Systematic Review and Meta-Analysis

An Updated Systematic Review and Meta-Analysis of Fluoroscopic Caudal, Interlaminar, and Transforaminal Epidural Injections in Lumbar Disc Herniation

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Disclaimer: There was no external funding in the preparation of this article.

Conflict of interest: See pg E586.

Article received: 06-25-2026
Accepted for publication: 07-21-2026

Free full article: www.painphysicianjournal.com

Background: Epidural injections are among the most frequently used interventions for management of low back and lower extremity pain. These injections are administered through caudal, interlaminar, and transforaminal approaches. Despite widespread use, controversy persists regarding effectiveness, appropriateness, medical necessity, and clinical indications. Although numerous studies have evaluated efficacy, there has been limited advancement in high-quality randomized evidence. In addition, multiple systematic reviews have repeatedly analyzed the same clinical trials, resulting in an evidence base that remains limited, inconsistent, and, at times, contradictory.

Objectives: To synthesize the latest clinical evidence evaluating the efficacy of the 3 epidural injection approaches: caudal, interlaminar, and transforaminal for the management of lumbar disc herniation.

Study Design: A systematic review and meta-analysis of randomized controlled trials (RCTs) evaluating transforaminal, interlaminar, and caudal epidural injections for management of chronic low back and lower extremity pain associated with lumbar disc herniation and radiculitis.

Methods: Randomized controlled trials with either placebo-controlled or active-controlled designs, performed under fluoroscopic guidance and including a minimum follow-up of 6 months, were identified and reviewed. Methodological quality was assessed using the Cochrane risk of-bias criteria and the Interventional Pain Management Techniques - Quality Appraisal of Reliability and Risk of Bias Assessment (IPM-QRB) for randomized therapeutic trials. The certainty of the evidence was evaluated using the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) framework. Levels of evidence were determined using best-evidence synthesis with modified qualitative grading ranging from Level I to Level V.

A comprehensive literature search was conducted across multiple databases to identify publications from 2020 through March 2026. Additional studies were identified through manual searches of the bibliographies of relevant review articles, systematic reviews, and clinical guidelines. Eligible trials underwent quality assessment and were incorporated into both qualitative and quantitative evidence synthesis.

Outcome Measures: The primary outcome measure was proportion of patients achieving significant pain relief and functional improvement, defined as at least a 50% improvement sustained for at least 3 months. Duration of benefit was categorized as short-term relief (< 6 months) or long-term relief (≥ 6 months).

Results: A total of 21 trials met the inclusion criteria. Among these, 7 evaluated caudal epidural injections, 13 evaluated transforaminal epidural injections, and 10 evaluated lumbar interlaminar epidural injections. Qualitative and quantitative analyses included conventional dual-arm and single-arm analyses for interlaminar epidural injections, as well as single-arm analyses for caudal

and transforaminal epidural injections, depending on the approach to the epidural space. In the dual-arm analysis of interlaminar injections, the addition of steroids was favored for pain relief at 6 and 12 months, with no significant difference in function. The findings demonstrated Level I evidence supporting the use of local anesthetic with steroids and Level II evidence supporting local anesthetic alone for both transforaminal and interlaminar approaches. For the caudal approach, Level II evidence supported both local anesthetics with steroids and local anesthetics alone for achieving short-term and long-term relief.

Limitations: Available literature remains limited, with few studies reporting intermediate- or long-term outcomes of at least 6 months using appropriate outcome measures. Conventional dual-arm meta-analysis was feasible only for interlaminar epidural injections. Heterogeneity was high in nearly all pooled analyses.

Conclusion: Epidural injections using local anesthetic with steroids demonstrated Level I evidence for both transforaminal and interlaminar approaches, whereas local anesthetic alone demonstrated Level II evidence. Caudal epidural injections provided Level II evidence for both local anesthetics with steroids and local anesthetics alone.

Key words: Chronic low back pain, lumbar radiculopathy, lumbar disc herniation, sciatica, epidural injections, local anesthetic, steroids, caudal epidural injections, interlaminar epidural injections, transforaminal epidural injections.

Pain Physician 2026: 29:E553-E590

The clinical use of epidural injections for management of low back and lower-extremity pain has been evaluated in multiple randomized controlled trials (RCTs), systematic reviews, and evidence-based guidelines, with numerous publications since 2020 (1-33). In addition, several reviews have examined utilization patterns, expenditures, cost-utility, and other issues related to clinical practice (34-39). Analyses of utilization patterns have demonstrated a decline in both epidural injection use and associated expenditures for the management of chronic spinal pain between 2001 and 2024 (6,7,34,38,39).

A recent publication by Manchikanti et al (7) reported a 13% decline in utilization of epidural procedures for chronic spinal pain management in the traditional Medicare population from 2019 to 2024. Consistent with previous analyses, procedural services increased by 144%, and rates per 100,000 beneficiaries by 103%, between 2000 and 2010, followed by a decline from 2010 to 2019, during which procedural services decreased by 9.5%. However, patient episodes declined by only 0.4% during that period. From 2019 to 2024, procedural rates declined by 13%, while episode rates decreased by 11.9%, corresponding to average annual reductions of 2.8% and 2.6%, respectively. Both these data and earlier publications have described multiple challenges faced by independent physicians, including increasing financial pressures that threaten the sustainability of independent practice (34-39).

Several systematic reviews have evaluated the role of epidural injections and reached conflicting conclusions (1-5,8-27). Many of these reviews have compared different routes of administration, as well as saline placebo, local anesthetic alone, and local anesthetic with steroids. In 2020, Oliveira et al (25) published a Cochrane systematic review evaluating epidural corticosteroid injections for lumbosacral radicular pain. That review included 25 placebo-controlled trials and concluded that based on moderate-quality evidence, epidural corticosteroid injections provide small, short-term benefits. However, the authors considered substances injected into the epidural space or surrounding spinal tissues to be appropriate placebos if they were inert (e.g., no pharmacological activity), innocuous (e.g., normal saline), or pharmacologically active but presumed not to provide sustained benefit (e.g., local anesthetic). This interpretation contradicts substantial evidence demonstrating the anti-inflammatory properties of local anesthetics, as well as their ability to provide sustained pain relief and improve clinical outcomes (1,18,19). By assuming that epidural lidocaine does not provide a durable therapeutic benefit, Oliveira et al treated local anesthetics as a placebo, resulting in an interpretation that differs from subsequent analyses of the same evidence.

In contrast, Manchikanti et al. (19) re-evaluated the Cochrane dataset in 2022 using qualitative and quantitative methods, including both dual-arm and single-arm analyses, for RCTs evaluating epidural injections for chronic low back and lower-extremity pain associated with sciatica or lumbar radiculopathy. Although the same RCTs were included, only 10 of the 25 studies had been performed under fluoroscopic guidance. Shanthanna et al (26) also conducted an extensive review of the addition of corticosteroids to local anesthetics for non-cancer pain injections. They concluded that

corticosteroids provided only small additional benefits while introducing potential harm, and further recognized that local anesthetic injections alone may have therapeutic value beyond their diagnostic role.

In addition, Manchikanti et al (18) conducted a systematic review evaluating 3 categories of epidural injections for lumbar radiculopathy or sciatica: saline with steroids, local anesthetic alone, and local anesthetic with steroids. Using both conventional dual-arm and single-arm meta-analyses, they reached conclusions that differed substantially from those of the Cochrane review. The overall evidence was graded as Level I (strong evidence) at 1 and 3 months and Level II (moderate evidence) at 6 and 12 months. Their analysis demonstrated significant effectiveness of epidural injections with or without steroids for radiculopathy, with Level I evidence supporting local anesthetic with steroids and Level II to Level I evidence supporting local anesthetic alone.

In 2022, Fang et al (20) compared local anesthetics with steroids versus local anesthetics alone for the treatment of degenerative disc disease. They concluded that the addition of steroids resulted in superior pain relief and functional outcomes during the first year, with functional improvement continuing through 2 years. Knezevic et al (17) demonstrated that the parasagittal approach is an effective and safe alternative to the midline approach for interlaminar epidural injections, providing greater pain relief and improved functional outcomes following the procedure.

Among more recent publications, Zhang et al (10) reported that epidural steroid injections provide significant short-term to medium-term relief of sciatica caused by lumbar disc herniation and recommended them as a viable treatment option. Zhu et al (21), in a systematic review evaluating the effectiveness of epidural steroid injections for low back pain in older adults across multiple study designs, concluded that lumbar epidural steroid injections may reduce pain and improve functional status, particularly when compared with medication management. In contrast, Zhu et al (8), in a systematic review with network meta-analysis of non-surgical interventions for chronic sciatica, concluded that the evidence regarding the effectiveness of non-surgical treatments remains highly uncertain. Similarly, de Bruijn (22), in a systematic review and meta-analysis of the clinical relevance of epidural steroid injections for lumbosacral radicular syndrome, analyzed 17 studies and concluded that there was insufficient evidence to support clinically meaningful benefits at any follow-up interval.

More recently, a systematic review conducted by the American Academy of Neurology Guidelines Subcommittee concluded that epidural steroid injections provide only probable short-term benefit for radicular pain, with insufficient evidence supporting long-term relief (30). In contrast, a network meta-analysis comparing the 3 epidural approaches for lumbosacral disc herniation suggested a potential advantage for the transforaminal approach (31). Furthermore, a comprehensive evidence synthesis including 72 randomized controlled trials reaffirmed the overall short-term effectiveness of epidural steroid injections for sciatica secondary to lumbar disc herniation (32).

Gill et al (23), in a systematic review and meta-analysis that included randomized controlled trials, prospective studies, and retrospective studies, identified 41 eligible studies and found that transforaminal epidural injections produced the greatest pain relief and functional improvement. However, they also emphasized that substantial heterogeneity among studies highlights the need for standardized treatment protocols and additional high-quality research.

Among studies directly comparing the 3 epidural approaches, Manchikanti et al (27) published a systematic review and meta-analysis in 2021 that included 21 trials, comprising 7 studies of caudal epidural injections, 12 of transforaminal epidural injections, and 10 of lumbar interlaminar epidural injections. They concluded that epidural injections with local anesthetic and steroids provided Level I evidence for both transforaminal and interlaminar approaches, whereas local anesthetic alone demonstrated Level II evidence. Caudal epidural injections demonstrated Level II evidence for both local anesthetic with steroids and local anesthetic alone.

The purpose of the present systematic review and meta-analysis is to update the available evidence and evaluate the efficacy, or lack thereof, of epidural injections using saline, local anesthetic alone, or local anesthetic with steroids across the caudal, interlaminar, and transforaminal approaches.

Methods

A systematic review and meta-analysis was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (40). Additional methodological approaches from previously published systematic reviews were also incorporated (1,41-51).

Data Sources and Searches

A comprehensive literature search was conducted through March 2026. In addition, all studies included in previous epidural injection guidelines and systematic reviews were reviewed for eligibility and inclusion.

Study Selection

Predefined inclusion criteria required RCTs with either placebo-controlled or active-controlled designs, performed under fluoroscopic guidance, and reporting outcomes with a minimum follow-up of 6 months. The present review included epidural injections using sodium chloride solution, local anesthetic, or steroids administered through caudal, interlaminar, or transforaminal approaches. Prespecified outcome measures included assessments of pain and functional status, with composite outcomes defined as a 50% or greater improvement in both pain and function.

Data Extraction and Methodologic Quality Assessment

Data extraction and quality assessment methods were adapted from a previously published systematic review (27), with updated procedures for extraction and evaluation. Methodologic quality was assessed using the Cochrane review criteria (Appendix Table 1, 52) and the Interventional Pain Management Techniques - Quality Appraisal of Reliability and Risk of Bias Assessment (IPM-QRB) criteria (Appendix Table 2, 53).

Data Synthesis and Analysis

Data were synthesized using both qualitative and quantitative methods. The overall strength of evidence for the qualitative analysis was assessed using best-evidence synthesis, as shown in Table 1 (54).

Dual-Arm Meta-Analysis

Dual-arm meta-analysis was performed with a DerSimonian-Laird random-effects model, using Hedges g, in Python, version 3 (Python Software Foundation). Changes from baseline in pain and function were analyzed as standardized mean differences (SMD) with 95% confidence intervals (CI). Treatment effects were presented in forest plots using a random-effects model. Statistical heterogeneity was assessed using the I^2 statistic.

Single-Arm Meta-Analysis

Single-arm meta-analysis was performed with a DerSimonian-Laird random-effects model in Python, version 3 (Python Software Foundation). Pain and functional improvement outcomes were analyzed as mean differences with 95% confidence intervals, using a random-effects model. Disability scores were converted to a common 0 to 100 scale. When the standard deviation of change was not reported, it was imputed from the baseline and follow-up standard deviations assuming a correlation of 0.5. Data presented only in figures were digitized. Treatment effects were presented using forest plots. Statistical heterogeneity was assessed using the I^2 statistic.

