20)	Group II (20)	*P* value
	Mean ± SD	Mean ± SD	
Baseline	45.9 ± 54.83	33.3 ± 36.87	0.339
3 months	35.6 ± 53.05	21.2 ± 18.87	0.264
6 months	35.1# ± 53.25	20.5 ± 19.09	0.256
12 months	35.1# ± 53.25	20.5 ± 19.06	0.256

# indicates significant difference with baseline values ($P = 0.05$)

Opioid Intake

Table 3 illustrates opioid intake between both groups at baseline and at 12 months that showed no significant change in intake of opioids. However, opioid intake significantly decreased from their baseline opioid intake in both groups at 12 months in Group I.

Therapeutic Procedural Characteristics

Therapeutic procedural characteristics with average pain relief per procedure are illustrated in Table 4. Average overall relief per year was 30.3 ± 19.49 weeks in Group I and 23.1 ± 21.36 weeks in Group II, with no significant differences. However, when patients were separated into successful and failed groups, the total number of injections per year was 3.8 ± 1.21 in Group I and 3.4 ± 1.08 in Group II for successful subjects with relief of 42.8 ± 9.06 weeks in Group I and 37.8 ± 14.00 weeks in Group II. In contrast, in failed subjects the number of injections per year was 2.6 ± 0.98 in Group I and 1.4 ± 0.52 in Group II with average relief of 7.0 ± 8.08 weeks in Group I and 1.0 ± 2.14 weeks in Group II.

Epidurals were considered to be successful if a patient obtained consistent relief with the first and second injections of at least one and 3 weeks respectively and if the relief with the second injection outlasted the first injection. All others were considered to be failures.

Changes in Weight

The weight was monitored for all the patients initially and also at one year. There was a mild reduction in weight in both groups with no significant differences noted (Table 5).

Adverse Events

There were no major adverse events reported over a period of one-year in any of the 40 patients.

Table 4. *Illustration of procedural characteristics with procedural frequency, average relief per procedure, and average total relief in weeks over a period of one year.*

	Successful group		Failed group		Overall	
	Group I (13)	Group II (12)	Group I (7)	Group II (8)	Group I (20)	Group II (20)
1st injection relief	8.2 ± 9.99 (13)	5.8 ± 6.17 (12)	2.4 ± 1.72 (7)	0.4# ± 1.01 (8)	6.2 ± 8.49 (20)	3.7 ± 5.48 (20)
2nd injection relief	13.3 ± 6.27 (13)	14.9 ± 13.98 (12)	1.1 ± 2.19 (7)	1.7 ± 1.52 (3)	9.1 ± 7.86 (20)	12.3 ± 3.83 (15)
3rd injection relief	13.0 ± 5.49 (11)	13.3 ± 5.12 (9)	4.5 ± 2.12 (2)	-	11.7 ± 5.97 (13)	13.3 ± 5.12 (9)
4th injection relief	10.9 ± 3.27 (8)	12.6 ± 1.13 (7)	7.5 ± 7.78 (2)	-	10.2 ± 4.13 (10)	12.6 ± 1.13 (7)
5th injection relief	11.6 ± 1.94 (5)	14.8 ± 4.92 (4)	-	-	11.6 ± 1.95 (5)	14.8 ± 4.92 (4)
Number of injections per year	3.8 ± 1.21 (13)	3.4 ± 1.08 (12)	2.6 ± 0.98 (7)	1.4# ± 0.52 (8)	3.4 ± 1.27 (20)	2.6 ± 1.35 (20)
Total relief per year (weeks)	42.8 ± 9.06 (13)	37.8 ± 14.00 (12)	7.0 ± 8.08 (7)	1.0 ± 2.14 (8)	30.3 ± 19.49 (20)	23.1 ± 21.36 (20)

# indicates significant difference between groups ($P < 0.05$)

Discussion

Evaluation of the effectiveness of caudal epidural injection with or without steroids in spinal stenosis associated with chronic function-limiting low back and lower extremity pain, in this randomized, double-blind, equivalence trial, showed significant (≥ 50%) reduction of pain in 65% of the patients in Group I and 55% of the patients in Group II, along with a 40% reduction in the ODI scores from baseline in 80% of the patients in Group I and 55% of the patients in Group II. There were no changes in the employment characteristics despite the increase in functional status, but, the proportion of eligible patients for employment was small. Opioid intake was reduced significantly at 12-month follow-up in both groups.

