KJP The Korean Journal of Pain
| Review Article |
Korean J Pain 2015 April; Vol. 28, No. 2: 75-87
pISSN 2005-9159 eISSN 2093-0569
http://dx.doi.org/10.3344/kjp.2015.28.2.75

What is the Role of Epidural Injections in the Treatment of Lumbar Discogenic Pain: A Systematic Review of Comparative Analysis with Fusion

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Background: Lumbar discogenic pain without pain mediated by a disc herniation, facet joints, or the sacroiliac joints, is common and often results in chronic, persistent pain and disability. After conservative treatment failure, injection therapy, such as an epidural injection, is frequently the next step considered in managing discogenic pain. The objective of this systematic review is to determine the efficacy of lumbar epidural injections in managing discogenic pain without radiculopathy, and compare this approach to lumbar fusion or disc arthroplasty surgery.

Methods: A systematic review of randomized trials published from 1966 through October 2014 of all types of epidural injections and lumbar fusion or disc arthroplasty in managing lumbar discogenic pain was performed with methodological quality assessment and grading of evidence. The level of evidence was based on the grading of evidence criteria which, was conducted using 5 levels of evidence ranging from levels I to V.

Results: Based on a qualitative assessment of the evidence for both approaches, there is Level II evidence for epidural injections, either caudal or lumbar interlaminar.

Conclusions: The available evidence suggests fluoroscopically directed epidural injections provide long-term improvement in back and lower extremity pain for patients with lumbar discogenic pain. There is also limited evidence showing the potential effectiveness of surgical interventions compared to nonsurgical treatments. (Korean J Pain 2015; 28: 75-87)

Key Words: Discogenic pain; Epidural injections; Lumbar disc arthroplasty; Lumbar fusion; Randomized trials.

Received January 21, 2015. Revised March 7, 2015. Accepted March 13, 2015.
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INTRODUCTION

The economic impact and growing prevalence of low back pain is substantial [1,2]. An assessment of the state of US health revealed that in 2010, 3 of the 5 disorders that contributed to the most years lived with a disability were related to chronic pain, including low back pain, other muscular disorders, and neck pain [2]. Consequently, determining the appropriate strategy for managing chronic low back pain, and the disability related to it, is of utmost importance. Options range from simple exercise instructions to complex fusions [1,3-16]. The rising costs of managing spinal pain have reached approximately $100 billion per year [1].

The intervertebral disc has two distinct but inter-related mechanisms that can cause pain. These can include compression of neural structures by a herniated disc, and pathologic changes that can occur within the disc, serving as a primary pain generator [17-20]. Low back pain without disc herniation or facet joint pain, described as discogenic pain, internal disc disruption, and painful degenerative disc disease, has been identified as the primary source of pain in multiple clinical studies published over the past several decades [6,18-26]. Pain and disability secondary to disc herniation has been described in only a small proportion of patients. Thus, discogenic pain may be a primary source of low back pain. Even though this remains one of the greatest health care crises, it has remained poorly defined and its diagnosis and treatment continue to be controversial [6,19-26]. Malik et al. [19] concluded that despite its extensive affirmation in the literature and enormous resources regularly devoted to it, currently discogenic pain lacks clear diagnostic criteria and uniform treatment or terminology. Bogduk et al. [21], in a state-of-the-art review of lumbar discogenic pain, concluded that all of the null hypotheses that have been raised against the concept of discogenic pain and its diagnosis have each been refuted by one or more studies.

Mirza et al. [27] described that patients suffering with discogenic pain may be attracted to an expanding range of costly diagnostic and therapeutic interventions. Phillips et al. [8] concluded that the body of literature supports fusion surgery as a viable treatment option for reducing pain and improving function in patients with chronic low back pain refractory to nonsurgical care when a diagnosis of disc degeneration can be made. Bydon et al. [9] concluded that despite the significant improvement in Oswestry Disability Index (ODI) scores in the lumbar fusion groups in 3 studies, pooled data revealed no significant difference when compared to the nonoperative groups.

Lu et al. [28], in a systematic review of nonoperative management of discogenic back pain, identified 11 RCTs investigating traction therapy, injections, and ablative techniques. The results revealed that there were few high quality studies evaluating nonoperative treatments for reducing discogenic low back pain; however, the results from 5 RCTs investigating methylene blue injection, steroid injection, ramus communicans, ablation, intradiscal electrothermal therapy, and biacuplasty favored intervention over sham therapy; however, these are emerging treatments. In contrast, epidural injections are a well established therapy. Saltychev et al. [12] also reached similar conclusions with a lack of strong evidence for lumbar fusion compared to conservative treatment. Deyo et al. [29] asked for restraint from resorting to fusion surgery. Other assessments have shown a lack of significant evidence supporting multiple intradiscal therapies [6,30].

