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Prospective Evaluation

Fluoroscopically Guided Caudal Epidural Steroid Injections in Degenerative Lumbar Spinal Stenosis

Kenneth Botwin, MD[1], Lee Ann Brown, MD[1], Mark Fishman, DO[2], and Sanjiv Rao[3]

From: [1]Florida Spine Institute, Clearwater, FL, [2]South Florida Institute of Sports Medicine, Westin, FL, [3]Nova Southeastern University College of Medicine, Fort Lauderdale, FL

Dr. Botwin[1] is Fellowship Director, Florida Spine Institute, Clearwater, FL.
Dr. Brown[1] is a psyiatrist at the Florida Spine Institute, Clearwater, FL.
Dr. Fishman[2] is with the South Florida Institute of Sports Medicine, Westin, FL.
Rao[3] is a student, Nova Southeastern University College of Osteopathic Medicine, Fort Lauderdale, FL.

Address correspondence:
Kenneth P. Botwin, MD
Fellowship Director
Florida Spine Institute
2250 Drew Street
Clearwater, FL 33765

E-mail: contactus@floridaspineinstitute.com

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Background: Caudal epidural steroid injections are commonly utilized to help reduce radicular pain in lumbar spinal stenosis. There have been studies done to evaluate the effectiveness of this procedure non-fluoroscopically guided. Search revealed no prospective studies evaluating the effectiveness of fluoroscopically guided caudal epidural injections on patients with bilateral radicular pain from degenerative lumbar spinal stenosis.

Objective: To evaluate the therapeutic benefit of fluoroscopically guided caudal epidural steroid injections in the treatment of bilateral radicular pain from symptomatic Degenerative Lumbar Spinal Stenosis (DLSS).

Design: This prospective cohort study was performed on 34 patients with bilateral radicular pain from lumbar spinal stenosis who received fluoroscopically guided caudal epidural injections at a multidisciplinary spine center as they did not improve with conservative care. The patients' degenerative lumbar spinal stenosis was confirmed by magnetic resonance imaging and classified as mild, moderate, or severe. The patients were evaluated by an independent observer and completed questionnaires, prior to initial injection, at 6 weeks, 6 months and 12 months after the injections.

Outcome Measures: Visual analog scale, patient satisfaction scale, standing/walking tolerance scale and Oswestry low back pain disability questionnaire.

Results: A total of 34 patients met our inclusion criteria and were followed at 6 weeks, 6 months, and 12 months. Sixty-five percent of patients at 6 weeks, 62% at 6 months, and 54% at 12 months had a successful outcome, reporting at least a >50% reduction between pre-injection and post injection visual analog pain scores. Fifty nine percent of patients had an improved walking tolerance at 6 weeks (P <0.0001), 56% at 6 months (P <0.0001), and 51% at 12 months (P=0.0005). Fifty percent of patients had an improved standing tolerance at 6 weeks (P= 0.0002), 54% at 6 months (P < 0.0001), and 51% at 12 months (P=0.0005). The patient satisfaction scale revealed 64% of patients felt completely or somewhat better at 6 weeks, 59% at 6 months and 52% at 12 months. Owestry low back pain disability questionnaire scores showed statistically significant improvement from initial scores to 6 weeks (P < 0.0001), initial to 6 months (P= 0.0095), and initial to 12 months (P=0.00015). The outcome was statistically significant even in severe stenotic patients when comparing initial mean scores to 12 month mean scores in standing tolerance (P =0.2956), walking tolerance (P=0.0250), and VAS (P= 0.0199).

Conclusion: Fluoroscopically guided caudal epidural steroid injections may help reduce bilateral radicular pain and improve standing and walking tolerance in patients with DLSS.

Key words: Injections, epidural radiculopathy, lumbar spinal stenosis, rehabilitation

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This is a prospective cohort design study of 76 fluoroscopically guided caudal epidural steroid injections (FGCESIs) performed in 34 patients with bilateral lumbar radicular pain from degenerative lumbar spinal stenosis (DLSS) to determine the efficacy of the injection.

Epidural steroid injections performed under intermittent fluoroscopic guidance, in combination with epidurography, has been advocated as a means to ensure proper localization within the epidural space (1-5). Incorrect needle placement in caudal epidural injections occurs with relative frequency (25% to 38.5% incidence) when performed without fluoroscopic guidance (3,4). Even when the sacral hiatus is easily palpable, incorrect needle placement occurs at a frequency of 12.5% to 14.2% without the use of fluoroscopy (2). Steroid preparations injected epidurally may not always reach their intended target and have the potential to have their flow restricted by an anatomic abnormality, such as a midline septum. Only visualization of proper ionic contrast flow on epidurography confirms delivery of the injectate to the intended target. Futhermore, a negative return of blood with needle aspiration does not always assure the absence of vascular uptake and only the use of fluoroscopy ensures the proper and safe delivery of injectate in the epidural space.