Both qualitative and quantitative analyses were performed to evaluate the direction and magnitude of treatment effects. For placebo-controlled trials, the net treatment effect between the 2 groups was analyzed. For active-controlled trials, treatment effects were determined by comparing baseline values with follow-up outcomes.

Trials that met the inclusion criteria and achieved a score of 9 or higher out of 13 based on the Cochrane review criteria (52) were classified as high quality. Trials with scores between 5 and 8 were considered moderate quality, whereas those scoring below 5 were classified as low quality and were excluded from the analysis.

All included trials were also assessed using the IPM-QRB criteria (53). Studies with scores between 32 and 48 were considered high quality, those scoring between 16 and 31 were classified as moderate quality, and studies with scores below 16 were considered low quality and excluded from the analysis.

Table 1. *Qualitative modified approach to grading of evidence of therapeutic effectiveness of studies.*

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

Modified from: Manchikanti L et al. A modified approach to grading of evidence. *Pain Physician* 2014; 17:E319-E325 (54).

Assessment Utilizing Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) Criteria

The Grading of Recommendations, Assessment, Development and Evaluation (GRADE) framework is a transparent and systematic approach for summarizing evidence and developing clinical practice recommendations (55). It is the most widely used framework for evaluating the certainty of evidence and informing healthcare recommendations.

GRADE classifies the certainty of evidence into 4 levels: very low, low, moderate, and high, as shown in Table 2 (55). The certainty of evidence is determined by evaluating factors including risk of bias, imprecision, inconsistency, indirectness, and publication bias. These factors may either increase or decrease confidence in the overall evidence. The criteria for upgrading or downgrading the certainty of evidence are summarized in Table 3 (55).

The methodological quality assessment of the included trials and the GRADE appraisal were performed independently by two authors (RNJ and MRS) in an unblinded manner. Any disagreements were resolved through consultation with a third author (ADK). When a potential conflict of interest related to study authorship was identified, the authors involved were excluded from the quality assessment of the respective studies.

Outcome Measures

The primary outcome was the proportion of patients achieving at least 50% improvement in pain and function, sustained for at least 3 months. An outcome was considered clinically significant if there was a reduction of at least 2 points on the Visual Analog Scale (VAS) or Numeric Rating Scale (NRS), or a reduction in pain of at least 50% accompanied by improvement in functional status. A study was considered positive and effective if the primary outcome was statistically significant ($P \leq 0.05$).

Table 4 presents the strength of recommendations based on the National Guideline Clearinghouse Extent of Adherence to Trustworthy Standards (NEATS) instrument, as modified by the guideline panel (42-45).

Analysis of Evidence

The evidence was evaluated using both qualitative and quantitative synthesis methods. Quantitative synthesis was performed using conventional meta-analysis and single-arm meta-analysis.

Results

Figure 1 illustrates the literature search process and selection of studies for inclusion. After full-text review and removal of duplicate publications, 27 trials were identified for consideration (28,29,56-80). Of these, 21 trials met the predefined inclusion criteria (59-80). None of the newly identified trials (28,29,56-58) met the inclusion criteria, primarily because of insufficient long-term follow-up. Among the included studies, 7 evaluated caudal epidural injections (59,60,69-73), 10 evaluated interlaminar epidural injections (61-63,69,71,72,74-77), and 13 evaluated transforaminal epidural injections (64-69,71-75,78-80).

Among the 21 included trials (59-80), one was a placebo-controlled trial (64), one compared epidural steroid injection with conservative management (60), 7 compared local anesthetic alone with local anesthetic plus steroids (59,61-63,65,66,68), one compared different types of steroids (80), and 6 compared different injection techniques (69,71-75). Among the technique comparison studies, 3 compared all 3 routes of administration (69,71,72), whereas 3 compared 2 routes of administration (73-75).

Table 2. *GRADE certainty ratings.*

Certainty	What it means
Very low	The true effect is probably markedly different from the estimated effect
Low	The true effect might be markedly different from the estimated effect
Moderate	The authors believe that the true effect is probably close to the estimated effect
High	The authors have a lot of confidence that the true effect is similar to the estimated effect

Source: BMJ Best Practice. Evidence-based medicine (EBM) toolkit. Learn EBM. What is GRADE? Accessed 1/27/2026. https://bestpractice-bmj-com.bibliotheek.ehb.be/info/evidence/learn-ebm/what-is-grade/ (55)

Table 3. *Reasons rate certainty in evidence up or down.*

Certainty can be rated down for:	Certainty can be rated up for:
• Risk of bias • Imprecision • Inconsistency • Indirectness • Publication bias	• Large magnitude of effect • Dose-response gradient • All residual confounding would decrease magnitude of effect (in situations with an effect)

Source: BMJ Best Practice. Evidence-based medicine (EBM) toolkit. Learn EBM. What is GRADE? Accessed 1/27/2026. https://bestpractice-bmj-com.bibliotheek.ehb.be/info/evidence/learn-ebm/what-is-grade/ (55)

Table 4. *Guide for strength of recommendations as modified for American Society of Interventional Pain Physicians (ASIPP) guidelines.*

Rating for Strength of Recommendation	
Strong	There is high confidence that the recommendation reflects best practice. This is based on: a) strong evidence for a true net effect (e.g., benefits exceed harms); b) consistent results, with no or minor exceptions; c) minor or no concerns about study quality; and/or d) the extent the panelists' agreement. Other compelling considerations (discussed in the guideline's literature review and analyses) may also warrant a strong recommendation. ASIPP Adaptation: Consensus was achieved that there is high certainty that the net benefit is substantial providing strong recommendation. Recommendation: Strong
Moderate	There is moderate confidence that the recommendation reflects best practice. This is based on: a) good evidence for a true net effect (e.g., benefits exceed harms); b) consistent results, with minor and/or few exceptions; c) minor and/or few concerns about study quality; and/or d) the extent of panelists' agreement. Other compelling considerations (discussed in the guideline's literature review and analyses) may also warrant a moderate recommendation. ASIPP Adaptation: Consensus was achieved that there is high certainty that the net benefit is moderate or there is moderate certainty that the net benefit is moderate to substantial. Recommendation: Moderate
Weak	There is some confidence that the recommendation offers the best current guidance for practice. This is based on: a) limited evidence for a true net effect (e.g., benefits exceed harms); b) consistent results, but with important exceptions; c) concerns about study quality; and/or d) the extent of panelists' agreement. Other considerations (discussed in the guideline's literature review and analyses) may also warrant a weak recommendation. ASIPP Adaptation: The consensus achieved that there is potential improvement in certain individuals or groups of patients based on individual professional judgement and shared decision making. Recommendation: Weak

Adapted and modified from: Jue JJ et al. Developing and Testing the Agency for Healthcare Research and Quality's National Guideline Clearinghouse Extent of Adherence to Trustworthy Standards (NEATS) Instrument. *Ann Intern Med* 2019; 170:480-487 Source: (42-45).

Methodological Quality Assessment

Appendix Tables 3 and 4 present the methodological quality assessment scores for all included RCTs using the Cochrane review criteria (52) and the IPM-QRB criteria (53).

These findings highlight the value of the interventional pain management-specific IPM-QRB assessment, which yielded results that differed from those obtained using the Cochrane review criteria. Agreement between the Cochrane review and IPM-QRB scoring systems was observed in 18 of the 21 trials. In the remaining 3 trials (74,79,80), the IPM-QRB criteria assigned lower quality ratings than the Cochrane review criteria.

Effectiveness of Epidural Injections

The descriptive characteristics of the included studies evaluating transforaminal, interlaminar, and caudal epidural injections are presented in Tables 5 to 8.

Evidence Synthesis

Evidence synthesis was performed using both qualitative and quantitative analysis and was evaluated according to the GRADE criteria.

Quantitative Synthesis (Meta-Analysis)

Meta-analysis was conducted using both conventional and single-arm approaches for transforaminal, interlaminar, and caudal epidural injections.

Placebo-Controlled Trials

Only one placebo-controlled trial met the inclusion criteria (64), and one additional trial compared epidural steroid injections with conservative management (60). Consequently, these studies were not included in the meta-analysis of active-controlled trials.

Active-Controlled Trials

A total of 19 trials used an active-controlled design. These studies underwent conventional meta-analysis when feasible, followed by single-arm meta-analysis.

Transforaminal Epidural Injections

Only one active-controlled trial met the inclusion criteria for conventional meta-analysis, along with one placebo-controlled trial. Consequently, conventional meta-analysis was not feasible. Therefore, single-arm meta-analysis was performed, as described below.

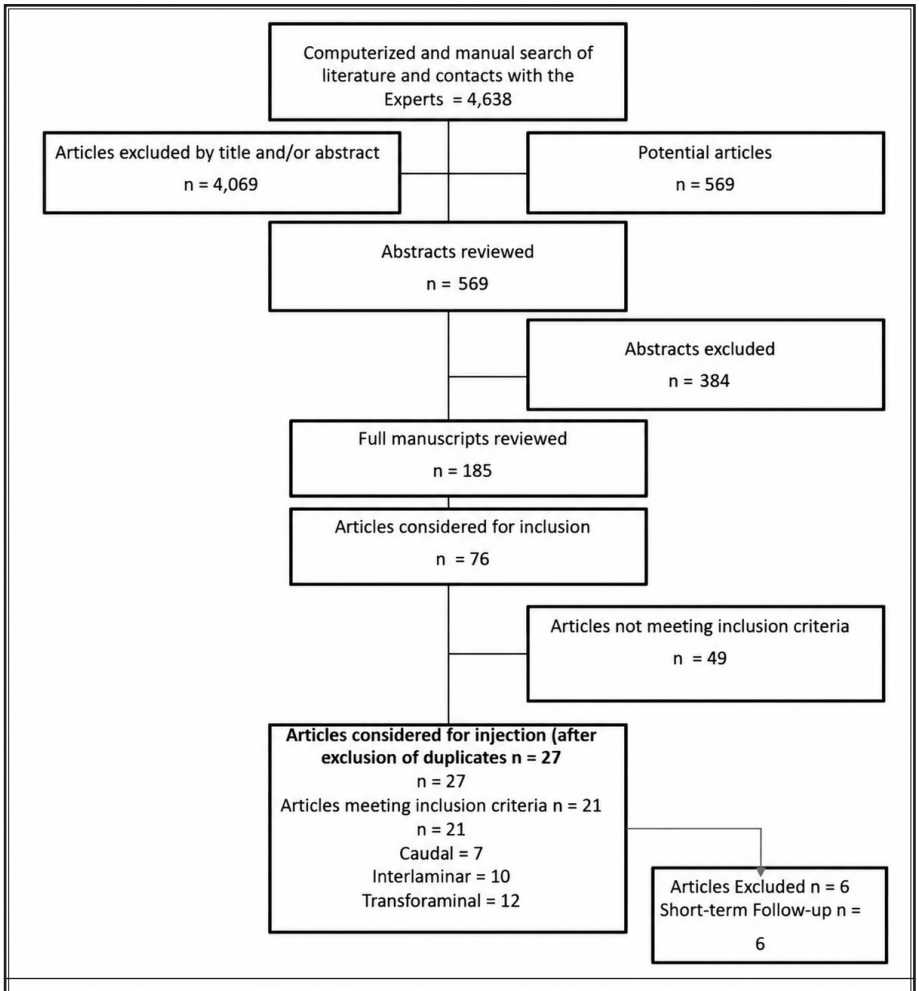


Fig. 1. *Flow diagram illustrating published literature evaluating epidural injection therapy in managing disc herniation, radiculopathy, or sciatica.*

Figure 2 presents the results of the single-arm meta-analyses evaluating the effects of transforaminal epidural steroid injections on pain and functional outcomes at 6 and 12 months.

In addition to analyzing the comparative treatment groups, all eligible studies were also analyzed regardless of their comparator, including comparisons based on injectate or injection technique, provided that appropriate data were available. This analysis was performed separately for transforaminal, interlaminar, and caudal epidural injections.

Figure 2A presents the results of the single-arm meta-analysis of steroid-treated groups from 6 trials (65,71,73-75,80) evaluating pain at 6 months using the Numeric Rating Scale (NRS) or Visual Analog Scale (VAS) following transforaminal epidural steroid injections. A total of 7 data points were included because one study (80) evaluated 2 different steroids. As shown in Fig. 2A, the pooled mean difference in pain score from baseline to 6 months was a reduction of 4.42 points (95% CI: -4.93 to -3.92; I^2 = 90%; $P < 0.001$).

Figure 2B presents the results of the single-arm meta-analysis of steroid-treated groups from 5 trials (65,71,73-75) evaluating functional outcomes at 6 months using the Oswestry Disability Index (ODI) or Roland-Morris Disability Questionnaire (RMDQ) following transforaminal epidural steroid injections. As shown in Fig. 2B, the pooled mean difference in functional scores from baseline to 6 months was a reduction of 25.71 points on a 0 to 100 scale (95% CI: -34.44 to -16.99; I^2 = 99%; $P < 0.001$).