The average procedures per year were 3 to 4 with average total relief per year of 30.3 ± 19.49 weeks in Group I and 23.1 ± 21.36 weeks in Group II. However, the patients were then divided into successful and failed groups 15 of the 40 patients assigned to the failed group and 25 to the successful group. In the analysis of the successful group, the number of procedures per year was 3 to 4 with total relief per year of 42.8 ± 9.06 weeks in Group I and 37.8 ± 14.00 weeks in Group II over a period of one year. Overall, the results are less than enthusiastic with an average relief of only 4 to 12 weeks with the initial 2 procedures and 10 to 15 weeks in the overall population with subsequent procedures after the first 2 procedures. However, the results are much more encouraging in the successful group even though approximately one-third of the patients were in the failed. Consequently, the results of this study illustrate that if the response is fair to poor with the first 2 injections, patients will continue to exhibit an extremely poor response with future treatments and very few people continue the treatment. In fact, the total relief in the failed group over a period of one year was 7.0 ± 8.08 weeks in Group I in 7 patients and it was 1.0 ± 2.14 weeks in 8 patients in Group II — a dismal result.

This study may be criticized for the lack of a placebo group and also for publication of preliminary results in a small number of patients (20 in each group). Due to the lack of published randomized trials and

Table 5. *Characteristic of monitoring of weight.*

Weight (lbs)	Group I (20)	Group II (20)	P value
	Mean ± SD	Mean ± SD	
Initial weight	186 ± 55.15	192 ± 58.95	0.741
Weight at one year	183 ± 56.04	189 ± 59.74	0.713
Change	-3.5 ± 10.55	-2.2 ± 5.59	0.480

the paucity of evidence in managing spinal stenosis with symptomatology utilizing contemporary interventional pain management practice with epidurals performed under fluoroscopic visualization and with continued follow-up rather than providing treatments initially and following them at a later date, the authors felt that it was essential to publish the results. Further, based on the sample size calculations, 20 patients is adequate. In addition, spinal stenosis which failed to respond to other conservative modalities of treatments is a refractory management problem. On the issue of placebo-control, the difficulties are insurmountable with interventional techniques in the United States. Consequently, in this evaluation, we utilized an active control group with local anesthetics and a treatment group with steroids, which is considered appropriate. Further, active control trials or pragmatic trials provide generalizability or external validity which is superior to placebo-control trials. Thus, in the modern era, practical clinical trials or equivalence/non-inferiority trials measuring effectiveness are considered more appropriate than placebo-control trials, also known as explanatory trials, measuring efficacy (47,58-62). Practical clinical trials or equivalence/non-inferiority trials are considered clinically oriented with external validity and generalizability because they show the existence of effect and also measure the effectiveness of therapies (63).

The results of this evaluation, even though less than enthusiastic and very modest, are generalizable to interventional pain management settings employing appropriate diagnostic techniques and performing the procedures utilizing contemporary methods under fluoroscopic visualization with or without steroids, by a caudal approach, with intermittent follow-up. The results of this evaluation are similar to the results in post lumbar laminectomy syndrome (54), but inferior to patients with low back pain but with or without disc herniation and/or radiculitis (52,53). Further, almost one-third of the patients in this evaluation were non-responsive to caudal epidural injections, which is similar to the post surgery syndrome group but with the non-responsive proportion higher than in patients with low back pain with or without disc herniation. Even then, the results of this randomized, double-blind equivalence trial are superior and practical compared to previously published reports, especially in the light of the fact that none of them were randomized or double-blinded.