The rationale for fusion is based on the premise that if the pain generator is emanating from the disc, eliminating the painful segmental motion should cure the problem. However, there are many problems with fusion surgery. First, it could lead to increased stress on adjacent levels leading to transitional joint pains. Second, the surgery itself leads to the destruction of healthy tissue. Third, it can be complicated by intraspinal scarring. Fourth, the instrumentation alone has been associated with the development of pain. Fifth, the outcomes of fusion for pain alone have been suboptimal. Consequently, total disc replacement has been developed, which shares some of the same potential complications. Fusion surgery and disc replacement have been increasing with a lack of consensus regarding the efficacy of lumbar spinal fusion for discogenic pain. Randomized studies showed the effectiveness of fusion with good to excellent pain relief in only 39% of the patients, whereas, one study found that only 63% of the patients with discogenic pain showed any improvement after surgery [29]. Further, successful surgical fusion, which is sometimes used as a hallmark of success, does not necessarily translate into significant pain reduction or functional status improvement [31]. A Cochrane review failed to find a clinically significant difference between lumbar disc arthroplasty and fusion surgery, even though lumbar

arthroplasty offers a motion sparing alternative to fusion [32]. Further, there have not been any randomized trials comparing disc arthroplasty with nonoperative management. The rising costs of managing low back pain and the costs of lumbar fusion and arthroplasty without proven efficacy have invited scrutiny from payers [27,28]. In fact, a review commissioned by the Centers for Medicare and Medicaid Services (CMS) Coverage and Advisory Committee [33], conducted by the Washington Health Care Technology Assessment program [34], concluded that lumbar fusion for degenerative disc disease lacked sufficient evidence of efficacy and safety to justify unconditional coverage.

In contrast to fusion and arthroplasty, the role of epidural injections for axial discogenic pain has not been addressed with the same rigor, subjecting the therapy to a systematic review [6,35-38]. Considering the presence of numerous modalities of treatments with intradiscal therapies, apart from surgical fusion and arthroplasty, it may be worthwhile to consider epidural injections — a simple and common procedure frequently performed in managing low back and lower extremity pain with or without steroids [6,35-43]. Consequently, this systematic review is undertaken to determine the comparative efficacy of lumbar fusion and epidural injections utilizing all 3 anatomical approaches in the treatment of lumbar discogenic pain.

MATERIALS AND METHODS

The methodology utilized in this systematic review followed the widely accepted review process derived from evidence-based systematic reviews and meta-analysis of randomized trials [44,45].

Only randomized controlled trials (RCTs) of epidural injections and fusion and/or disc arthroplasty were utilized, either placebo- or active-controlled. The trials were eligible if the assessment was performed for discogenic pain. The duration of symptoms of the study participants was chronic pain of more than 3 months. For this evaluation, the studies including disc herniation, radiculitis, central or foraminal stenosis, or post surgery syndrome were not included.

All trials providing appropriate management and with outcome evaluations of 3 months or longer, statistical evaluations, and at least 25 patients were reviewed.

The primary outcome measure was pain relief. The secondary outcome measure was functional status improvement.

A search for literature published from 1966 through October 2014 was performed utilizing data from PubMed, Cochrane library, the US National Guideline Clearinghouse (NGC), previous systematic reviews, and cross references.

The search strategy emphasized low back and lower extremity pain, discogenic pain, pain treated with either lumbar fusion, lumbar disc arthroplasty, caudal, lumbar interlaminar, or lumbar transforaminal epidural injections in the lumbosacral spine. Search terms included: (epidural injection) OR epidural steroid) OR epidural perineal injection) OR interlaminar epidural) OR intraarticular corticosteroid) OR nerve root blocks) OR intraarticular injection) OR periradicular infiltration) OR saline injection) OR transforaminal injection) OR corticosteroid) OR methyl prednisolone) OR (surgical [Title/Abstract]) OR surgery [Title/Abstract]) OR fusion [Title/Abstract]) AND (meta-analysis [pt] OR randomized controlled trial [pt] OR controlled clinical trial [pt] OR randomized controlled trials [mh] OR random allocation [mh] OR double-blind method [mh] OR single-blind method [mh] OR clinical trial [pt] OR clinical trials [mh] OR ("clinical trial" [tw]) OR (single [tw] OR double [tw] OR trebl* [tw] OR tripl* [tw]) AND (mask* [tw] OR blind* [tw]) OR (placebos [mh] OR placebo* [tw] OR random* [tw] OR research design [mh:noexp]) NOT (animals [mh] NOT human [mh]) AND (Lumbar) AND ("back pain" [Title/Abstract]) OR spondylosis [Title/Abstract]) OR DDD [Title/Abstract]) OR "disc degeneration" [Title/Abstract]) OR "degenerative disk disease" [Title/Abstract]) OR "degenerative disc disease" [Title/Abstract])

The quality of each individual article used in this analysis was assessed by Cochrane review criteria for randomized trials as shown in Appendix 1 [44]. Only randomized trials meeting the inclusion criteria with at least 5 of 12 Cochrane criteria were utilized for analysis.

Meta-analysis was considered if more than 2 randomized trials were homogeneous initially with clinical assessment followed by a meta-analysis.