Figure 2C presents the results of the single-arm meta-analysis of steroid-treated groups from 4 trials (65,73,75,78) evaluating pain at 12 months using the NRS or VAS following transforaminal epidural steroid injections. As shown in Fig. 2C, the pooled mean difference in pain score from baseline to 12 months was a reduction of 4.81 points (95% CI: -6.24 to -3.38; I^2 = 98%; $P < 0.001$).

Figure 2D presents the results of the single-arm meta-analysis of steroid-treated groups from 4 trials (65,73,75,78) evaluating functional outcomes at 12 months using the Oswestry Disability Index (ODI) or Roland-Morris Disability Questionnaire (RMDQ) following transforaminal epidural steroid injections. As shown in Fig. 2D, the pooled mean difference in functional scores from baseline to 12 months was a reduction of 36.81 points on a 0 to 100 scale (95% CI: -48.99 to -24.63; I^2 = 99%; $P < 0.001$).

As demonstrated in this analysis of transforaminal

Table 5. *Characteristics of fluoroscopic randomized trials of conservative or placebo or local anesthetic, or local anesthetic and steroids in transforaminal epidural injections in lumbar disc herniation.*

Study Study Characteristics Methodological Quality Scoring	Participants and Interventions	Outcome Measures	Pain Relief and Function				Results				Conclusion/ Comment(s)
			3 mos.	6 mos.	12 mos.	24 mos.	Short-term ≤ 6 mos.	Long-Term			
								> 6 mos.	≥ 12 mos.	24 mos.	
Karppinen et al, 2001 (64) RA, PC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 13/13 IPM-QRB = 34/48	Total=160 Methylpred-nisolone-bupivacaine = 80 Saline = 80 Sodium chloride solu-tion, or methylpred-nisolone (40 mg) and bupivacaine (5 mg) Number of injections = 1	VAS, ODI, Nottingham Health Profile, cost, physical examination Follow-up: 12 months with only initial procedures	A signifi-cant treat-ment effect in favor of saline treat-ment for back pain.	The treatment effects in both leg pain and back pain favored the saline treatment.	There were no treatment effects in favor of either treatment.	NA	Lack of effective-ness of steroid with bupivacaine	Lack of effective-ness of steroid with bupiva-caine	Lack of effective-ness of steroid with bupivacaine	NA	Negative Trial An ineffective or inap-propriate placebo design, without applicable results. Overall saline appears to have been superior at 3 months and 6 months, but no significant difference at one year between both groups. Leg pain decreased on average by 65% in both groups. Surgery was avoided in the majority of the patients with 18 patients in the steroid group and 15 in the saline group undergoing surgery.

Table 5 cont. *Characteristics of fluoroscopic randomized trials of conservative or placebo or local anesthetic, or local anesthetic and steroids in transforaminal epidural injections in lumbar disc herniation.*

Study Study Characteristics Methodological Quality Scoring	Participants and Interventions	Outcome Measures	Pain Relief and Function				Results				Conclusion/ Comment(s)
			3 mos.	6 mos.	12 mos.	24 mos.	Short-term ≤ 6 mos.	Long-Term			
								> 6 mos.	≥ 12 mos.	24 mos.	
Manchikanti et al, 2014 (65) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 11/13 IPM-QRB = 44/48	Total = 120 Lidocaine = 60 Lidocaine with steroids = 60 Lidocaine vs lidocaine mixed with steroid with infraneural approach Average number of injections = 5 to 6 for 2 years	NRS pain scale, ODI, employment status, opioid intake Responsive 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 75% vs LA with steroid 67% Responsive: LA 90% vs LA with steroid 82%	Overall: LA 73% vs LA with steroid 67% Responsive LA 88% vs LA with steroid 87%	Overall: LA 75% vs LA with steroid 57% Responsive LA 92% vs LA with steroid 73%	Overall: LA 65% vs LA with steroid 57% Re-sponsive LA 80% vs LA with steroid 73%	Effectiveness in both groups. Lidocaine alone or with steroids effective.	Effectiveness in both groups. Lido-caine alone or with steroids effective.	Effectiveness in both groups. Lidocaine alone or with steroids effective.	Effectiveness in both groups. Lidocaine alone or with steroids effective.	Positive Trial Similar results with local anesthetic or with local anesthetic and steroids. Nonresponsive patients: local anesthetic = 11, steroids = 15. Local anesthetics were somewhat superior, though not statistically significant. On average, a total of 5-6 injections were admin-istered over a period of 2 years.
Riew et al, 2000 & 2006 (66,67) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 9/13 IPM-QRB = 32/48	Total = 55 Bupivacaine alone (1 mL, 0.25%)=27 Bupivacaine (1 mL, 0.25%) with steroid (1 mL betamethasone)=28 Number of injections = 1-4	Need for operative treatment, North American Spine Society Questionnaire Follow-up: 1 months to 28 months	71% of steroid group chose not to have surgery and 33% of bupivacaine group chose not to have surgery	71% of steroid group chose not to have surgery and 33% of bu-pivacaine group chose not to have surgery	71% of steroid group chose not to have surgery and 33% of bupi-vacaine group chose not to have surgery	NA	*P*	*P*	*P*	NA	Positive Trial Epidural bupivacaine with steroids was significantly more effective than transforaminal bupivacaine with steroids was significantly more effective than epidural bupivacaine alone in avoiding surgery.

Table 5 cont.. *Characteristics of fluoroscopic randomized trials of conservative or placebo or local anesthetic, or local anesthetic and steroids in transforaminal epidural injections in lumbar disc herniation.*

Study Study Characteristics Methodological Quality Scoring	Participants and Interventions	Outcome Measures	Pain Relief and Function				Results				Conclusions/ Comment(s)
			3 mos.	6 mos.	12 mos.	24 mos.	Short-term ≤ 6 mos.	Long-Term			
								> 6 mos.	≥ 12 mos.	24 mos.	
Tafazal et al, 2009 (68) RA, AC, F Disc herniation or radiculopathy and spinal stenosis Quality Scores: Cochrane = 11/13 IPM-QRB = 32/48	Total: 150 patients Lumbar disc herniation: 76 Local anesthetic = 34 Local anesthetic with steroid = 42 Local anesthetic group: Injection of 2 mL of 0.25% bupivacaine Local anesthetic with steroid group: Injection of 2 mL of 0.25% bupiva-caine and 40 mg of methylprednisolone. Bupivacaine only: Lumbar disc herniation: 34 Foraminal stenosis: 25 Bupivacaine with steroids Lumbar disc herniation: 42 Foraminal stenosis: 23 Number of injections = 1 to 3	VAS, ODI, LBOS Avoidance of surgery Outcomes: 12 weeks 1 year for surgery Excellent outcome	ODI: LA 13.8 ± 3.7 versus LA with steroid 13.6 ± 3.1 VAS leg pain: LA 24.3 ± 5.5 versus LA with steroid 27.4.6 ± 4.7	NA	Disc herniation group showed greater reduction in the ODI with a mean change of 15 points from baseline of 46.6 in the bupivacaine only group and 43.4 in bupivacaine and steroid group. There was a mean change in the VAS of 26 mm in the disc prolapse group.	NA	Excellent to good outcomes in 54% Bupivacaine alone and bupivacaine with steroid are both effective	NA	The requirements for treatments were the same in local anesthetic alone group or local anesthetic with steroids. Overall surgery rates was 18%, the surgery rate was 22% in the bupivacaine only group and 14% in the bupivacaine and steroid group.	NA	Positive Trial Corticosteroid addition to local anesthetic failed to provide any additional benefit when compared to local anesthetic injection alone. There was no significant difference between both groups. Surgery was avoided in both groups.
Ackerman & Ahmad, 2007 (69) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 8/13 IPM-QRB = 25/48	Total = 90 Caudal = 30 Interlaminar = 30 Transforaminal = 30 Methylprednisolone + saline Number of injections = 1 to 3	Numeric pain score (0 – 10), rating of pain relief, ODI, BDI, contrast dispersion pattern Follow-up: 24 weeks	Caudal = 57% Interlaminar = 60% Transforaminal = 83%	Caudal = 57% Interlaminar = 60% Transforaminal = 83%	NA	NA	Effective in all arms	Effective in all arms	NA	NA	Positive Trial Positive mid-term results in a relatively small trial.

Table 5 cont. *Characteristics of fluoroscopic randomized trials of conservative or placebo or local anesthetic, or local anesthetic and steroids in transforaminal epidural injections in lumbar disc herniation.*

Study Study Characteristics Methodological Quality Scoring	Participants and Interventions	Outcome Measures	Pain Relief and Function				Results				Conclusion/ Comment(s)
			3 mos.	6 mos.	12 mos.	24 mos.	Short-term ≤ 6 mos.	Long-Term			
								> 6 mos.	≥ 12 mos.	24 mos.	
Kamble et al, 2016 (71) RA, AC, F Single level disc prolapse Quality Scores: Cochrane = 9/13 IPM-QRB = 32/48	Transforaminal = 30 Number of injections = 1-3 Interlaminar = 30 Number of injections = 1-3 Caudal = 30 Number of injections = 1-3	VAS, ODI	NA	Transforaminal = VAS baseline 7.1 ± 0.7 to 2.6 ± 0.7 ODI = 37.7 ± 2.83 to 16.8 ± 2.53 Interlaminar = VAS baseline 7.0 ± 0.7 to 3.4 ± 1.4 ODI = 36.9 ± 2.82 to 21.4 ± 6.08 Caudal = VAS baseline 7.2 ± 0.6 to 3.5 ± 1.0. ODI = 38.3 ± 2.78 to 21.9 ± 3.35	NA	NA	All 3 techniques were effective	NA	NA	NA	Positive Trial While all 3 techniques were effective, transforaminal group showed su-periority. However, there was no difference between caudal and interlaminar approaches.
Pandey, 2016 (72) RA, AC, F Disc prolapse Quality Scores: Cochrane = 8/13 IPM-QRB = 29/48	Total = 140 patients Caudal = 82 Transforaminal = 40 Interlaminar = 18 All were treated with steroid and local anesthetic with or without sodium chloride solution	JOA score	NA	JOA scores Caudal = baseline 15.39 to 24.30 Transforaminal = baseline 15.57 to 26.65 Interlaminar = baseline 15.33 to 25	JOA scores Caudal = baseline 15.39 to 24.02 Effectiveness = 74.3% Transforaminal = baseline 15.57 to 26.55 Effectiveness = 90% Interlaminar = baseline 15.33 to 24.72 Effectiveness = 77.7%	NA	*P*	*P*	*P*	NA	Positive Trial In comparing caudal epidural with interlaminar and transforaminal, authors showed response in 74.3% with caudal route, 77.7% with interlaminar, and 90% with transforaminal approach. Overall results are positive. There is no significant difference between caudal and interlaminar; however, transforaminal appears to be superior.
Rados et al, 2011 (74) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 9/13 IPM-QRB = 30/48	Total = 64 IL = 32 TF = 32 Lidocaine with methylprednisolone Number of injections = 1 to 3	VAS, ODI, 50% pain relief Follow-up: 6 months	NA	Interlaminar lidocaine with methylprednisolone = 53% Transforaminal lidocaine with methylprednisolone = 63%	NA	NA	Effective with both approaches	NA	NA	NA	Positive Trial Positive results with short follow-up period in comparison of 2 approaches with lidocaine with methylprednisolone

Table 5 cont. *Characteristics of fluoroscopic randomized trials of conservative or placebo or local anesthetic, or local anesthetic and steroids in transforaminal epidural injections in lumbar disc herniation.*

Study Study Characteristics Methodological Quality Scoring	Participants and Interventions	Outcome Measures	Pain Relief and Function				Results				Conclusion/ Comment(s)
			3 mos.	6 mos.	12 mos.	24 mos.	Short-term ≤ 6 mos.	Long-Term			
								> 6 mos.	≥ 12 mos.	24 mos.	
Ghai et al, 2014 (75) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 10/13 IPM-QRB = 42/48	Total = 62 Parasagittal interlaminar = 32 Transforaminal = 30 2 mL of methylprednisolone (80 mg) mixed with 2 mL of normal saline for both PIL and transforaminal groups Number of epidural steroid injections: Transforaminal group: 60 PIL group: 58 Average procedures: 2	Visual analog scale, Oswestry Disability questionnaire, significant improvement, greater than 50% pain relief from baseline, Patient Global Impression	PIL group: 78% Transforaminal group: 77%	PIL group: 75% Transforaminal group: 77%	PIL group: 69% Transforaminal group: 77%	NA	Effectiveness in both arms	Effectiveness in both arms	Effectiveness in both arms	NA	Positive Trial This is relatively small active control trial with a long-term follow-up assessing the role of parasagittal interlaminar epidural injections and transforaminal epidural injections showing equal improvement with steroids without local anesthetic.
Vad et al, 2002 (78) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 5/13 IPM-QRB = 16/48	Total: 50 patients Transforaminal: 25 Trigger point injections: 25 Transforaminal injections were performed by safe triangle approach or sacral foramen injection utilizing contrast followed by 1.5 mL of betamethasone acetate 9 mg and 1.5 mL of 2% preservative free Xylocaine. Trigger point injections were performed with 3 mL of normal saline	Outcome measures included visual numeric score, Roland-Morris score, finger to floor distance, and patient satisfaction score. Outcomes were measured at 3 weeks, 6 weeks, 3 months, 6 months, and 12 months.	In transforaminal group 84% showed improvement in trigger point injection group 48% showed improvement	In transforaminal group 84% showed improvement. In trigger point injection group 48% showed improvement	In transforaminal group 84% showed improvement in trigger point injection group 48% showed improvement.	NA	Transforaminal steroids with lidocaine effective	Transforaminal steroids with lidocaine effective	Transforaminal steroids with lidocaine effective	NA	Positive Trial This is a randomized trial, but randomization was by patient choice with patients receiving either a high dose transforaminal epidural steroid injection or saline trigger point injection. Study yielded positive results for transforaminal epidural injections at one-year follow-up.