An Embase/Medline search revealed there have been no published prospective studies to assess the outcome of fluoroscopically guided caudal epidural injections in patients with degenerative lumbar spinal stenosis. Several noncontrolled studies have assessed the outcome of non-fluoroscopically guided caudal epidural steroid injections with varied results for radicular pain from both herniated nucleus pulposus or stenosis (6-10). There has been one double-blind, controlled study of 23 patients who were treated for radiculopathy using non-fluoroscopically guided caudal epidural injections comparing normal saline, procaine, and triamcinolone to normal saline alone (11). This did reveal that the active treatment group had an objective improvement with the straight leg raise.

Our main objective was to see if there was an improvement in the patient's condition after a caudal epidural steroid injection. We present a prospective study to assess short term (6 weeks), intermediate term (6 months), and long term (12 months) benefits from FGCESIs in patients with symptomatic degenerative lumbar spinal stenosis.

Methods

A total of 34 consecutive patients presented to a multidisciplinary spine care practice with complaints of lower back pain and bilateral radicular pain. Patients received a fluoroscopically guided caudal epidural steroid injection if they did not improve after at least a 6-week treatment consisting of a combination of analgesics, anti-inflammatories, and physical therapy. Patients were included in the prospective study if they met the inclusion criteria. This consisted of any patient with a history consistent with bilateral radicular pain, included in this history were findings of neurogenic claudication, physical examination and part one McGill pain questionnaire (12). They also must have filled out a questionnaire that included a visual analog scale (13), Oswestry Low Back Pain Disability Questionnaire (14), standing/walking tolerance scale, and patient satisfaction scale (Table 1) at baseline, 6 weeks, 6 months, and 12 months after their procedure. Magnetic resonance imaging (MRI) revealed DLSS as interpreted by a single board certified neuroradiologist. Central stenosis was classified based upon mid sagittal diameter measured in millimeters (mm) obtained on T2 sagittal images at the narrowest intervertebral level. The classification was mild $\geq$13 mm, moderate 11- <13 mm, and severe $\leq$ 11 mm diameter. The level with the most severe stenosis was used for the classification of the 34 patients, 18 had two stenotic levels, 8 had three, two had 4, and 6 had one stenotic level. All of these MRIs did reveal lateral stenosis as well. The institutional review board approved all procedures. Informed consent was obtained from all patients after explaining the nature of the investigation and the associated risks involved. All participants were provided with an opportunity to discuss and/or participate in the study. Appropriate precautions were taken to protect the identity of the patients participating in this study. Exclusion criteria consisted of lack of return of the mailed questionnaire, peripheral neuropathy on physical examination, cauda equina syndrome, epidural lipomatosis, unilateral radicular pain, arterial vascular disease (documented by diminished pulses or arterial doppler), herniated nucleus pulposus, epidural steroid injection within 6 months, congenital spinal stenosis, contraindications to corticosteroids e.g. previous lumbar surgery, degenerative spondylolisthesis, litigation or workers compensation, and pain duration of less than 12 weeks.

Table 1. *Scales included in patient questionnaire*

Oswestry Disability Questionnaire measured in %	
0–20%	Minimally disabled
20–40%	Moderately disabled
40–60%	Severally disabled
60–80%	Crippled
80–100%	Bed bound or exaggerating
Standing/walking tolerance tests	
Standing tolerance test, min	
0 =	0–5
1=	6–10
2 =	11–30
3 =	31–60
Walking tolerance test, feet	
0 =	0–50
1 =	51–200
2 =	201–500
3 =	500+
Patient satisfaction scale	
Completely better	
Somewhat better	
Same	
Slight worse	
Worse	