At least 2 of the review authors independently, in an unblinded standardized manner, performed each search and methodological quality assessment. The primary authors of assessed manuscripts were not involved in the methodological quality assessment. All searches were combined to obtain a unified strategy. Any disagreements between reviewers were resolved by a third author and

Table 1. Grading of Evidence Modified by ASIPP

Level I	Evidence obtained from multiple relevant high quality randomized controlled trials
Level II	Evidence obtained from at least one relevant high quality randomized controlled trial or multiple relevant moderate or low quality randomized controlled trials
Level III	Evidence obtained from at least one relevant moderate or low quality randomized controlled trial with multiple relevant observational studies or Evidence obtained from at least one relevant high quality nonrandomized trial or observational study with multiple moderate or low quality observational studies
Level IV	Evidence obtained from multiple moderate or low quality relevant observational studies
Level V	Opinion or consensus of large group of clinicians and/or scientists

Developed and modified from: Manchikanti L, Falco JFE, Benyamin RM, Kaye AD, Boswell MV, Hirsch JA. A modified approach to grading of evidence. Pain Physician 2014; 17: E319-25 [46].

consensus.

An analysis of the evidence was performed based on modified grading of evidence which was developed from Cochrane criteria of evidence synthesis and multiple other criteria including the US Preventive Services Task Force (USPSTF) analysis of evidence criteria as shown in **Table 1** [46].

Summary measures included a 50% or more reduction in pain in at least 50% of the patients or at least a 3-point decrease in pain scores and a relative risk of adverse events, including side effects.

Randomized trials were judged to be positive if the intervention (fusion/disc arthroplasty or epidural injections) was clinically relevant and effective, either with a placebo control or active control, with a difference in effect for the primary outcome measure in a statistically significant manner at the conventional 5% level. Any improvement of less than 6 months was considered as short-term and 6 months or longer was considered as long-term for injection therapy and less than 12 months was considered as short-term for fusion. Since epidural injections can have a short-term benefit, repeat injections were allowed. Furthermore, the outcomes were judged at the reference point with positive or negative results reported at one month, 3 months, 6 months, 1 year, and 2 years.

RESULTS

Fig. 1 shows a flow diagram of the study selection as recommended by Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [45].

Of the multiple trials for consideration [11,47-56], 5 trials of lumbar fusion [47-51] and 2 trials of epidural injections [53,55] were considered for quality assessment. There were no trials available comparing total disc arthroplasty with conservative management. Of the 5 trials of lumbar fusion [47-51], 3 trials met the inclusion criteria of fusion surgery versus nonsurgical therapy [47-50] after exclusion of duplicates [47,48], and one trial [51] assessed fusion after disc excision. These 3 trials [47-50] and 2 trials of epidural injections [53,55] were considered for

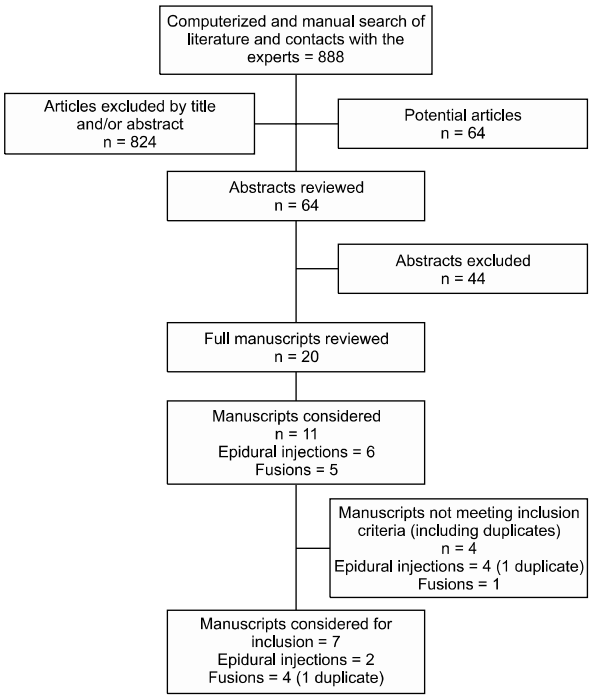

Fig. 1. Flow diagram illustrating published literature evaluating lumbar fusion/disc arthroplasty and epidural injections in lumbar discogenic pain.

inclusion.

1. Methodological quality assessment

The methodological quality assessment of RCTs is presented in Table 2 for fusion and epidural trials. All 3 trials of fusion were of moderate quality scoring 7 of 12; whereas, both epidural injection trials showed high quality scoring 10 or 11 of 12.

2. Study characteristics

Table 3 shows the study characteristics of randomized fusion and epidural trials in managing lumbar discogenic pain.