Table 5 cont. *Characteristics of fluoroscopic randomized trials of conservative or placebo or local anesthetic, or local anesthetic and steroids in transforaminal epidural injections in lumbar disc herniation.*

Study Study Characteristics Methodological Quality Scoring	Participants and Interventions	Outcome Measures	Pain Relief and Function				Results				Conclusion / Comment(s)
			3 mos.	6 mos.	12 mos.	24 mos.	Short-term ≤ 6 mos.	Long-Term			
								> 6 mos.	≥ 12 mos.	24 mos.	
Jeong et al, 2007 (79) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 10/13 IPM-QRB = 31/48	Total=193 Ganglionic = 104 Preganglionic = 89 0.5 mL of bupivacaine hydrochloride and 40 mg of 1 mL of triamcinolone Number of injections = 1	VAS Follow-up: 7-30 days 6 months	Pregan-glionic = 88.4% Ganglionic = 70.9%	Preganglionic = 60.4% Ganglionic = 67.2%	NA	NA	Both ap-proaches effective	Both ap-proaches effective	NA	NA	Positive Trial Moderate quality study with mid-term positive results.
Kennedy et al, 2014 (80) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 10/13 IPM-QRB = 30/48	Total patients = 78 Dexamethasone 15 mg or 1.5 mL = 41 patients Triamcinolone 60 mg or 1.5 mL = 37 patients Number of Injections: 1 to 3	NRS, ODI, at least 50% re-duction in pain and disability scores	Dexa-methasone group 73% reduction in pain scores, 68% reduction in ODI scores Triamcino-lone group 73% reduc-tion in pain scores, 68% reduction in ODI scores	Dexamethasone group 73% reduction in pain scores, 71% reduction in ODI scores Triamcinolone group 76% reduction in pain scores, 65% reduction in ODI scores	NA	NA	Both drugs effective	Both drugs effective	NA	NA	Positive Trial In this comparative assessment of dexamethasone 15 mg with triamcinolone 60 mg, there was no significant difference with pain or functionality at 6 months.

RA = Randomized; AC = Active Control; F = Fluoroscopy; PC = Placebo-control; IPM-QRB = Interventional Pain Management techniques - Quality Appraisal of Reliability and Risk of Bias Assessment; NRS = Numeric Rating Scale; ODI = Oswestry Disability Index; VAS = Visual Analog Scale; BDI = Beck Depression Inventory; NPI = Numerical Pain Intensity; LBOS = Low Back Outcome Score; JOA – Japanese Orthopaedic Association; PIL = Parasagittal Interlaminar; LA = local anesthetic; NA = Not Applicable; P = Positive

Table 6. *Characteristics of fluoroscopic randomized trials of conservative or placebo or local anesthetic, or local anesthetic and steroids in interlaminar epidural injections in lumbar disc herniation.*

Study Study Characteristics Methodological Quality Scoring	Participants and Interventions	Outcome Measures	Pain Relief and Function				Results				Conclusion/ Comment(s)
			3 mos.	6 mos.	12 mos.	24 mos.	Short-term ≤ 6 mos.	Long-Term			
								> 6 mos.	≥ 12 mos.	24 mos.	
Manchikanti et al, 2014 (61) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 11/13 IPM-QRB = 44/48	Total = 120 Local anesthetic = 60 Local anesthetic and steroids = 60 Xylocaine or Xylocaine with non-particulate Celestone Average number of injections = 5 to 6 for 2 years	NRS, ODI, employment status, opioid intake, significant improvement 50% or greater of NRS scores and ODI scores Responsive 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: Lidocaine 72% vs. lidocaine with steroid 82% Responsive: Lidocaine 86% vs. lidocaine with steroid 83%	Overall: Lidocaine 63% vs. lidocaine with steroid 85% Responsive: Lidocaine 76% vs. lidocaine with steroid 86%	Overall: Lidocaine 67% vs. lidocaine with steroid 85% Responsive: Lidocaine 80% vs. lidocaine with steroid 86%	Overall: Lidocaine 60% vs lidocaine with steroid 70% Responsive: Lidocaine 72% vs. lidocaine with steroid 71%	Both treatments are effective	Both treatments are effective	Both treatments are effective	Both treatments are effective	Positive Trial Positive randomized trial with long-term follow-up. Overall, similar results with local anesthetic or with local anesthetic and steroids with significant improvement. Steroids were superior at 6 months with pain relief and 12 months with functional status A significantly higher proportion of patients non-responsive to the first 2 injections in the local anesthetic group 10 vs one. On average, a total of 5-6 injections were provided over a period of 2 years.
Ghai et al, 2015 (62) RA, DB, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 10/13 IPM-QRB = 39/48	Total = 69 Lidocaine = 34 Lidocaine + methylprednisolone = 35 Local anesthetic group: 8 mL of 0.5% lidocaine Lidocaine + methylprednisolone: 6 ml of 0.5% lidocaine mixed with 80 mg (2 mL) of methylprednisolone acetate Average procedures: 2	NRS and functional disability using Modified Oswestry Disability Questionnaire Follow-up: 1 year	Lidocaine: 50% Lidocaine with methylprednisolone: 86%	Lidocaine: 56% Lidocaine with methylprednisolone: 86%	Lidocaine: 59% Lidocaine with methylprednisolone: 89%	NA	Both arms effective. Steroids superior	Both arms effective. Steroids superior	Both arms effective. Steroids superior	NA	Positive Trial This active control trial with a long-term follow-up comparing lidocaine alone with lidocaine with methylprednisolone showed similar results after 3 months, even though quality of relief was superior in the local anesthetic with steroid group.

Table 6 cont. *Characteristics of fluoroscopic randomized trials of conservative or placebo or local anesthetic, or local anesthetic and steroids in interlaminar epidural injections in lumbar disc herniation.*

Study Study Characteristics Methodological Quality Scoring	Participants and Interventions	Outcome Measures	Pain Relief and Function				Results				Conclusion/ Comment(s)
			3 mos.	6 mos.	12 mos.	24 mos.	Short-term ≤ 6 mos.	Long-Term			
								> 6 mos.	≥ 12 mos.	24 mos.	
Ökmen & Ökmen 2017 (63) RA, AC, F Disc herniation Quality Scores: Cochrane = 12/13 IPM-QRB = 40/48	Total = 120 Epidural bupivacaine 0.25%, 10 mL = 60 Epidural bupivacaine 0.25%, 10 mL + 40 mg of methylprednisolone = 60 Procedures administered at L4-5 under fluoroscopic guidance Number of injections = 1-2	VAS, ODI Follow-up: 1 to 12 months	Significantly better results in epidural bupivacaine and steroid group Both groups showed significant improvement from baseline, more significant in the steroid group than bupivacaine alone group.	Significantly better results in epidural bupivacaine and steroid group Both groups showed significant improvement from baseline, more significant in the steroid group than bupivacaine alone group.	Significantly better results in epidural bupivacaine and steroid group Both groups showed significant improvement from baseline, more significant in the steroid group than	NA	Bupivacaine steroids superior	Bupivacaine steroids superior	Bupivacaine steroids superior	NA	Positive Trial Positive results for both epidural bupivacaine and epidural bupivacaine with steroids. Significant improvement in epidural bupivacaine and steroid group from baseline with pain and function, as well as ODI compared to bupivacaine.
Ackerman & Ahmad, 2007 (69) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 8/13 IPM-QRB = 25/48	Total = 90 Caudal = 30 Interlaminar = 30 Transforaminal = 30 Methylprednisolone + saline Number of injections = 1 to 3	Numeric pain score (0 - 10), rating of pain relief, ODI, BDI, contrast dispersion pattern Follow-up: 24 weeks	Caudal = 57% Interlaminar = 60% Transforaminal = 83%	Caudal = 57% Interlaminar = 60% Transforaminal = 83%	NA	NA	Effective in all arms	Effective in all arms	NA	NA	Positive Trial Positive mid-term results in a relatively small trial.
Kamble et al, 2016 (71) RA, AC, F Single level disc prolapse Quality Scores: Cochrane = 9/13 IPM-QRB = 32/48	Transforaminal = 30 Number of injections = 1-3 Interlaminar = 30 Number of injections = 1-3 Caudal = 30 Number of injections = 1-3	VAS, ODI	NA	Transforaminal = VAS baseline 7.1 ± 0.7 to 2.6 ± 0.7 ODI = 37.7 ± 2.83 to 16.8 ± 2.53 Interlaminar = VAS baseline 7.0 ± 0.7 to 3.4 ± 1.4 ODI = 36.9 ± 2.82 to 21.4 ± 6.08 Caudal = VAS baseline 7.2 ± 0.6 to 3.5 ± 1.0. ODI = 38.3 ± 2.78 to 21.9 ± 3.35	NA	NA	All 3 techniques were effective	NA	NA	NA	Positive Trial While all 3 techniques were effective, transforaminal group showed superiority. However, there was no difference between caudal and interlaminar approaches.

Table 6 cont. *Characteristics of fluoroscopic randomized trials of conservative or placebo or local anesthetic, or local anesthetic and steroids in interlaminar epidural injections in lumbar disc herniation.*

Study Study Characteristics Methodological Quality Scoring	Participants and Interventions	Outcome Measures	Pain Relief and Function				Results				Conclusion/ Comment(s)
			3 mos.	6 mos.	12 mos.	24 mos.	Short-term ≤ 6 mos.	Long-Term			
								> 6 mos.	≥ 12 mos.	24 mos.	
Pandey, 2016 (72) RA, AC, F Disc prolapse Quality Scores: Cochrane = 8/13 IPM-QRB = 29/48	Total = 140 patients Caudal = 82 Transforaminal = 40 Interlaminar = 18 All were treated with steroid and local anesthetic with or without sodium chloride solution	JOA score	NA	JOA scores Caudal = baseline 15.39 to 24.30 Transforaminal = baseline 15.57 to 26.65 Interlaminar = baseline 15.33 to 25	JOA scores Caudal = baseline 15.39 to 24.02 Effectiveness = 74.3% Transforaminal = baseline 15.57 to 26.55 Effectiveness = 90% Interlaminar = baseline 15.33 to 24.72 Effectiveness = 77.7%	NA	*P*	*P*	*P*	NA	Positive Trial In comparing caudal epi-dural with interlaminar and transforaminal, authors showed response in 74.3% with caudal route, 77.7% with interlaminar, and 90% with transfo-raminal approach. Overall results are posi-tive. There is no signifi-cant difference between caudal and interlaminar; however, transforaminal appears to be superior.
Rados et al, 2011 (74) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 9/13 IPM-QRB = 30/48	Total = 64 IL = 32 TF = 32 Lidocaine with methylprednisolone Number of injections = 1 to 3	VAS, ODI, 50% pain relief Follow-up: 6 months	NA	Interlaminar lidocaine with methylprednisolone = 53% Transforaminal lidocaine with methylprednisolone = 63%	NA	NA	Effective with both approaches	NA	NA	NA	Positive Trial Positive results with short follow-up period in comparison of 2 approaches with lidocaine with methylprednisolone
Ghai et al, 2014 (75) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 10/13 IPM-QRB = 42/48	Total = 62 Parasagittal interlaminar = 32 Transforaminal = 30 2 mL of methylprednisolone (80 mg) mixed with 2 mL of normal saline for both PIL and transforaminal groups Number of epidural steroid injections: Transforaminal group: 60 PIL group: 58 Average procedures: 2	Visual analog scale, Oswestry Disability questionnaire, significant improvement, greater than 50% pain relief from baseline, Patient Global Impression	PIL group: 78% Transforaminal group: 77%	PIL group: 75% Transforaminal group: 77%	PIL group: 69% Transforaminal group: 77%	NA	Effectiveness in both arms	Effectiveness in both arms	Effectiveness in both arms	NA	Positive Trial This is relatively small active control trial with a long-term follow-up assessing the role of parasagittal interlaminar epidural injections and transforaminal epidural injections showing equal improvement with steroids without local anesthetic.