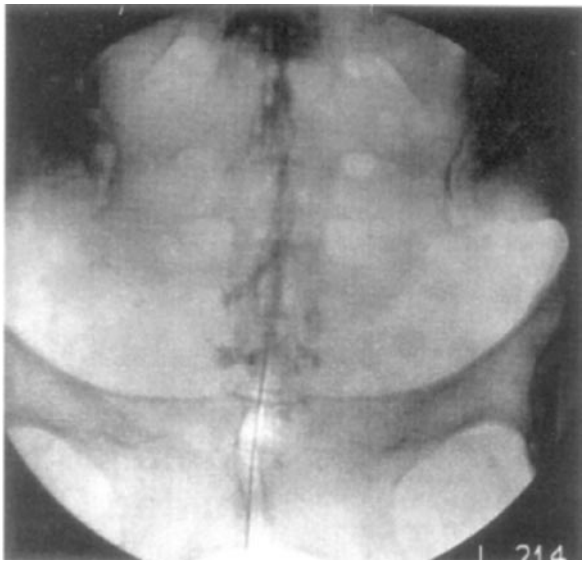
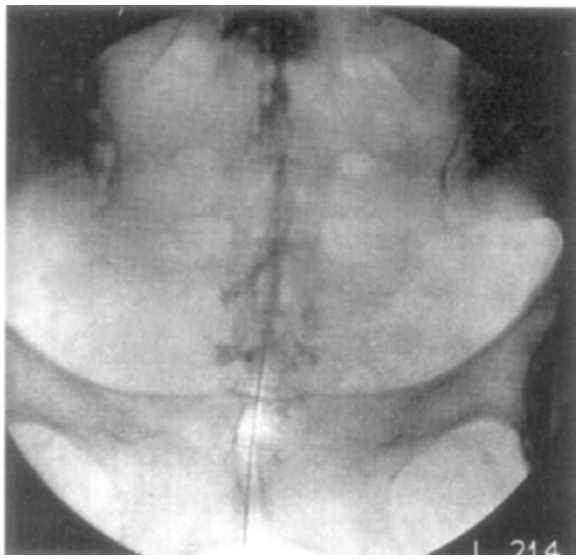


Fig. 1. *An AP fluoroscopic image showing the proper location of the needle in the sacral hiatus. Isovue contrast demonstrates epidural flow within the epidural space.*

All epidural injections were performed at an ambulatory surgical center by 5 physicians with extensive experience in fluoroscopically guided caudal epidural steroid injections. After the injections patients were told to resume their normal activities the same day and to resume modified Williams flexion exercises (15) the following day.

The technique was standardized in all procedures. Patients were placed in the prone position on a radiology table. A wedge shaped pillow was placed under the hips to tilt the pelvis and bring the sacral hiatus into greater prominence. The sacrococcygeal area was prepared using an iodine-based antiseptic solution (Povidone Iodine USP solution, The Clinipad Corporation, Rocky Hill, CT) and an alcohol solution (Kendall Webcol alcohol prep 70% isopropyl alcohol, Marsfield, MA). The interventionalist then used the sterile gloved middle finger of the dominant hand to localize the tip of the coccyx through palpation. In this position the area under the proximal interphalangeal joint was marked. Using a fluoroscope (OEC Compact 7600 Salt Lake City, UT), a 22-gauge, 3.5 inch/90mm spinal needle (Quincke type point, luer lock, Spinocan, Becton Dickinson, Franklin Lakes, NJ) was guided under fluoroscopic guidance to the midline of the sacral hiatus (Fig. 1). A lateral fluoroscopic view (Fig. 2) was used to confirm the needle was in the caudal epidural space. Aspirations were routinely performed. If negative for aspirate, Isovue M-300 (iopamidol injection Bracco Diagnostic, Princeton, NJ) 2 mL was instilled to confirm epidural flow of the injectate and to rule out intravascular, intrathecal, and/or soft tissue infiltration. Once an epidurographic conformation was obtained, a solution of 10mL of 0.5% preservative-free xylocaine (Lidocaine HCL injection, Astra Pharmaceuticals, Westborough, MA) and 80 mg Kenalog (Triamcinolone acetonide, Bristol Myers Squibb, Princeton, NJ) was injected. The total injectate was 14 mL including contrast. Plain radiographs in the AP and lateral views were taken after all injections to document both the contrast pattern and needle placement.

All patients had been monitored by pulse oximetry, blood pressure, and EKG during and after the procedure. Patients had been transferred to the recovery unit for 40 minutes. All patients had been seen by the