The literature search and methodological quality assessment showed 3 randomized trials of fusion surgery versus nonsurgical therapy [48-50]. These trials included patients with moderately severe pain and disability of at least one year duration after failure of conservative management. These trials excluded patients with neural compression, generalized disc degeneration shown on radiographs, spinal stenosis, spondylolisthesis, fracture, infection, or neoplasm. Discography was not used as a requirement for inclusion criteria. Fusion was performed either with instrumented posterolateral fusion (PLF), or noninstrumented PLF and anterior lumbar interbody fusion (ALIF) or posterior lumbar interbody fusion (PLIF). Patients in the nonsurgical groups were treated with standard nonoperative care which mainly included physical therapy [49] or with structured rehabilitation [47] including an exercise program [47,48] and/or cognitive interventions [50]. Overall, the improvement appeared to be superior in the surgical group with disability and pain relief. However, none of the trials assessed any criterion-based significant improvement of 50% or more. Fusion rate in the surgical group was over 80%; whereas, the reoperation rate in the surgical group was approximately 7%. All the trials were shown to have moderate methodological quality.

There was significant risk of bias across studies, with the most common being the assessment of outcome results not being blinded. Furthermore, the blinding of patients and personnel is not feasible in a study with a surgical intervention. Even though random-sequence generation was common in all studies, some studies utilized additional methods to generate treatment groups with similar characteristics. In addition, studies were at high risk of sampling bias due to patient crossover [9]. The sampling bias was highest in the study by Fairbank et al. [50] with 28%, whereas all studies had a proportion of patients who did not receive the treatment they were originally entitled to. In addition, the study by Fritzell et al. [49] compared lumbar fusion with usual care within the primary health care system rather than cognitive behavioral management.

Table 2. Methodological Quality Assessment of Randomized Trials Utilizing Cochrane Review Criteria

	Brox et al. [47,48]	Fritzell et al. [49]	Fairbank et al. [50]	Manchikanti et al. [53]	Manchikanti et al. [55]
Randomization adequate	Y	Y	Y	Y	Y
Concealed treatment allocation	N	N	N	Y	Y
Patient blinded	N	N	N	Y	Y
Care provider blinded	N	N	N	Y	Y
Outcome assessor blinded	N	N	N	N	N
Drop-out rate described	Y	Y	Y	Y	Y
All randomized participants analyzed in the group	Y	Y	Y	Y	Y
Reports of the study free of suggestion of selective outcome reporting	Y	Y	Y	Y	Y
Groups similar at baseline regarding most important prognostic indicators	Y	Y	Y	Y	N
Co-interventions avoided or similar	N	N	N	Y	Y
Compliance acceptable in all groups	Y	Y	Y	Y	Y
Time of outcome assessment in all groups similar	Y	Y	Y	Y	Y
Score	7/12	7/12	7/12	11/12	10/12

Y: Yes, N: No, U: Unclear. Source: Furlan AD, Pennick V, Bombardier C, van Tulder MI; Editorial Board, Cochrane Back Review Group. 2009 updated method guidelines for systematic reviews in the Cochrane Back Review Group. Spine (Phila Pa 1976) 2009; 34: 1929-41 [44].

Table 3. Description of Study Characteristics of Randomized Fusion and Epidural Trials in Lumbar Discogenic Pain

Study Study characteristics Methodological quality scoring	Patients/interventions	Outcome measures	Pain relief and function				Results	Comment(s)
Epidural								
			3 months	**6 months**	**12 months**	**2 years**		
Manchikanti et al. [53] RA, AC, F Caudal 11/12	Total = 120 Lidocaine = 60 Lidocaine with steroids = 60 Lidocaine vs. lidocaine mixed with steroid Number of injections = 1 to 5	NRS, ODI, employment status, functional status, opioid intake Successful category was defined as at least 3 weeks of significant improvement with the first 2 procedures. Significant improvement: 50% improvement in pain and function.	Overall: LA 60% vs. LA with steroid 72% Successful: LA 87% vs. LA with steroid 88%	Overall: LA 62% vs. LA with steroid 72% Successful: LA 89% vs. LA with steroid 93%	Overall: LA 55% vs. LA with steroid 68% Successful: LA 84% vs. LA with steroid 85%	Overall: LA 54% vs. LA with steroid 60% Successful: LA 84% vs. LA with steroid 73%	Pain and functional status improvement. For 2 years with repeat procedures with or without steroids.	Positive randomized double-blind trial There was no placebo control group Repeat injections were administered with return of pain
Manchikanti et al. [55] RA, AC, F Lumbar interlaminar 10/12	Total = 120 Local anesthetics = 60 Local anesthetics and steroids = 60 Lidocaine alone or with Celestone Number of injections = 1 to 5	NRS, ODI, employment status, opioid intake, significant improvement 50% or greater of NRS scores and ODI scores Successful category was defined as at least 3 weeks of significant improvement with the first 2 procedures. Significant improvement: 50% improvement in pain and function.	Overall: LA 83% vs. LA with steroid 77% Successful: LA 90% vs. LA with steroid 86%	Overall: LA 72% vs. LA with steroid 75% Successful: LA 78% vs. LA with steroid 83%	Overall: LA 77% vs. LA with steroid 67% Successful: LA 84% vs. LA with steroid 71%	Overall: LA 72% vs. LA with steroid 67% Successful: LA 78% vs. LA with steroid 70%	Pain and functional status improvement. For 2 years with repeat procedures with or without steroids.	Positive results in a large active control trial There was no placebo control group Repeat injections were administered with return of pain
Lumbar fusion vs. nonsurgical treatment								
Brox et al. [47,48] RA, AC 7/12	Total number of patients = 124 Lumbar instrumented transpedicular fusion = 66 Cognitive intervention and exercise = 58	ODI, pain, general function, global back disability assessment, overall rating, work and medication, emotional distress, fear-avoidance beliefs, and life satisfaction. Follow-up: 48 months	**One year** At the one-year follow-up visit, the ODI was significantly reduced from 41 to 26 after surgery, compared with 42 to 30 after cognitive intervention and exercises. The success rate was 70% after surgery and 76% after cognitive intervention and exercises.		**4 years** At 4 years, no significant difference in either lumbar fusion group or cognitive intervention group. There was no significant difference between fusion and cognitive intervention group with outcomes. With functional status there was no difference in return to work. 23% of patients assigned to fusion had undergone repeat surgery. 24% of the patients randomly assigned to cognitive intervention and exercise had undergone surgery. Long-term improvement was not better after instrumented transpedicular fusion compared with cognitive intervention and exercises.		At the end of one-year, the success rate was 70% after surgery and 76% after cognitive intervention and exercises. The early complication rate in the surgical group was 18%. Over a period of short-term as well as long-term follow-ups of one-year and 4 years, there were no significant differences in either lumbar fusion group or the cognitive intervention group.	In this fairly large trial, there was no significant difference between lumbar instrumented transpedicular fusion compared to cognitive intervention and exercise.