Table 6 cont. *Characteristics of fluoroscopic randomized trials of conservative or placebo or local anesthetic, or local anesthetic and steroids in interlaminar epidural injections in lumbar disc herniation.*

Study Study Characteristics Methodological Quality Scoring	Participants and Interventions	Outcome Measures	Pain Relief and Function				Results				Conclusion/ Comment(s)
			3 mos.	6 mos.	12 mos.	24 mos.	Short-term ≤ 6 mos.	Long-Term			
								> 6 mos.	≥ 12 mos.	24 mos.	
Candido et al, 2013 (76) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 10/13 IPM-QRB = 37/48	106 patients Midline inter-laminar = 53 Parasagittal in-terlaminar = 53 120 mg meth-ylprednisolone with 2 mL of 0.5% lidocaine Number of Injections: Not available	Pain relief, disability, NRS, ODI, use of opioid medication Follow-up: 12 months	ODI Midline = 36% Parasagittal = 51% Pain: Midline = 29% Parasagittal = 50%	ODI Midline = 21% Parasagittal = 55% Pain: Midline = 29% Parasagittal = 53%	ODI Midline = 15% Parasagittal = 56% Pain: Midline = 28% Parasagittal = 55%	NA	Parasagittal superior	Parasagittal superior	Parasagittal superior	NA	Positive Trial The authors showed significant evidence that parasagittal approach with injection of local anesthetic and steroids was superior to midline approach of interlaminar epidural injections. This study shows combination of methylprednisolone with lidocaine was superior administered with a parasagittal approach compared to midline approach.
Amr, 2011 (77) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 12/13 IPM-QRB = 38/48	Total = 200 Local anesthetic + steroid = 100 Local anesthetic + steroid + ketamine = 100 Triamcinolone plus preservative free ketamine and 0.9% saline Number of injections = 1	Pain scores, Oswestry low back pain disability questionnaire	Significant improve-ment in ketamine group	Significant improvement in ketamine group	Significant improvement in ketamine group	NA	Effective with addition of ketamine to bupiva-caine and triamcinolone	Effec-tive with addition of ketamine to bupivacaine and triam-cinolone	Effec-tive with addition of ketamine to bupivacaine and triam-cinolone	NA	Positive Trial Positive randomized trial for ketamine with long-term follow-up with ketamine with local anesthetic and steroid.

RA = Randomized; AC = Active Control; F = Fluoroscopy; DB = Double-Blind; IPM-QRB = Interventional Pain Management techniques - Quality Appraisal of Reliability and Risk of Bias Assessment; NRS = Numeric Rating Scale; ODI = Oswestry Disability Index; VAS = Visual Analog Scale; BDI = Beck Depression Inventory; NPI = Numerical Pain Intensity; JOA – Japanese Orthopaedic Association; NA = Not Applicable; IL = interlaminar; TF = transforaminal

Table 7. *Characteristics of fluoroscopic randomized trials of conservative or placebo or local anesthetic, or local anesthetic and steroids in caudal epidural injections in lumbar disc herniation.*

Study Study Characteristics Methodological Quality Scoring	Participants and Interventions	Outcome Measures	Pain Relief and Function				Results				Conclusion/ Comment(s)
			3 mos.	6 mos.	12 mos.	24 mos.	Short-term ≤ 6 mos.	Long-Term			
								> 6 mos.	≥ 12 mos.	24 mos.	
Manchikanti et al, 2012 (59) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 12/13 IPM-QRB = 44/48	Total = 120 Lidocaine = 60 Lidocaine with steroids = 60 Lidocaine vs. lidocaine mixed with steroid Number of injections = 1 to 5	NRS, ODI, employment status, opioid intake Responsive 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 62% vs. LA with steroid 72% Responsive: LA 77% vs LA with steroid 80%	Overall: LA 72% vs LA with steroid 73% Responsive: LA 87% vs LA with steroid 86%	Overall: LA 67% vs LA with steroid 72% Responsive: LA 85% vs LA with steroid 84%	Overall: LA 60% vs LA with steroid 65% Responsive: LA 77% vs LA with steroid 76%	Lidocaine & lidocaine with steroid effective	Lidocaine & lidocaine with steroid effective	Lidocaine & lidocaine with steroid effective	Lidocaine & lidocaine with steroid effective	Positive Trial Positive double-blind randomized trial with superiority of steroids with average pain relief for steroids. Overall improvement with local anesthetic alone or with steroids was similar. Nonresponsive patients were also similar with 13 and 10 in local anesthetic only and with steroids group. Over a period of 2 years, on average, a total of 5-6 injections were provided.
Murakibhavi & Khemka, 2011 (60) RA, NTC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 8/13 IPM-QRB = 27/48	Group A = 50 control conserva-tive management Group B = 52 caudal epidural with lidocaine and methylprednisolone Total = 102 patients Conservative management or caudal epidural steroid injections	VAS, ODI, BDI, NPI	Group A = 32% Group B = 92%	Group A = 24% Group B = 86%	NA	NA	Steroids effective	Steroids effective	NA	NA	Positive Trial Positive short-term results, with methylprednisolone and lidocaine.
Ackerman & Ahmad, 2007 (69) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 8/13 IPM-QRB = 25/48	Total = 90 Caudal = 30 Interlaminar = 30 Transforaminal = 30 Methylprednisolone + saline Number of injections = 1 to 3	Numeric pain score (0 - 10), rating of pain relief, ODI, BDI, contrast disper-sion pattern Follow-up: 24 weeks	Caudal = 57% Interlaminar = 60% Transforaminal = 83%	Caudal = 57% Interlaminar = 60% Transforaminal = 83%	NA	NA	Effective in all arms	Effective in all arms	NA	NA	Positive Trial Positive mid-term results in a relatively small trial.

Table 7 cont. *Characteristics of fluoroscopic randomized trials of conservative or placebo or local anesthetic, or local anesthetic and steroids in caudal epidural injections in lumbar disc herniation.*

Study Study Characteristics Methodological Quality Scoring	Participants and Interventions	Outcome Measures	Pain Relief and Function				Results				Conclusion/ Comment(s)
			3 mos.	6 mos.	12 mos.	24 mos.	Short-term ≤ 6 mos.	Long-Term			
								> 6 mos.	≥ 12 mos.	24 mos.	
Dashfield et al, 2005 (70) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 10/13 IPM-QRB = 33/48	Total = 60 Caudal = 30 Endoscopy =30 Lidocaine with triamcinolone Number of injections = 1	Pain relief, SF-MPQ, HADS scores	SI	SI	NA	NA	Lidocaine with triamcinolone effective	Lidocaine with triamcinolone effective	NA	NA	Positive Trial Positive mid-term results in a relatively small trial.
Kamble et al, 2016 (71) RA, AC, F Single level disc prolapse Quality Scores: Cochrane = 9/13 IPM-QRB = 32/48	Transforaminal = 30 Number of njections = 1-3 Interlaminar = 30 Number of njections = 1-3 Caudal = 30 Number of njections = 1-3	VAS, ODI	NA	Transforaminal = VAS baseline 7.1 ± 0.7 to 2.6 ± 0.7 ODI = 37.7 ± 2.83 to 16.8 ± 2.53 Interlaminar = VAS baseline 7.0 ± 0.7 to 3.4 ± 1.4 ODI = 36.9 ± 2.82 to 21.4 ± 6.08 Caudal = VAS baseline 7.2 ± 0.6 to 3.5 ± 1.0. ODI = 38.3 ± 2.78 to 21.9 ± 3.35	NA	NA	All 3 techniques were effective	NA	NA	NA	Positive Trial While all 3 techniques were effective, transfo-raminal group showed superiority. However, there was no difference between caudal and in-terlaminar approaches.

Table 7 cont. *Characteristics of fluoroscopic randomized trials of conservative or placebo or local anesthetic, or local anesthetic and steroids in caudal epidural injections in lumbar disc herniation.*

Study Study Characteristics Methodological Quality Scoring	Participants and Interventions	Outcome Measures	Pain Relief and Function				Results				Conclusion/ Comment(s)
			3 mos.	6 mos.	12 mos.	24 mos.	Short-term ≤ 6 mos.	Long-Term			
								> 6 mos.	≥ 12 mos.	24 mos.	
Pandey, 2016 (72) RA, AC, F Disc prolapse Quality Scores: Cochrane = 8/13 IPM-QRB = 29/48	Total = 140 patients Caudal = 82 Transforaminal = 40 Interlaminar = 18 All were treated with steroid and local anesthetic with or without sodium chloride solution	JOA score	NA	JOA scores Caudal = baseline 15.39 to 24.30 Transforami-nal = baseline 15.57 to 26.65 Interlaminar = baseline 15.33 to 25	JOA scores Caudal = baseline 15.39 to 24.02 Effectiveness = 74.3% Transforaminal = baseline 15.57 to 26.55 Effectiveness = 90% Interlaminar = baseline 15.33 to 24.72 Effectiveness = 77.7%	NA	*P*	*P*	*P*	NA	Positive Trial In comparing caudal epidural with interlami-nar and transforami-nal, authors showed response in 74.3% with caudal route, 77.7% with interlaminar, and 90% with transforami-nal approach. Overall results are positive. There is no significant difference between caudal and interlaminar; however, transforaminal appears to be superior.
Singh et al, 2017 (73) RA, AC, F Single level prolapsed lumbar intervertebral disc Quality Scores: Cochrane = 8/13 IPM-QRB = 30/48	Number of patients = 80 Caudal with ste-roids group = 40 mL of methyl-prednisolone, 80 mg along with lignocaine 2% diluted in 20 mL of normal saline caudal epidural injections were given at an in-terval of 3 weeks irrespective of previous epidural injection effect SNRB = 40 A single injection of 2 mL of meth-ylprednisolone, 80 mg, mixed with 5 mL of lignocaine 2%	VAS, ODI & significant pain relief of 50%	VAS Caudal vs. SNRB = 61.5% vs. 55.5% ODI decreased caudal vs. SNRB = 64.6% vs. 52.8%	VAS Caudal vs. SNRB= 59.6% vs. 52.9% ODI decreased caudal vs. SNRB = 65.1% vs. 48.6%	VAS Caudal vs. SNRB= 58.2% vs. 46.8% ODI decreased caudal vs. SNRB = 65.4% vs. 46.7%	NA	Caudal epidural superior to SNRB with steroids	Caudal epidural superior to SNRB with steroids	Caudal epidural superior to SNRB with steroids	Caudal epidural superior to SNRB with steroids	Positive Trial Positive short-term and long-term relief in both caudal and SNRB; how-ever, relief in the caudal group was superior. However, this study suffered with multiple limitations of 3 caudal epidural injections compared to one SNRB and high volumes of injections, which are clinically inappropri-ate in both caudal and SNRB groups.

RA = Randomized; AC = Active Control; F = Fluoroscopy; DB = Double-Blind; IPM-QRB = Interventional Pain Management techniques - Quality Appraisal of Reliability and Risk of Bias Assessment; NRS = Numeric Rating Scale; ODI = Oswestry Disability Index; VAS = Visual Analog Scale; BDI = Beck Depression Inventory; NPI = Numerical Pain Intensity; JOA – Japanese Orthopaedic Association; NA = Not Applicable; IL = interlaminar; TF = transforaminal

Table 8. *Characteristics of comparative fluoroscopic epidural injections in lumbar disc herniation.*

Study Study Characteristics Methodological Quality Scoring	Participants and Interventions	Outcome Measures	Pain Relief and Function				Results				Conclusion/ Comment(s)
			3 mos.	6 mos.	12 mos.	24 mos.	Short-term ≤ 6 mos.	Long-Term			
								> 6 mos.	≥ 12 mos.	24 mos.	
CAUDAL VERSUS INTERLAMINAR											
Ackerman & Ahmad, 2007 (69) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 8/13 IPM-QRB = 25/48	Total = 90 Caudal = 30 Interlaminar = 30 Transforaminal = 30 Methylprednisolone + saline Number of injections = 1 to 3	Numeric pain score (0 - 10), rating of pain relief, ODI, BDI, contrast dispersion pattern Follow-up: 24 weeks	Caudal = 57% Interlaminar = 60% Transforaminal = 83%	Caudal = 57% Interlaminar = 60% Transforaminal = 83%	NA	NA	Effective in all arms	Effective in all arms	NA	NA	Positive Trial Positive mid-term results in a relatively small trial.
Kamble et al, 2016 (71) RA, AC, F Single level disc prolapse Quality Scores: Cochrane = 9/13 IPM-QRB = 32/48	Transforaminal = 30 Number of Injections = 1-3 Interlaminar = 30 Number of Injections = 1-3 Caudal = 30 Number of Injections = 1-3	VAS, ODI	NA	Transforaminal = VAS baseline 7.1 ± 0.7 to 2.6 ± 0.7 ODI = 37.7 ± 2.83 to 16.8 ± 2.53 Interlaminar = VAS baseline 7.0 ± 0.7 to 3.4 ± 1.4 ODI = 36.9 ± 2.82 to 21.4 ± 6.08 Caudal = VAS baseline 7.2 ± 0.6 to 3.5 ± 1.0. ODI = 38.3 ± 2.78 to 21.9 ± 3.35	NA	NA	All 3 techniques were effective	NA	NA	NA	Positive Trial While all 3 techniques were effective, transforaminal group showed superiority. However, there was no difference between caudal and interlaminar approaches.
Pandey, 2016 (72) RA, AC, F Disc prolapse Quality Scores: Cochrane = 8/13 IPM-QRB = 29/48	Total = 140 patients Caudal = 82 Transforaminal = 40 Interlaminar = 18 All were treated with steroid and local anesthetic with or without sodium chloride solution	JOA score	NA	JOA scores Caudal = baseline 15.39 to 24.30 Transforaminal = baseline 15.57 to 26.65 Interlaminar = baseline 15.33 to 25	JOA scores Caudal = baseline 15.39 to 24.02 Effectiveness = 74.3% Transforaminal = baseline 15.57 to 26.55 Effectiveness = 90% Interlaminar = baseline 15.33 to 24.72 Effectiveness = 77.7%	NA	*P*	*P*	*P*	NA	Positive Trial In comparing caudal epidural with interlaminar and transforaminal, authors showed response in 74.3% with caudal route, 77.7% with interlaminar, and 90% with transforaminal approach. Overall results are positive. There is no significant difference between caudal and interlaminar; however, transforaminal appears to be superior.