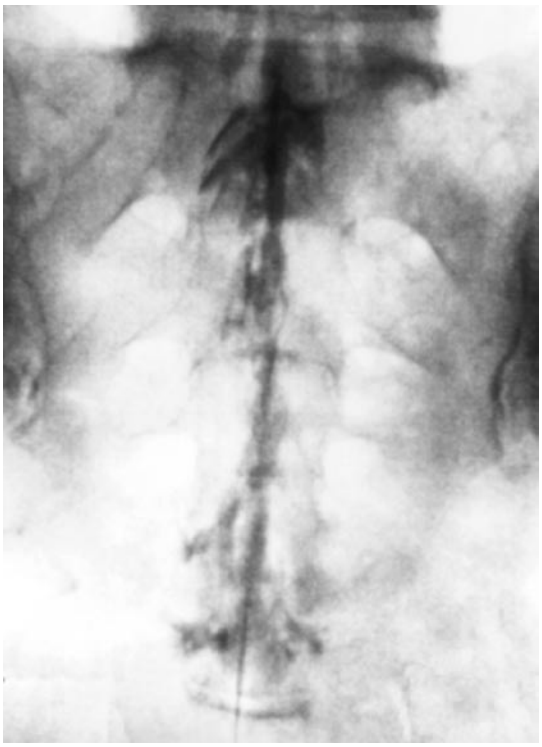


Fig. 2. *Fluoroscopic views showing needle position in the caudal epidural space with Isovue contrast delineating an epidural flow pattern.*

physician who performed the injection and by a registered nurse prior to discharge.

A preprocedure questionnaire that included VAS, standing/walking tolerance, and Oswestry low back pain disability questionnaire were administered and recorded by an ambulatory surgical center registered nurse. Patients were also mailed the same questionnaire, which also included a patient satisfaction scale, to evaluate their condition 6 weeks, 6 months and 12 months after their procedures. An independent observer did a review of these questionnaires. The observer was a physician trained in fluoroscopically guided caudal epidural injections but who did not perform any of the injections in the study. All epidurograms were reviewed to ensure epidural placement was achieved.

Statistical analysis was performed using SAS (Statistical Analysis Systems, SAS Institute, Cary NC) Version 9.1. Outcome was measured in four ways; standing tolerance, walking tolerance, VAS, and Oswestry questionnaire. Measurements were taken prior to the first injection, at 6 weeks, 6 months, and 12 months following the initial injection.

All patients who underwent surgery were excluded from analysis due to possible confounding factors.

Results

A total of 37 patients were enrolled in the study. Three out of 37 of these patients (12%) required surgery after receiving one epidural injection prior to the 6-week questionnaire; therefore 34 patients were included in this study. The average age was 74.6 years standard deviation (+5.704) (range, 65–89 years) (Table 2). The mean duration of symptoms was 24.5 months (range 6–71 months). There were 15 male and 19 females. We administered a total of 76 injections, with a mean of 2.2 injections per patient. All patients had injections performed prior to the 6-week questionnaire and did not have any injections after this time period. No patients were involved with any litigation. Mean initial VAS, standing tolerance, walking tolerance, and Oswestry was 7.68 (standard deviation + 1.063), 1.12 (+0.993), 1.0 (+0.747), and 34.12 (+14.66) respectively. Mean 6 week VAS, standing tolerance, walking tolerance and Oswestry was 4.04 (+2.349), 1.62 (+1.085), 1.5 (+0.947) and 24.62 (+14.512). Mean 6-month VAS, standing tolerance, walking tolerance and Oswestry was 4.18 (+2.584), 1.76 (+ 1.139), 1.65 (+1.026) and 28.12 (+16.820). Mean 12 month VAS, standing tolerance, walking tolerance,

and Oswestry was 4.62 (+2.784), 1.64 (+1.125), 1.58 (+0.984), 28.67 (+16.920). The patient satisfaction scale revealed 64% felt completely better or somewhat better at 6 weeks, 59% of patients felt completely or somewhat better at 6 months, and 52% felt completely or somewhat better at 12 months. No major complications from the procedures were observed in the treatment group.

Imaging studies on all patients showed a combination of both central and lateral stenosis (lateral recess and neural foraminal). All patients had at least 2 intervertebral levels affected by both central and lateral stenosis. Patients were categorized by a single neuroradiologist based upon the worst radiographic level. No criteria was applied to evaluate the degree of lateral stenosis; however, the severity of central stenosis was graded based upon a mid-sagittal diameter which was obtained from T2 sagittal images at the narrowest area at the involved intervertebral levels. Eighteen patients were classified as having moderate stenosis, 10 mild, and 6 severe.

Three patients underwent a surgical procedure prior to the 6-week questionnaire and were excluded from the data. Their initial VAS was 7.7. Their VAS, standing tolerance, and walking tolerance was 3.1, 2.4 and 2.7. The mean age of these patients was 74.4 years. The MRI findings in these patients revealed 2 had severe stenosis, 1 had moderate stenosis.

All statistical analysis were performed using SAS (Statistical Analysis Systems, Version 9.1). Our main objective was to see if there was an improvement in the patient's condition after a caudal epidural steroid injection over time. Outcome was measured in four ways, standing tolerance, walking tolerance, VAS, and Oswestry Questionnaire. Measurements were taken prior to injection after 6 weeks, 6 months, and 12 months (Table 3).