Table 3. Continued

Study Study characteristics Methodological quality scoring	Patients/interventions	Outcome measures	Pain relief and function		Results	Comment(s)
Fritzell et al. [49] RA, AC 7/12	Total included = 294 Surgical group = 222 Nonsurgical group = 72 Surgical fusion with autologous bone from iliac crest with PLIF or ALIF. Nonsurgical treatment, physical therapy supplemented with other forms of treatment such as information and education, treatment aimed at pain relief with TENS, cognitive and functional training, and coping strategies.	ODI, Million Score, GFS, Zung Depression Scale Follow-up: 24 months or 2 years	**12 months** Oswestry scores pain reduced 33% and 7% Overall a larger number of patients in the surgical group 63% rated themselves as much better or better compared with 29% in the nonsurgical group. The net back to work rate was significantly in favor of surgical treatment or 36% versus 13%. The early complication rate in the complication rate in the surgical group was 17%.	**1–2 years** At the 2 year follow-up, back pain was reduced in the surgical group by 33%, compared with 7% in the nonsurgical group. Pain improved most during the first 6 months and then gradually deteriorated. Disability according to Oswestry was reduced by 25% and 6%.	Authors concluded that lumbar fusion in a well informed and selected group of patients with severe chronic low back pain can diminish pain and decrease disability more effectively than commonly used nonsurgical treatment. In the analysis including the follow-up at 6 and 12 months, there was a highly significant reduction of both back and leg pain in the surgical group on all measuring points compared with the preoperative baseline values and also compared with the nonsurgical group. The back pain components in the nonsurgical group also improved significantly, but to a much lesser extent.	Even though this is a large randomized trial, the number of patients in the conservative group was small. Further, uniform cognitive modalities were not applied. The improvement was only borderline without significant improvement of 50% at any time.
Fairbank et al. [50] RA, AC 7/12	Surgery = 176 Rehabilitation = 173	ODI, shuttle walking text, SF-36 Follow-up: 24 months	**2 years** Both groups reported reductions in disability during 2 years of follow-up. At 24 months ODI changed favorably in the surgery and rehabilitation group. The mean ODI changed favorably from 46.1 to 34 in the surgery group and from 44.8 to 36.1 in the rehabilitation group. The estimated mean difference between the groups was -4.1 in favor of surgery [P = 0.045]. There were no significant differences between the treatment groups in the shuttle walking test or any of the other outcome measures.		This is a large randomized trial with equal apportionment of the patients with appropriate nonsurgical management. Both groups showed reductions in disability. Intensive rehabilitation: Daily outpatient program of education and exercise running on 5 days per week for 3 weeks continuously. The surgical technique was left to the choice of the surgeon with highly variable approaches with and without implants, with interbody cages and bone graft material.	Overall the results are equivalent in both groups. No clear evidence emerged that primary spinal fusion surgery was anymore beneficial than intensive rehabilitation. Further, authors also concluded that both groups reported reductions in disability during 2 years of follow-up, possibly unrelated to the interventions.