Table 8 cont. *Characteristics of comparative fluoroscopic epidural injections in lumbar disc herniation.*

Study Study Characteristics Methodological Quality Scoring	Participants and Interventions	Outcome Measures	Pain Relief and Function				Results				Conclusion/ Comment(s)
			3 mos.	6 mos.	12 mos.	24 mos.	Short-term ≤ 6 mos.	Long-Term			
								> 6 mos.	≥ 12 mos.	24 mos.	
CAUDAL VERSUS TRANSFORAMINAL											
Ackerman & Ahmad, 2007 (69) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 8/13 IPM-QRB = 25/48	Total = 90 Caudal = 30 Interlaminar = 30 Transforaminal = 30 Methylprednisolone + saline Number of injections = 1 to 3	Numeric pain score (0 – 10), rating of pain relief, ODI, BDI, contrast disperson pattern Follow-up: 24 weeks	Caudal = 57% Interlaminar = 60% Transforaminal = 83%	Caudal = 57% Interlaminar = 60% Transforaminal = 83%	NA	NA	Effective in all arms	Effective in all arms	NA	NA	Positive Trial Positive mid-term results in a relatively small trial.
Kamble et al, 2016 (71) RA, AC, F Single level disc prolapse Quality Scores: Cochrane = 9/13 IPM-QRB = 32/48	Transforaminal = 30 Number of Injections = 1-3 Interlaminar = 30 Number of injections = 1-3 Caudal = 30 Number of injections = 1-3	VAS, ODI	NA	Transforaminal = VAS baseline 7.1 ± 0.7 to 2.6 ± 0.7 ODI = 37.7 ± 2.83 to 16.8 ± 2.53 Interlaminar = VAS baseline 7.0 ± 0.7 to 3.4 ± 1.4 ODI = 36.9 ± 2.82 to 21.4 ± 6.08 Caudal = VAS baseline 7.2 ± 0.6 to 3.5 ± 1.0. ODI = 38.3 ± 2.78 to 21.9 ± 3.35	NA	NA	All 3 techniques were effective	NA	NA	NA	Positive Trial While all 3 techniques were effective, transforaminal group showed superiority. However, there was no difference between caudal and interlaminar approaches.
Pandey, 2016 (72) RA, AC, F Disc prolapse Quality Scores: Cochrane = 8/13 IPM-QRB = 29/48	Total = 140 patients Caudal = 82 Transforaminal = 40 Interlaminar = 18 All were treated with steroid and local anesthetic with or without sodium chloride solution	JOA score	NA	JOA scores Caudal = baseline 15.39 to 24.30 Transforaminal = baseline 15.57 to 26.65 Interlaminar = baseline 15.33 to 25	JOA scores Caudal = baseline 15.39 to 24.02 Effectiveness = 74.3% Transforaminal = baseline 15.57 to 26.55 Effectiveness = 90% Interlaminar = baseline 15.33 to 24.72 Effectiveness = 77.7%	NA	*P*	*P*	*P*	NA	Positive Trial In comparing caudal epidural with interlaminar and transforaminal, authors showed response in 74.3% with caudal route, 77.7% with interlaminar, and 90% with transforami-nal approach. Overall results are positive. There is no significant difference between caudal and interlaminar; however, transforaminal appears to be superior.

Table 8 cont. *Characteristics of comparative fluoroscopic epidural injections in lumbar disc herniation.*

Study Study Characteristics Methodological Quality Scoring	Participants and Interventions	Outcome Measures	Pain Relief and Function				Results				Conclusion/ Comment(s)
			3 mos.	6 mos.	12 mos.	24 mos.	Short-term ≤ 6 mos.	Long-Term			
								> 6 mos.	≥ 12 mos.	24 mos.	
Singh et al, 2017 (73) RA, AC, F Single level prolapsed lumbar intervertebral disc Quality Scores: Cochrane = 8/13 IPM-QRB = 30/48	Number of patients = 80 Caudal with steroids group = 40 2 mL of methylprednisolone, 80 mg along with lignocaine 2% diluted in 20 mL of normal saline caudal epidural injections were given at an in-terval of 3 weeks irrespective of previous epidural injection effect SNRB = 40 A single injection of 2 mL of methylprednisolone, 80 mg, mixed with 5 mL of lignocaine 2%	VAS, ODI & significant pain relief of 50%	VAS Caudal vs. SNRB = 61.5% vs. 55.5% ODI decreased caudal vs. SNRB = 64.6% vs. 52.8%	VAS Caudal vs. SNRB= 59.6% vs. 52.9% ODI decreased caudal vs. SNRB = 65.1% vs. 48.6%	VAS Caudal vs. SNRB= 58.2% vs. 46.8% ODI decreased caudal vs. SNRB = 65.4% vs. 46.7%	NA	Caudal epidural superior to SNRB with steroids	Caudal epidural superior to SNRB with steroids	Caudal epidural superior to SNRB with steroids	Caudal epidural superior to SNRB with steroids	Positive Trial Positive short-term and long-term re-lief in both caudal and SNRB; however, relief in the caudal group was superior. However, this study suffered with multiple limitations of 3 caudal epidural injections compared to one SNRB and high volumes of injections, which are clinically inappropriate in both caudal and SNRB groups.
INTERLAMINAR VERSUS TRANSFORAMINAL											
Ackerman & Ahmad, 2007 (69) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 8/13 IPM-QRB = 25/48	Total = 90 Caudal = 30 Interlaminar = 30 Transforaminal = 30 Methylprednisolone + saline Number of injections = 1 to 3	Numeric pain score (0 - 10), rating of pain relief, ODI, BDI, contrast disper-sion pattern Follow-up: 24 weeks	Caudal = 57% Interlaminar = 60% Transforaminal = 83%	Caudal = 57% Interlaminar = 60% Transforaminal = 83%	NA	NA	Effective in all arms	Effective in all arms	NA	NA	Positive Trial Positive mid-term results in a relatively small trial.
Kamble et al, 2016 (71) RA, AC, F Single level disc prolapse Quality Scores: Cochrane = 9/13 IPM-QRB = 32/48	Transforaminal = 30 Number of injections = 1-3 Interlaminar = 30 Number of injections = 1-3 Caudal = 30 Number of injections = 1-3	VAS, ODI	NA	Transforaminal = VAS baseline 7.1 ± 0.7 to 2.6 ± 0.7 ODI = 37.7 ± 2.83 to 16.8 ± 2.53 Interlaminar = VAS baseline 7.0 ± 0.7 to 3.4 ± 1.4 ODI = 36.9 ± 2.82 to 21.4 ± 6.08 Caudal = VAS baseline 7.2 ± 0.6 to 3.5 ± 1.0. ODI = 38.3 ± 2.78 to 21.9 ± 3.35	NA	NA	All 3 techniques were effective	NA	NA	NA	Positive Trial While all 3 techniques were effective, transforaminal group showed superiority. However, there was no difference between caudal and interlaminar approaches.

Table 8 cont. *Characteristics of comparative fluoroscopic epidural injections in lumbar disc herniation.*

Study Study Characteristics Methodological Quality Scoring	Participants and Interventions	Outcome Measures	Pain Relief and Function				Results				Conclusion/ Comment s)
			3 mos.	6 mos.	12 mos.	24 mos.	Short-term ≤ 6 mos.	Long-Term			
								> 6 mos.	≥ 12 mos.	24 mos.	
Pandey, 2016 (72) RA, AC, F Disc prolapse Quality Scores: Cochrane = 8/13 IPM-QRB = 29/48	Total = 140 patients Caudal = 82 Transforaminal = 40 Interlaminar = 18 All were treated with steroid and local anesthetic with or without sodium chloride solution	JOA score	NA	JOA scores Caudal = baseline 15.39 to 24.30 Transforaminal = baseline 15.57 to 26.65 Interlaminar = baseline 15.33 to 25	JOA scores Caudal = baseline 15.39 to 24.02 Effectiveness = 74.3% Transforaminal = baseline 15.57 to 26.55 Effectiveness = 90% Interlaminar = baseline 15.33 to 24.72 Effectiveness = 77.7%	NA	NA	*P*	*P*	NA	Positive Trial In comparing caudal epidural with interlaminar and transforaminal, authors showed response in 74.3% with caudal route, 77.7% with interlaminar, and 90% with transforaminal approach. Overall results are positive. There is no significant difference between caudal and interlaminar; however, transforaminal appears to be superior.
Rados et al, 2011 (74) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 9/13 IPM-QRB = 30/48	Total = 64 IL = 32 TF = 32 Lidocaine with methylprednisolone Number of injections = 1 to 3	VAS, ODI, 50% pain relief Follow-up: 6 months	NA	Interlaminar lidocaine with methylprednisolone = 53% Transforaminal lidocaine with methylprednisolone = 63%	NA	NA	NA	Effective with both approaches	NA	NA	Positive Trial Positive results with short follow-up period in comparison of 2 approaches with lidocaine with methylprednisolone
Ghai et al, 2014 (75) RA, AC, F Disc herniation or radiculopathy Quality Scores: Cochrane = 10/13 IPM-QRB = 42/48	Total = 62 Parasagittal interlaminar = 32 Transforaminal = 30 2 mL of methylprednisolone (80 mg) mixed with 2 mL of normal saline for both PIL and transforaminal groups Number of epidural steroid injections: Transforaminal group: 60 PIL group: 58 Average procedures: 2	Visual analog scale, Oswestry Disability questionnaire, significant improvement, greater than 50% pain relief from baseline, Patient Global Impression	PIL group: 78% Transforaminal group: 77%	PIL group: 75% Transfo-raminal group: 77%	PIL group: 69% Transfo-raminal group: 77%	NA	Effectiveness in both arms	Effectiveness in both arms	Effectiveness in both arms	NA	Positive Trial This is relatively small active control trial with a long-term follow-up assessing the role of parasagittal interlaminar epidural injections and transforaminal epidural injections showing equal improvement with steroids without local anesthetic.