To see if a statistically significant difference existed before and after treatment, a paired sample t-test was performed on the difference between pre and post injection values. Irrespective of which outcome was measured, there was a statistically significant improvement between pre and post injection values between the initial and 6-week follow up, initial and 6 month follow up, and initial and 12 month follow up (all *P*-values <0.0095) (Table 4,5). Our results were confirmed using the non-parametric Wilcoxon signed rank test (all *P*-values <0.005).

We compared the initial VAS, standing and walking mean scores with the 6 week, 6 month, and 12 month mean scores using an improvement of ≥50%. We found 65% improvement in VAS, 50% improvement in the standing tolerance, and 59% in the walking tolerance at 6 weeks; 62% improvement in the VAS, 54% improvement in the standing tolerance, and 56% in the walking tolerance at 6 months; and 54% improvement in the VAS, 51% improvement in the standing tolerance, and 51% improvement in the walking tolerance at 12 months.

Table 2. *Baseline demographics*

No. of patients:	34	
Total no. of injections:	76	
Mean Age, yr (range):	74.6	(65-89) (SD t 5.704)
Sex: men, women	15 men	19 women
No. of patients involved in litigation:	0	
Mean duration of pain, mo: (range =)	24.5	=(6-71)

Table 3. *Outcome mean scores at initial visit and after 6 weeks (n=34)*

Outcome Measure	Initial Mean	6 week mean	t Test P Value
VAS	7.68	4.04	*<0.0001*
Standing tolerance	1.12	1.62	*0.0002*
Walking tolerance	1.03	1.50	*<0.0001*
Oswestry	34.12	24.62	*<0.0001*

VAS, visual analog scale. Thirty-four patients were included in these data Oswestry value is in %

Table 4. Outcome mean scores at initial and 6 month visits (n=34)

Outcome Measure	Initial Mean	6 month mean	t Test P Value
VAS	7.68	4.18	*<0.0001*
Standing tolerance	1.12	1.76	*<0.0001*
Walking tolerance	1.03	1.65	*<0.0001*
Oswestry	34.12	28.12	*<0.0095*

VAS visual analog scale 34 patients were included in these data.

Table 5. Outcome mean scores at initial and 12 months (n=34)

Outcome Measure	Initial Mean	6 month mean	t-test p-value
VAS	7.68	4.62	*.0001*
Standing tolerance	1.12	1.64	*0.0005*
Walking tolerance	1.03	1.58	*<0.0001*
Oswestry	34.12	28.67	*0.0015*

VAS visual analog scale 34 patients were included in these data.

Analysis between 6 month and 12 month follow up visits revealed a significant difference between standing tolerance and VAS in between that time period, but not in walking tolerance or Oswestry (Table 6). VAS and standing tolerance declined, possibly indicating either maximal improvement or the need for another injection at 6 months.

Further analysis were performed to see if there was a difference in response to treatment between patients with mild, moderate, and severe stenosis, the status of which was determined by MRI. The difference between initial and 6-month values (Table 7), and initial and 12-month values (Table 8) were used for this analysis and results were obtained using a paired difference t-test and the Wilcoxon signed rank test.

Analysis of the difference between initial and 6 month scores showed that within the mild stenosis group, VAS and Oswestry significantly improved. Within the moderate group, standing tolerance, walking tolerance, and VAS significantly improved. The severe stenotic group showed improvement in standing tolerance, walking tolerance, and VAS, however, our results could not be corroborated with the non-parametric test.

Analysis at the 12-month follow up period revealed statistically significant improvement in all 4 outcome measures for the mild stenotic group. Wilcoxon signed rank testing confirmed our results, however, giving a *P*-value of 0.0625 for standing tolerance (Table 8). Within the moderate stenotic group all outcome measures showed significant improvement and these results were confirmed using nonparametric measures (Table 8). The severe stenotic group showed improvement in walking tolerance and VAS; however, Wilcoxon testing for walking tolerance also gave a p-value of 0.0625 (Table 8).

A Wilcoxon two-sample test was performed to investigate a possible difference in improvement between the mild stenotic group and the severe stenotic group. The data were broken down into 2 groups; mild vs. severe, and the difference between baseline and 6 month scores and baseline and 12 month scores was used as the variable in the analysis. No significant difference was found between the 2 groups irrespective of the outcome measured. Hence, we were able to conclude that whether the stenosis was mild or severe the improvement after steroid injection was no different between the 2 groups.