Treatment of disabling pain secondary to lumbar spinal stenosis is challenging with or without surgery. Reports of surgery claim superiority over conservative management. However, the conservative management utilized in the past, including caudal epidural injections, has not been studied according to the criteria of contemporary interventional pain management. Consequently, the management of lumbar spinal stenosis continues to be an enigma since its first description in 1954, as a syndrome characterized by the narrowing of the lumbar vertebral canal, concurrent neurogenic spinal claudication, radicular pain, and motor weakness in the lower limbs (64). Thus, it appears that there is only a subgroup of patients with lumbar spinal stenosis that respond to surgical intervention. Similarly, there are subgroups of patients who respond to non-surgical interventions, such as caudal epidural injections. However, neither the present preliminary evaluation nor previous studies are able to delineate the features of these subgroups. Future studies must focus on these aspects.

Radiographic and anatomical findings of lumbar spinal stenosis are characterized by a narrowing of the spinal canal. Narrowing may occur in the central spinal canal, in the area under the facet joints (subarticular stenosis), or more likely, in the neural foramina. Compression of the nerve root causes symptomatic lumbar spinal stenosis, which can be characterized into several distinct entities defined by the underlying reasons for the spinal nerve root compression. In this study, we included only the patients with central stenosis either congenital or acquired. Patients with neuroforaminal stenosis were not included. Further, patients with post laminectomy and post fusion were excluded. Even though, the mechanism whereby compression of the spinal nerve roots resulting in the typical symptoms and signs of spinal stenosis has not been fully elucidated, evidence suggests that in the presence of stenosis and nerve root compression, lumbar extension reduces the cross-sectional area of the central canal, as well as the neural foramina, exerting further pressure on the venules surrounding the nerve roots. This process, in turn, leads to engorgement and ischemic nerve impairment with the ischemic mechanism accounting for typical reversibility of symptoms when patients flex their spines forward (65-72). Further, the pathophysiology of radicular pain is complex, even though mechanical compression and inflammation are considered to be the main culprits (73-81).

The underlying mechanism of epidurally administered local anesthetic and steroids is less clear than the mechanism of pain in spinal stenosis. Consequently, it has been long hypothesized that the effects of neu-

ral blockade are dependent on the anti-inflammatory properties of corticosteroids (82-90). However, there is also emerging evidence that local anesthetics may be as equally effective as steroids in managing low back pain with or without disc herniation, secondary to post laminectomy syndrome, and of facet joint origin, and in multiple other types of nerve blocks (49-54,91-101). It has been postulated that local anesthetics result in positive effects by exerting the effect on multiple pathophysiologic mechanisms involved in chronic pain, including noxious peripheral stimulation, excess nociception resulting in sensitization (102,103), excess release of neural transmitters causing complex central responses (104,105) and pheno-type changes considered as part of the neuronal plasticity (105-107). Further, in an evaluation in rats (108), the authors evaluated the effect of the nerve root infiltration with local anesthetic with or without steroids on mechanical allodynia. They concluded that corticosteroids may be unnecessary for nerve root blocks since they provided no additional benefit. Thus, the present evaluation indicates the lack of any significant role for the addition of steroids using a caudal approach in managing pain secondary to spinal stenosis as have other studies of low back pain (52-54,97,99).

Finally, it is important to reinforce the importance of target delivery of the injectate to the optimum site of pathology. Using the blind approach to epidural procedures is often claimed to be one of the reasons for variable and failed responses. Inaccurate needle placement resulting in inaccurate placement of the drug has been reported in 20% to 38% of patients (109,110). Thus, it is not hard to see the vital important of utilizing fluoroscopy to overcome this and maximize accurate delivery to the target site.

In summary, the evidence in this preliminary evaluation of a randomized equivalence trial demonstrates that caudal epidural injections with or without steroids in patients with spinal stenosis with low back and lower extremity pain provide significant pain relief and improvement in functional status.

Conclusion

This preliminary report of the results of a randomized, double-blind equivalence trial of caudal epidural injections with local anesthetic with or without steroids with chronic function-limiting low back pain and lower extremity pain has demonstrated pain relief effectiveness in 55% to 65% of the patients and improvement in functional status in 55% to 80% with 3 to 4 procedures over the course of one-year.

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