RA = Randomized; AC = Active Control; F = Fluoroscopy; IPM-QRB = Interventional Pain Management techniques - Quality Appraisal of Reliability and Risk of Bias Assessment; ODI = Oswestry Disability Index; BDI = Beck Depression Inventory; VAS = Visual Analog Scale; JOA – Japanese Orthopaedic Association; NA = Not Applicable; P = Positive; SNRB – selective nerve root block; PIL = Parasagittal Inter-laminar

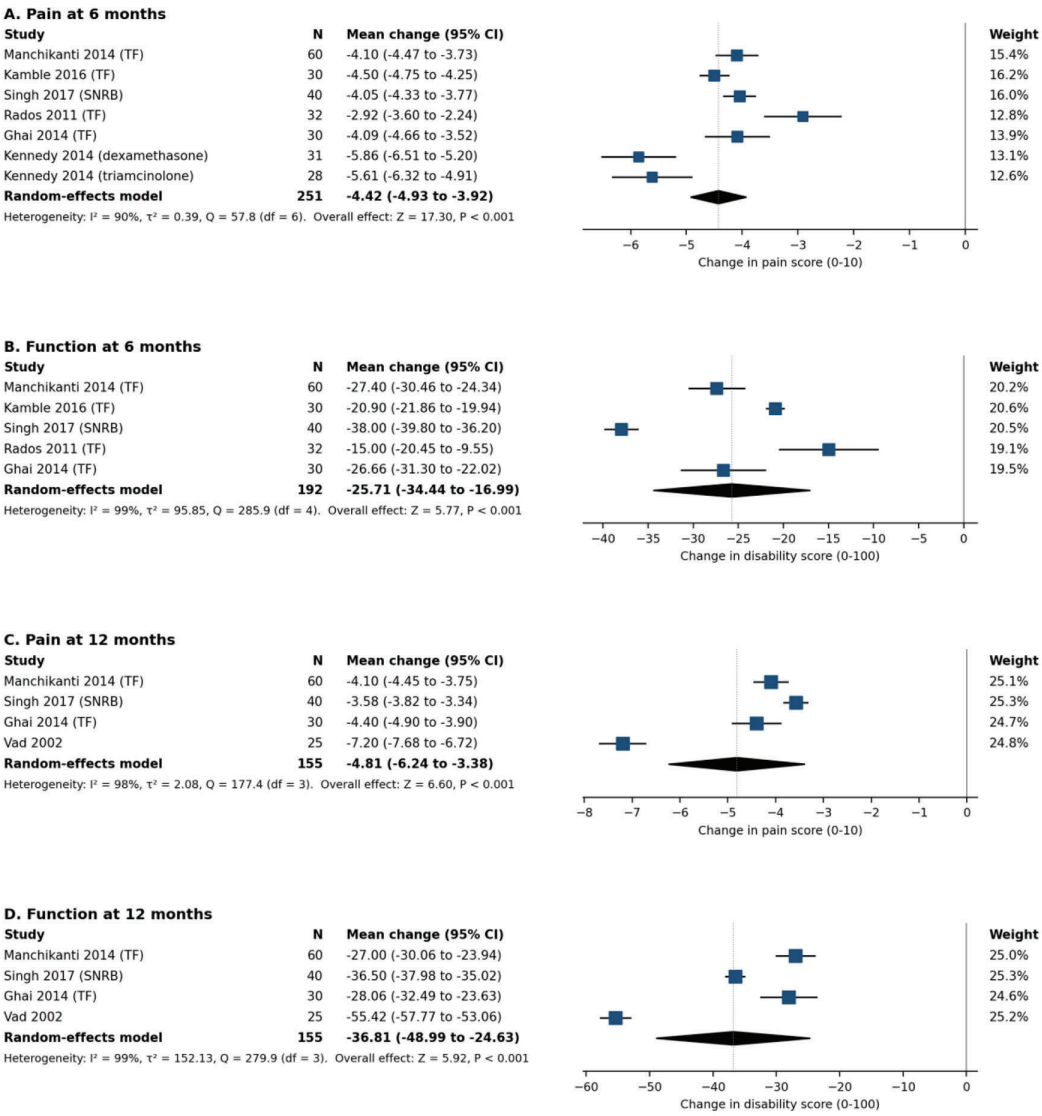


Fig. 2. *Results of single-arm meta-analyses testing the effects of transforaminal epidural steroid injections on pain and functionality at 6 and 12 months. A. Change in pain level at 6 months; B. Change in functionality level at 6 months; C. Change in pain level at 12 months; D. Change in functionality level at 12 months.*

epidural injections, 6 trials contributed data for the 6-month pain analysis, whereas 4 trials provided data for the 12-month analysis. Pain scores improved by 4.42 points at 6 months following transforaminal epidural steroid injections, as shown in Fig. 2A. This improvement was sustained through 12 months, with a mean reduction in pain score of 4.81 points.

Functional outcomes demonstrated a similar pattern. As shown in Fig. 2B, disability scores improved by 25.71 points on a 0 to 100 scale at 6 months. At the 12-month follow-up (Fig. 2D), the mean improvement in functional score was 36.81 points, indicating sustained improvement in disability.

Interlaminar Epidural Injections

Pain relief and functional improvement were evaluated using conventional dual-arm meta-analysis at both 6 and 12 months (Fig. 3).

Three trials (61-63), including 287 patients, provided data eligible for a dual-arm meta-analysis com-

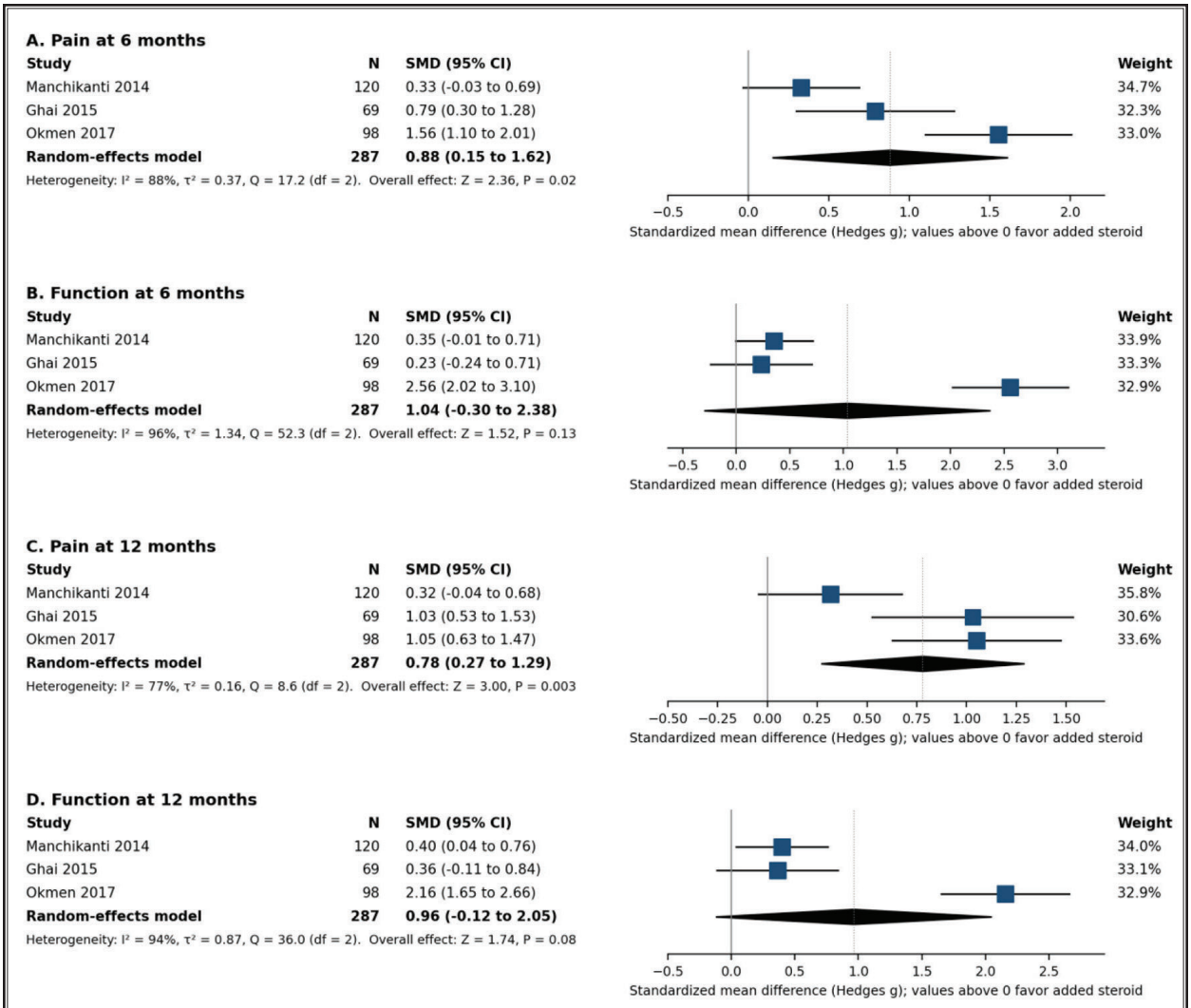


Fig. 3. *Results of dual-arm meta-analyses testing the effects of interlaminar epidural steroid injections on pain and functionality at 6 and 12 months. A. Change in pain level at 6 months; B. Change in functionality at 6 months; C. Change in pain at 12 months; D. Change in functionality at 12 months.*

paring local anesthetic alone with local anesthetic plus steroids.

Figure 3A presents the results of the dual-arm meta-analysis evaluating pain at 6 months using the NRS or VAS in patients who underwent interlaminar epidural steroid injections. As shown in Fig. 3A, the standardized mean difference (SMD) in pain scores at 6 months was 0.88 (95% CI: 0.15 to 1.62, $P = 0.02$; $I^2 = 88\%$), favoring the addition of steroids.

Figure 3B presents the results of the dual-arm meta-analysis evaluating 6-month functional outcomes using the ODI or RMDQ in patients who underwent interlaminar epidural steroid injections (61-63). As shown in Fig. 3B, the standardized mean difference (SMD) in functional scores at 6 months was 1.04 (95% CI: -0.30 to 2.38, $P = 0.13$; $I^2 = 96\%$), a difference that was not statistically significant.

Figure 3C presents the results of the dual-arm meta-analysis of local anesthetic alone and local anesthetic with steroid groups from 3 studies (61-63) evaluating pain at 12 months using the NRS or VAS in patients who underwent interlaminar epidural steroid

injections. As shown in Fig. 3C, the standardized mean difference (SMD) in pain scores at 12 months was 0.78 (95% CI: 0.27 to 1.29, $P = 0.003$; $I^2 = 77\%$), favoring the addition of steroids.

Figure 3D presents the results of a dual-arm meta-analysis comparing local anesthetic alone versus local anesthetic with steroid groups from 3 studies (61-63) evaluating functional outcomes at 12 months using the ODI or RMDQ in patients who underwent interlaminar epidural steroid injections. As shown in Fig. 3D, the standardized mean difference (SMD) in functional scores at 12 months was 0.96 (95% CI: -0.12 to 2.05, $P = 0.08$; $I^2 = 94\%$), a difference that was not statistically significant.

Figure 4 presents the results of the single-arm meta-analysis evaluating the effects of interlaminar epidural steroid injections (ILESI) on pain and functional outcomes at 6 and 12 months.

Figure 4A presents the results of a single-arm meta-analysis of steroid-treated groups from 8 trials (61-63,71,74-77) evaluating 6-month pain using the NRS or VAS in patients who underwent interlaminar epidural steroid injections. A total of 9 data points were included because one study (76) evaluated 2 different approaches. As shown in Fig. 4A, the pooled mean difference in pain score from baseline to 6 months was a reduction of 3.50 points (95% CI: -4.41 to -2.58; $I^2 = 98\%$; $P < 0.001$).

Figure 4B presents the results of the single-arm meta-analysis evaluating the effects of ILESI on functional outcomes at 6 months. Data were derived from the steroid-treated groups of 8 trials (61-63,71,74-77) that assessed functional outcomes using the ODI or RMDQ. As shown in Fig. 4B, the pooled mean difference in functional score from baseline to 6 months was a reduction of 24.15 points on a 0 to 100 scale (95% CI: -32.08 to -16.21; $I^2 = 99\%$; $P < 0.001$).

Figure 4C presents the results of the single-arm meta-analysis of steroid-treated groups from 6 trials (61-63,75-77) evaluating pain at 12 months, measured with the NRS or VAS, in patients who underwent interlaminar epidural steroid injections. A total of 7 data points were included because one study (76) evaluated 2 different approaches. As shown in Fig. 4C, the pooled mean difference in pain score from baseline to 12 months was a reduction of 3.51 points (95% CI: -4.83 to -2.20; $I^2 = 99\%$; $P < 0.001$).

Figure 4D presents the results of the single-arm meta-analysis of steroid-treated groups from 6 trials (61-63,75-77) evaluating 12-month functional outcomes using the ODI or RMDQ in patients who underwent interlaminar epidural steroid injections. A total of 7 data points were included because one study (76) evaluated 2 different approaches. As shown in Fig. 4D, the pooled mean difference in functional score from baseline to 12 months was a reduction of 26.36 points on a 0 to 100 scale (95% CI: -33.95 to -18.77; $I^2 = 99\%$; $P < 0.001$).

Single-arm analysis demonstrated significant improvement in both pain and functional outcomes at 6 and 12 months following lumbar interlaminar epidural steroid injections. As shown in Fig. 4A, pain scores decreased by 3.50 points at the 6-month follow-up and by 3.51 points at the 12-month follow-up. Functional outcomes also improved substantially, as shown in Fig. 4B, with disability scores decreasing by 24.15 points at 6 months and by 26.36 points at the 12-month follow-up (Fig. 4D).

Caudal Epidural Injections

Conventional dual-arm meta-analysis for pain relief and functional improvement at 6 and 12 months was not performed for caudal epidural injections because an insufficient number of eligible studies were available.

Figure 5 presents the results of the single-arm meta-analysis evaluating the effects of caudal epidural steroid injections (CESI) on pain and functional outcomes at 6 and 12 months.

Figure 5A presents the results of a single-arm meta-analysis of steroid-treated groups from 4 trials (59,70,71,73) evaluating pain at 6 months, measured with the NRS or VAS, in patients who underwent caudal epidural steroid injections. As shown in Fig. 5A, the pooled mean difference in pain score from baseline to 6 months was a reduction of 3.55 points (95% CI: -4.42 to -2.68; $I^2 = 94\%$; $P < 0.001$).

Figure 5B presents the results of a single-arm meta-analysis of steroid-treated groups from 3 trials (59,71,73) evaluating 6-month functional outcomes using the ODI or RMDQ in patients who underwent caudal epidural steroid injections. As shown in Fig. 5B, the pooled mean difference in functional score from baseline to 6 months was a reduction of 31.81 points on a 0 to 100 scale (95% CI: -49.87 to -13.76; $I^2 = 99\%$; $P < 0.001$).