Table 6. Outcome mean scores at 6 months and 12 months visits (n=34)

Outcome Measure	6-month Mean	12-month mean	t-test *P*-value
VAS	4.18	4.62	*0.0019*
Standing tolerance	1.76	1.64	*0.0119*
Walking tolerance	1.65	1.58	*0.3248*
Oswestry	28.12	28.67	*0.3586*

VAS visual analog scale 34 patients were included in these data.

Table 7. Initial individual scores compared to 6 month individual scores based upon MRI classification of severity of central stenosis (Mild >13mm, Moderate >11-13mm, Severe <11mm) obtained from thecal sac diameter on T2 sagittal MRI images.

	Mild n=10		Moderate n=18		Severe n=6	
	Initial mean	6 mo mean	Initial mean	6 mo mean	Initial mean	6 mo mean
Standing	80.80	2.30	67.67	1.33	33.33	2.17
	(P = 0.0150)		(P = 0.0007)		(p = 0.0422)	
Walking	20.20	1.80	6.06	1.56	67.67	1.67
	(0.0239)		(0.0242)		(0.0117)	
VAS	35.35	3.85	53.53	4.31	67.67	4.33
	(0.0020)		(<0.0001)		(0.0141)	
Owestry	40.40	21.80	17.17	29.22	83.83	35.33
	(0.0100)		(0.1980)		(0.5411)	

Paired difference t test p-value ( )

Table 8. *Initial individual scores compared to 12 month individual scores based upon MRI classifications of severity of central stenosis (Mild >13mm, Moderate 11-13mm, Severe <11mm) obtained from thecal sac diameter on T2 sagittal MRI images.*

	Mild n=10		Moderate n=18		Severe n=6	
	Initial mean	12 mo mean	Initial mean	12 mo mean	Initial mean	12 mo mean
Standing	80.80	2.20	0.67	1.24	1.33	1.83
	(0.0368)		(0.0078)		(0.2956)	
Walking	1.80	2.20	1.06	1.53	0.67	1.33
	(0.0239)		(0.0156)		(0.00250)	
VAS	7.35	4.50	7.53	4.74	8.67	4.83
	(0.0030)		(0.0005)		(0.0199)	
Owestry	32.40	26.80	33.17	27.47	39.83	35.17
	(0.0409)		(0.0099)		(0.5023)	

Paired difference t-test P-value

Discussion

Study Implications:

The results of our study reveal a statistically significant benefit to patients with DLSS and bilateral radicular pain at 6 weeks, 6 months, and 12 months following fluoroscopic caudal epidural steroid injections. All outcome measures, which included VAS, standing/walking tolerance, and Oswestry low back pain disability questionnaire, showed statistically significant improvement.

The outcomes of the study were similar to other prior studies evaluating the efficacy of epidural steroid injections in patients who had radicular pain from symptomatic degenerative lumbar spinal stenosis (16-18).

We also were able to show there was no significant difference between mild stenotic and severe stenotic patients with both sustaining improvement.

We did have a group of 3 patients excluded from the study. These 3 patients went to surgery prior to the 6 week evaluation. As these patients are not included in the data it can imply our results have a bias towards success of the injection being misleading.

The study can be improved by expanding it to in-

clude a larger patient population in order to better evaluate the efficacy of caudal epidural steroid injections in the patient with symptomatic degenerative lumbar spinal stenosis. It could also be improved by better classifying the degree of spinal stenosis on MRI imaging by perhaps measuring the circumferencial area (19) and even classifying degree of lateral stenosis (20,21).

The study not being double blinded was a further shortcoming, as both the physician and patient knew the contents of the injection and the possibility for pain relief. Thus, the disadvantages of an uncontrolled, non-blind study are acknowledged. The obvious gold standard to evaluate the efficacy of these injections is a randomized, double-blind controlled trial. Future outcome studies are also needed to evaluate the best routes of epidural steroid administration in this patient population. A trial comparing the outcomes from bilateral transforaminal epidural steroid injections in this patient population may or may not fair as well as the caudal approach.