RA: Randomized, AC: Active Control, F: Fluoroscopy, NRS: Numeric Rating Scale, ODI: Oswestry Disability Index, LA: Local Anesthetic, GFS: General Function Score, ALIF: Anterior Lumbar Interbody Fusion, PLIF: Posterior Lumbar Interbody Fusion, TENS: Transcutaneous Electrical Nerve Stimulation, Short-Form Health Survey: SF-36.

There were 2 epidural trials assessing the efficacy of epidural injections in lumbar discogenic pain: these included 2 caudal trials and one lumbar interlaminar trial meeting the inclusion criteria for methodological quality assessment. These trials [53,55] utilized a randomized, active-control design in a practical interventional pain management setting. All the patients received appropriate evaluation with controlled diagnostic blocks to eliminate facet joint pain and sacroiliac joint pain. Additionally, disc herniation and lumbar radiculitis were also excluded. In these trials, the authors utilized robust outcome measures with at least a 50% improvement in pain relief and functional status measured with the Numeric Rating Scale (NRS) and ODI. All of the outcomes were assessed at 3, 6, 12, 18, and 24 months posttreatment. Significant improvement of 50% or more of pain and function was observed in 72% of patients receiving local anesthetic only and 67% of patients receiving local anesthetic with steroids at the end of 2 years in the lumbar interlaminar epidural injection group. However, when only responsive patients were considered, the outcomes improved to 78% and 70% with local anesthetic only or with local anesthetic with steroids. In the caudal group significant improvements were also observed in 54% of the patients in the local anesthetic only group and 60% of the patients in the local anesthetic with steroid group showing improvement at 24 months when all patients were considered; however, when only responsive or successful patients were considered, 84% of the patients in the local anesthetic only group and 73% in the local anesthetic with steroid group showed significant improvement in pain relief and functional status improvement. In both groups, the proportion of patients with improvement were similar with a slightly higher number when only local anesthetics were used. However, a striking difference between the two approaches was that in the caudal epidural injection group there were 23 patients in the nonresponsive group who received local anesthetic only; 19 patients who received local anesthetic with steroid had a 35% nonresponsive rate. In contrast, in the lumbar interlaminar epidural group there were only 11 patients, with 5 in the local anesthetic only group and 6 in the local anesthetic with steroid group for a 9% nonresponsive rate. Consequently, it can be hypothesized that a lumbar interlaminar epidural injection may be efficacious since the drug can be delivered to target structures which might be at a higher level than the solution reaches with caudal epidural injections.

3. Meta-analysis

Meta-analysis was not available since there were only 2 trials for epidural injections: one caudal and one interlaminar with 2 different approaches. There were 3 trials assessing the effectiveness of lumbar fusion compared with nonsurgical treatments. All 3 trials varied in their fusion techniques as well as cognitive rehabilitation techniques. Thus, there was no homogeneity among the trials. Consequently, no meta-analysis was feasible.

4. Analysis of evidence

The evidence for caudal epidural injections in managing lumbar discogenic pain was Level II for long-term improvement based on 2 high-quality, relevant positive fluoroscopic epidural trials [53,55] without negative trials.

The evidence for lumbar fusion based on 3 moderate-quality relevant RCTs is Level III-IV with 2 of the 3 trials [47,48,50] providing no significant improvement with fusion and only one trial [49] providing marginally better results without robust outcomes.

DISCUSSION

This systematic review comparing epidural injections and fusion in managing lumbar discogenic pain, based on a high quality methodological quality assessment and qualitative evidence synthesis of 3 trials comparing lumbar fusion with conservative management, and 2 trials utilizing epidural injections for management of discogenic pain, shows that caudal and lumbar interlaminar epidural injections with or without steroids provide effective and significant improvement in pain and function in lumbar discogenic pain with long-term results, with Level II evidence for caudal and interlaminar approaches. However, the evidence for fusion appears to be Level III-IV, based on significant improvements of 50% or more at the end of 2 years, applying the same criteria as epidural injections with a lack of efficacy demonstrated by RCTs comparing fusion with conservative management. However, considering a low 15% improvement as success, the evidence may be considered Level III-IV based on 3 randomized trials of moderate quality, with only one trial providing marginally better results than conservative management.

There were no direct comparative trials comparing fu-

sion with epidural injections or disc arthroplasty with conservative management in managing discogenic pain. Thus, it appears that epidural injections may be superior to surgical fusion based on the available evidence with demonstration of cost utility [56]. Further, it is essential to take into consideration not only the costs, but also the complications of surgical interventions, including reoperation. Additional studies should include an economic analysis of costs, risks, and success of the various options for discogenic back pain. A rationale algorithm would include costs, outcomes, and risks of the proposed therapies. In this analysis, given the high success of epidural injections, the low costs and risks, when compared to surgical intervention epidurals should be considered early in a treatment continuum.

The evidence in this systematic review, while similar to previous systematic reviews, also is contradictory to multiple systematic reviews [8,9,12,29,57,58].