Review of epidural steroid injections in lumbar spinal stenosis:

Degenerative lumbar spinal stenosis (DLSS) is a frequent cause of functional impairment and disability in the elderly population. The pathophysiology of spinal stenosis is not well understood at this time though various hypothesis have been made (22,23). Encroachment results from vertebral body osteophytes or discs ventrally, zygapophyseal joint hypertrophy laterally, and hypertrophy or buckling of ligamentum flavum dorsally. Neurogenic claudication is the most common presenting symptom. Lower limb and /or buttock pain may be unilateral or bilateral. Low back pain is common, however, not always present. Magnetic resonance imaging (MRI) or myelography with Computerized tomography (CT) will show anatomically whether spinal stenosis is present, its location (level, central/lateral recess/foraminal), and it severity. Anatomical stenosis may be present in asymptomatic subjects, thus imaging studies must be correlated with other clinical data, signs, and symptoms (24,25). The natural history of DLSS is a slow progression, which may or may not lead to functional decline (26). Surgical intervention is recommended only for progressive neurologic deterioration, cauda equina syndrome, or most commonly, if pain becomes intolerable and significantly limits function despite a comprehensive trial of conservative management. Most patients with severe symptoms will be treated surgically, and studies have shown that these patients can achieve substantial improvement (27-30). Poor prognostic indicators include diabetes mellitus, previous lumbar spine surgery, hip joint pathology, and previous lumbar spine fracture (31).

The use of epidural steroid injections in the treatment of lumbosacral radiculopathy has become an important procedure that is therapeutic. The caudal epidural injection is one of several injection techniques in which the lumbar epidural space can be accessed. Cathelin (32) first described the procedure in 1901. The introduction of the midline lumbar epidural technique by Pages (33) in 1921 placed the caudal approach out of favor. The caudal approach was reintroduced as a technique for pain relief in childbirth by Hingson and Edwards (34) in 1943. Epidural steroid injections have been used in the treatment of lumbar radicular pain syndromes since 1952 (35,36). They were first reported in the United States in 1960 to benefit conditions causing nerve root irritation (36,37). These injections were performed "blind" (without fluoroscopic guidance).

Clinicians have differed as to the exact constituents of a caudal epidural injection with respect to the agents injected and their volumes. Most have mixed a corticosteroid: methylprednisolone acetate (Depo Medrol), bethamethasone acetate (Celestone Soluspan), or triamcinolone acetonide (Kenalog) with either local anesthetic or normal saline (6,11,38). The spread of agents in the caudal epidural space has been studied using large volumes of injectate (20–40 mL), enabling medication to reach the upper lumbar and lower thoracic intervertebral levels (39). An observational case study by Bryan et al (40) found that contrast reaches the L4-5 intervertebral level in 85% of patients with <8 ml.

The results of a meta-analysis of non-fluoroscopically guided epidural steroid therapy have suggested that there is a slight treatment benefit from epidural steroids; no more than 14% of individuals were relieved of pain (41).

Several studies (42-45) have isolated chemotoxic pain mediators such as matrix metalloproteinase, c-fos, phospholipase A2, and cytokines which are present in abnormal quantities after disc herniation. A study by Roberts et al (46) demonstrated the more the disc is degenerated, the higher the affinity for staining of matrix metalloproteinases. In vitro studies simulating lumbar stenosis have shown venous congestion, intraneural edema, and impaired axonal transport

is present secondary to chronic compression (47-49). Corticosteroids have been shown to be able to block the nociceptive C fiber conduction (50) and also inhibit prostaglandin synthesis (51). Spinal stenosis is a condition in which there is usually an intermittent compression of the nerve roots. This could lead to hyperemia, venous congestion, and perhaps leakage of neurotoxic substances. Therefore, the rationale for corticosteroid use in epidural injections for spinal stenosis is to impair prostaglandin synthesis, block the nociceptive c-fiber conduction, and possibly alter nerve root blood and chemotoxic mediator flow. Further research needs to be done to evaluate for the presence of chemotoxic mediators, which possibly may be present in some patients with DLSS.

Few studies have ones examining the efficacy of epidural steroid injections in treating radicular pain from degenerative lumbar spinal stenosis (DLSS). Non-fluoroscopically guided studies include prospective and non-controlled, non-blinded methodologies using the interlaminar and caudal approaches (52-55). Studies utilizing fluoroscopic guidance are both prospective and retrospective and were performed via the transforaminal and caudal approaches (16-18,56-58).

Non-fluoroscopic studies:

Only 2 studies via the interlaminar approach that were not fluoroscopically guided have been reported for treatment of radicular pain specifically as a result of DLSS. Rosen et al (52) did a retrospective study of 40 patients with radicular pain who underwent non-fluoroscopically guided interlaminar epidural injections. He found that approximately 60% received temporary relief after the epidural steroid injection for up to 2 months. Only 25% received long-term relief over 8 months. Cuckler et al (53), in 1985, performed a prospective, randomized, double-blind study on the efficacy of non-fluoroscopically guided interlaminar epidural steroid injections in the treatment of both HNP and DLSS. Only 2 of their 41 (5%) patients who received an epidural steroid injection received long-term relief. Their definition of long-term relief was an improvement of 75% or more in the pre-injection symptoms at 13 to 37 months (average 20 months) after injection. This study was limited in that initial analysis was at 24 hours, which is before steroid effect occurs, patients in both the steroid and control group (saline/procaine) received a second injection with steroid, all patients were given the injections at the L 3-4 level, conceivably above the level of their pathology. Thus the long term follow up between the two groups is invalid. Analysis was not done at set times as one would expect in a prospective study. Upon analysis of the patients with stenosis in the study showed long term failure in 18/37 subjects and surgery occurred in 27% of patients with lumbar spinal stenosis.