Multiple systematic reviews conducted in the past have sought to determine whether the fusion of the lumbar spine is superior to nonoperative management for the improvement of discogenic back pain. Mirza and Deyo [58] concluded that surgery may be more efficacious than unstructured nonsurgical care for chronic back pain, but may not be more efficacious than structured cognitive-behavioral therapy. Saltychev et al. [12], in their systematic review, concluded that there was strong evidence that lumbar fusion was not more effective than conservative treatment in reducing perceived disability because of chronic low back pain among patients with degenerative spinal diseases. Phillips et al. [8], in a systematic review of lumbar spine fusion for chronic low back pain due to degenerative disc disease, compiled and analyzed the currently available published literature on fusion as of July 2011, on fusion for chronic back pain with underlying disc degeneration, updating the evidence with recent studies, and broadening the scope of prior reviews to include a range of study designs beyond RCTs. In this extensive assessment, they included a total of 3,060 patients with a weighted average improvement and visual analog scale of back pain of 36.8 of 100, ODI of 22.2, with average satisfaction of 71.1 across the studies. They also showed radiographic fusion rates averaged 89.1% with a reoperation rate of 12.5%. They concluded that this body of literature supports fusion surgery as a viable treatment option for reducing pain and improving function in patients with chronic low back pain refractory to nonsurgical care when a diagnosis of disc degeneration can be made. However, multiple deficiencies may exist in this systematic review due to the inclusion of duplicate studies, thus increasing the number of patients assessed, as well as the inclusion of variable designs with highly variable surgical interventions, and conservative management with homogeneity. Bydon et al. [9], in contrast, concluded that despite the significant improvement in ODI in the lumbar fusion group in 3 studies, pooled data revealed no significant difference when compared with a nonoperative group. They included 5 RCTs meeting inclusion criteria; however, it appears that they may have included duplicate trials. Further, these trials lacked homogeneity to conduct a metaanalysis. Even then, the results were still equal between lumbar fusion and nonoperative management. They also showed that there was an overall improvement of 7.39 points in the ODI in favor of lumbar fusion [superior], however, it was unclear that this minuscule change in ODI would have led to a clinically significant difference. They also concluded that prospective randomized trials comparing a specific surgical technique versus a structured physical therapy program may improve evidence quality. Surprisingly, they also concluded that until then, either operative intervention by lumbar fusion or nonoperative management and physical therapy remained 2 acceptable treatment methods for intractable low back pain.

However, there are no systematic reviews, randomized trials, or observational studies comparing epidural injections as part of nonsurgical management in conjunction with other conservative modalities.

There was a single systematic review of nonoperative management of discogenic back pain [29]. In this assessment they identified 11 RCTs investigating traction therapy, injections, and ablative techniques. Results from 5 RCTs investigating methylene blue injection, steroid injection, ramus communicans ablation, intradiscal electrothermal therapy, and biacuplasty favored intervention over sham therapy. In this assessment, the trial by Manchikanti et al. [52] of caudal epidural injections was utilized and the level of evidence was 1.

Epidural injections are not only clinically effective, but also have been shown to be cost effective with caudal epidural injections with a cost utility assessment of $2,136 per quality-adjusted life-year (QALY) [56].

The limitations of this review include a paucity of liter-

ature without trials of disc arthroplasty comparing epidural injections to surgical trials, comparing to nonsurgical trials, and the inability to perform a metaanalysis due to a lack of homogeneity, either among epidural injections or lumbar fusion trials. All of the evidence is obtained from active control trials with epidural injections as well as for fusion. In this study, we utilized strict methodological quality assessment criteria and also had strict inclusion criteria with at least 25 patients in each group. Some may consider this as a deficiency as we have not eliminated one RCT from fusion and 2 RCTs from epidurals; however, size and quality are important conclusions and also provide strength to the systematic review.

In accordance with our objective of determining comparative efficacy, we have shown Level II evidence for epidural injections for long-term efficacy in managing chronic lumbar discogenic pain without facet joint or sacroiliac joint pain and also without disc herniation or radiculitis utilizing controlled diagnostic blocks and imaging in addition to symptomatology and physical findings. The continued debate in reference to the efficacy of epidural injections may be based on improper assessment utilizing local anesthetic as placebo and performing a meta-analysis on these trials without homogeneity which ultimately yielded inappropriate results [6,35-37,42,57-61].

In conclusion, fluoroscopically-directed epidural injections have been shown to be effective with Level II evidence with or without steroids, whereas, lumbar fusion, based on one moderate quality trial considered as borderline, showed effectiveness at Level III-IV.

ACKNOWLEDGEMENTS

The authors wish to thank Vidyasagar Pampati, MSc, for statistical assistance, Tom Prigge, MA, and Laurie Swick, BS, for manuscript review, and Tonie M. Hatton and Diane E. Neihoff, transcriptionists, for their assistance in preparation of this manuscript.

CONFLICT OF INTEREST

Dr. Hirsch is a consultant for Medtronic.

Dr Staats Is a Consultant for Medtronic, Boston Scientific, St Jude, Electrocore Medical, Currently is involved in research funded by Boston Scientific, St Jude, Spinal Modulation, Vertos.

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Appendix 1. Randomized controlled trials quality rating system of Cochrane reviews

A	1. Was the method of randomization adequate?	A random (unpredictable) assignment sequence. Examples of adequate methods are coin toss (for studies with 2 groups), rolling a dice (for studies with 2 or more groups), drawing of balls of different colors, drawing of ballots with the study group labels from a dark bag, computer-generated random sequence, pre-ordered sealed envelopes, sequentially-ordered vials, telephone call to a central office, and pre-ordered list of treatment assignments. Examples of inadequate methods are alternation, birth date, social insurance/ security number, date in which they are invited to participate in the study, and hospital registration number.	Yes/No/Unsure
B	2. Was the treatment allocation concealed?	Assignment generated by an independent person not responsible for determining the eligibility of the patients. This person has no information about the persons included in the trial and has no influence on the assignment sequence or on the decision about eligibility of the patient.	Yes/No/Unsure
C	Was knowledge of the allocated interventions adequately prevented during the study?		
	3. Was the patient blinded to the intervention?	This item should be scored "yes" if the index and control groups are indistinguishable for the patients or if the success of blinding was tested among the patients and it was successful.	Yes/No/Unsure
	4. Was the care provider blinded to the intervention?	This item should be scored "yes" if the index and control groups are indistinguishable for the care providers or if the success of blinding was tested among the care providers and it was successful.	Yes/No/Unsure
	5. Was the outcome assessor blinded to the intervention?	Adequacy of blinding should be assessed for the primary outcomes. This item should be scored "yes" if the success of blinding was tested among the outcome assessors and it was successful or: – for patient-reported outcomes in which the patient is the outcome assessor (e.g., pain, disability): the blinding procedure is adequate for outcome assessors if participant blinding is scored "yes" – for outcome criteria assessed during scheduled visit and that supposes a contact between participants and outcome assessors (e.g., clinical examination): the blinding procedure is adequate if patients are blinded, and the treatment or adverse effects of the treatment cannot be noticed during clinical examination – for outcome criteria that do not suppose a contact with participants (e.g., radiography, magnetic resonance imaging): the blinding procedure is adequate if the treatment or adverse effects of the treatment cannot be noticed when assessing the main outcome – for outcome criteria that are clinical or therapeutic events that will be determined by the interaction between patients and care providers (e.g., co-interventions, hospitalization length, treatment failure), in which the care provider is the outcome assessor: the blinding procedure is adequate for outcome assessors if item "4" (caregivers) is scored "yes" – for outcome criteria that are assessed from data of the medical forms: the blinding procedure is adequate if the treatment or adverse effects of the treatment cannot be noticed on the extracted data.	Yes/No/Unsure
D	Were incomplete outcome data adequately addressed?		
	6. Was the drop-out rate described and acceptable?	The number of participants who were included in the study but did not complete the observation period or were not included in the analysis must be described and reasons given. If the percentage of withdrawals and drop-outs does not exceed 20% for short-term follow-up and 30% for long-term follow-up and does not lead to substantial bias, a "yes" is scored.	Yes/No/Unsure
	7. Were all randomized participants analyzed in the group to which they were allocated?	All randomized patients are reported/analyzed in the group they were allocated to by randomization for the most important moments of effect measurement (minus missing values), irrespective of non-compliance and co-interventions.	Yes/No/Unsure
E	8. Are reports of the study free of suggestion of selective outcome reporting?	In order to receive a "yes," the review author determines if all the results from all pre-specified outcomes have been adequately reported in the published report of the trial. This information is either obtained by comparing the protocol and the report, or in the absence of the protocol, assessing that the published report includes enough information to make this judgment.	Yes/No/Unsure
F	Other sources of potential bias:		
	9. Were the groups similar at baseline regarding the most important prognostic indicators?	In order to receive a "yes," groups have to be similar at baseline regarding demographic factors, duration and severity of complaints, percentage of patients with neurological symptoms, and value of main outcome measure(s).	Yes/No/Unsure
	10. Were co-interventions avoided or similar?	This item should be scored "yes" if there were no co-interventions or they were similar between the index and control groups.	Yes/No/Unsure
	11. Was the compliance acceptable in all groups?	The reviewer determines if the compliance with the interventions is acceptable, based on the reported intensity, duration, number, and frequency of sessions for both the index intervention and control intervention(s). For example, physiotherapy treatment is usually administered over several sessions; therefore, it is necessary to assess how many sessions each patient attended. For single-session interventions (e.g., surgery), this item is irrelevant.	Yes/No/Unsure
	12. Was the timing of the outcome assessment similar in all groups?	Timing of outcome assessment should be identical for all intervention groups and for all important outcome assessments.	Yes/No/Unsure

Adapted from: Furlan AD, Pennick V, Bombardier C, van Tulder; Editorial Board, Cochrane Back Review Group. 2009 updated method guidelines for systematic reviews in the Cochrane Back Review Group. Spine (Phila Pa 1976) 2009 ; 34 : 1929-41 [44].