Fluoroscopic studies:

Only two studies without the use of fluoroscopy have been reported on the use of caudal epidural steroid injections for DLSS. Hoogmartens and Morelle (54) performed injections using hydrocortisone and reported satisfactory results in 48% of a group of 49 patients with lumbar spinal stenosis. A prospective study by Ciocon et al (55), showed short-term benefits in an uncontrolled clinical study with a 10 month follow up with outcome measured at 2 month intervals through the Roland 5-point scale. There was statistical significance for a favorable outcome. They did show in their study significant pain relief which led to a conclusion that caudal epidural injections in the elderly are a therapeutic option among patients with poor response to drug therapy and who are either poor surgical risks or have refused surgery.

Four previous studies have reported on the use of fluoroscopically guided transforaminal epidural steroid injections for the treatment of DLSS. Botwin et al (16) did a prospective cohort study of patients with unilateral radicular pain from DLSS. They performed an average of 1.9 injections per patient at the most symptomatic level with 75% of patients having >50% pain reduction on the VAS at one year. Additionally, 57% admitted improved standing tolerance and 64% noted improved walking tolerance at the one year follow up. Reiw et al (56) prospectively studied the effectiveness of selective root blocks in patients with lumbar radicular pain from a radiographically confirmed nerve root compression and who were otherwise considered surgical candidates. The study was carried out in a prospective, randomized, double blind, and controlled manner in which patients received injections of either 1 mL of 0.25% bupivacaine or 12 mL of 0.25% bupivacaine mixed with 6 mg of betamethasone. They were able to show that 29 of the 55 patients studied who had requested surgery and who were considered to be surgical candidates were able to avoid operative intervention. Compared with injection of bupivacaine alone, injection of bupivacaine with steroid was significantly more likely to result in the avoidance of surgery. Cooper and Lutz (18) retrospectively studied the use of transforami-

nal epidural steroid injections in the treatment of degenerative lumbar scoliotic stenosis and radiculopathy. They defined a successful outcome as a reduction of at least 2 points on the NRS, Summary Pain and Summary Function scores. They found that 55.8% of patients had a successful outcome at one month post injection and 37.2% of patients had a successful outcome at one year post injection. They also concluded that patients with radicular complaints of less than 12 weeks were more likely to have a successful outcome than those with complaints greater than 12 weeks. They also reported that 3 out of 4 patients who had previously failed at least one caudal ESI showed a favorable response to the transforaminal injection. Rosenberg and Grabinsky (57) retrospectively studied 82 patients who had received an average of 2.4 injections per patient via the transforaminal approach for radicular pain secondary to stenosis, HNP, degenerative discs, or spondylolisthesis. For stenotic patients, they showed a decrease in the mean pain score from 7.8 to 5.8 at 6 months and 5.1 at 12 months respectively.

There have been 2 previous retrospective studies on the use of caudal epidural steroid injections with the aid of fluoroscopic guidance for radiculopathy resulting from degenerative lumbar spinal stenosis. Barre' et al (17) studied 80 patients with back or bilateral leg pain who had undergone at lease one caudal ESI and 4 to 6 weeks of a flexion biased physical therapy program. Fifty percent of patients had at least a 2-point improvement on VAS and 42% of patients admitted that the procedure fully met their expectations or would undergo the procedure again for the same outcome. Delport et al (58) in 2004 reported a retrospective review of patients with lumbar spinal stenosis who underwent fluoroscopically guided transforaminal or caudal epidural injections. They reported that epidural injections are a reasonable treatment for lumbar spinal stenosis, providing a third of their patient population with sustained relief and more than half with sustained improvement in function (19).

Conclusion

Fluoroscopically guided caudal epidural steroid injections may help reduce bilateral radicular pain and improve standing and walking tolerance in patients with DLSS. Severity of lumbar spinal stenosis seen on MRI may not be predictor of a clinically significant response to caudal epidural steroid injection. These injections maybe a useful adjunct in non-operative treatment of radicular pain in DLSS.

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