Figures 5C and 5D present the results of the single-arm meta-analysis of steroid-treated groups from 2 trials (59,73) at 12 months. The pooled mean difference from baseline was a reduction of 4.31 points in pain score (95% CI: -4.60 to -4.02; $I^2 = 0\%$; $P < 0.001$)

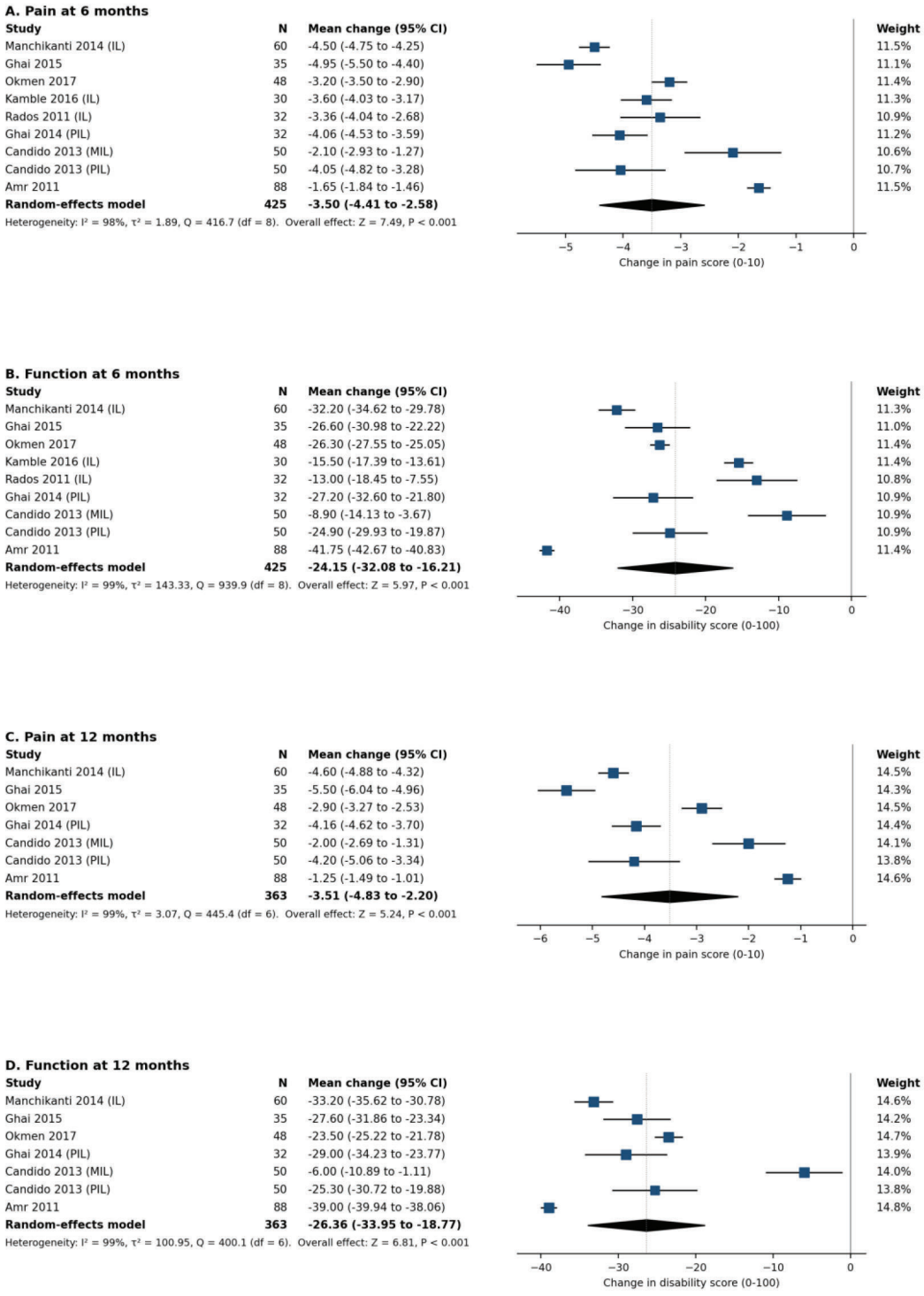


Fig. 4. *Results of single-arm meta-analysis testing the effects of interlaminar epidural steroid injections (ILESI) on pain and functionality at 6 and 12 months. A. Change in pain level at 6 months; B. Change in functionality level at 6 months; C. Change in pain level at 12 months; D. Change in functionality level at 12 months.*

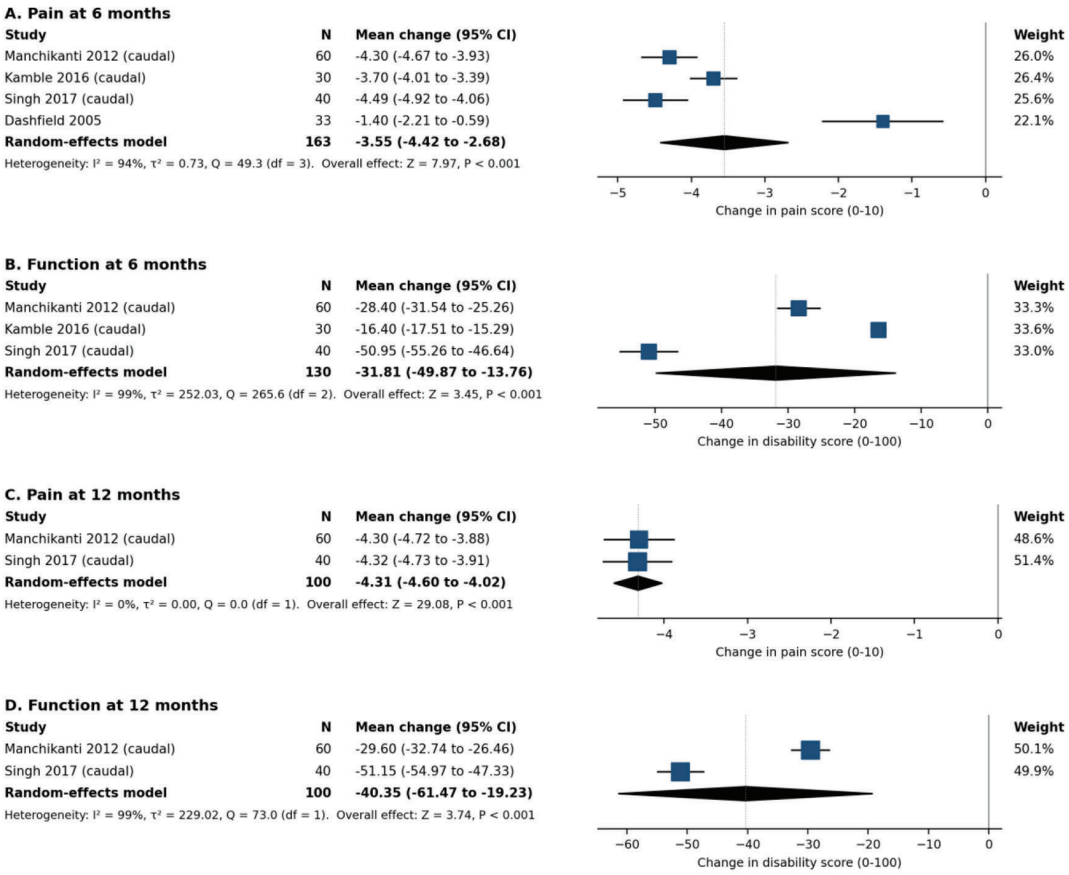


Fig. 5. *Results of single-arm meta-analysis testing the effects of caudal epidural steroid injections (CESI) on pain and functionality at 6 and 12 months. A. Change in pain level at 6 months; B. Change in functionality level at 6 months; C. Change in pain level at 12 months; D. Change in functionality level at 12 months.*

and a reduction of 40.35 points on a 0 to 100 scale in functional score (95% CI: -61.47 to -19.23; I^2 = 99%; P < 0.001).

Similar to the findings for transforaminal and interlaminar epidural injections, caudal epidural injections demonstrated significant improvements in pain and functional outcomes in the single-arm analysis at both 6 and 12 months. As shown in Fig. 5A, pain scores decreased by 3.55 points at 6 months and by 4.31 points at the 12-month follow-up. Functional outcomes also improved substantially, with disability scores decreasing by 31.81 points at 6 months and by 40.35 points at the 12-month follow-up.

Analysis of Evidence

GRADE assessment was performed as shown in Table 9. The GRADE evaluation considered methodologic limitations, consistency, indirectness, imprecision, publication bias, the number of patients in each study group, and the overall impact and certainty of the evidence. Among the 21 included RCTs, 5 were rated as having high impact and high certainty, 10 as having moderate impact and moderate certainty, and 6 as having low impact and low certainty.

Based on the qualitative analysis using the Cochrane review criteria, 16 trials were classified as high quality and 5 as moderate quality. Using the IPM-QRB criteria, 13 trials were classified as high quality and 8 as moderate quality. Overall, based on the findings from both assessment tools, 13 trials were high quality by both instruments, 3 were high quality by Cochrane review criteria and moderate quality by IPM-QRB criteria, and 5 were moderate quality by both; no trial was low quality.

Table 9. *GRADE assessment of randomized controlled trials evaluating the effectiveness of epidural injections in the lumbar spine.*

Article	Methodologic Limitation	Consistency	Indirectness	Imprecision	Publication Bias	Level of Certainty
Manchikanti et al (59)	Low	High	High	Low	Low	High
Ackerman & Ahmad (69)	High	Low	Low	High	Low	Low
Dashfield et al (70)	Moderate	Moderate	Moderate	Moderate	Low`	Moderate
Murakibhavi & Khemka (60)	High	Low	Low	Low	Low	High
Kamble et al (71)	Moderate	Moderate	Moderate	Moderate	Low	Moderate
Pandey (72)	High	Low	Low	Low	Low	High
Singh et al (73)	High	Low	Low	Low	Low	High
Manchikanti et al (61)	Low	High	High	High	Low	Low
Ghai et al (62)	Moderate	High	High	High	Low	Moderate
Okmen & Okmen (63)	Low	High	High	High	Low	Low
Rados (74)	High	Moderate	Moderate	Moderate	Low	Moderate
Ghai et al (75)	Low	High	High	High	Low	Low
Candido (76)	Moderate	Moderate	Moderate	Moderate	Low	Moderate
Amr (77)	Moderate	Moderate	Moderate	Moderate	Low	Moderate
Karppinen et al (64)	Moderate	Moderate	Moderate	Moderate	Low	Moderate
Manchikanti et al (65)	Low	High	High	High	Low	High
Riew et al (66,67)	Moderate	Moderate	Moderate	Moderate	Low	Moderate
Tafazal et al (68)	Moderate	Moderate	Moderate	Moderate	Low	Moderate
Vad et al (78)	High	Low	Low	Low	Low	Low
Jeong et al (79)	Moderate	Moderate	Moderate	Moderate	Low	Moderate
Kennedy et al (80)	Moderate	Moderate	Moderate	Moderate	Low	Moderate

Based on the quantitative analysis, conventional dual-arm meta-analysis of interlaminar epidural injections demonstrated a significant advantage with the addition of steroids for pain relief at 6 and 12 months, with no significant difference in functional improvement. In contrast, single-arm meta-analysis demonstrated significant improvements, with substantial reductions in both pain and disability scores following treatment with local anesthetic alone or local anesthetic with steroids.

The present systematic review and meta-analysis comparing transforaminal, interlaminar, and caudal approaches, using qualitative and quantitative analyses together with GRADE assessment, demonstrated Level I evidence with moderate certainty and a moderate recommendation for epidural injections using either local anesthetic with steroids or local anesthetic alone in the management of lumbar disc herniation. When evaluated by route of epidural access, there was Level I evidence supporting local anesthetic with steroids and Level II evidence supporting local anesthetic alone for the transforaminal and interlaminar approaches. For the caudal approach, Level II evidence supported both local anesthetics with steroids and local anesthetics alone for providing short-term and long-term relief, with moderate certainty and a moderate recommendation.

Discussion

The present systematic review and meta-analysis comparing transforaminal, interlaminar, and caudal approaches using qualitative and quantitative analyses along with GRADE assessment demonstrated Level I evidence, with moderate certainty and a moderate recommendation, supporting caudal, interlaminar, and transforaminal epidural injections for the management of lumbar disc herniation using either local anesthetic with steroids or local anesthetic alone. When the evidence was evaluated by route of epidural access, the use of local anesthetics with steroids was supported by level I evidence. In contrast, Level II evidence supported the use of local anesthetic alone for transforaminal and interlaminar approaches. For the caudal approach, Level II evidence supported both local anesthetic with steroids and local anesthetic alone for short-term and

long-term relief, with moderate certainty and a moderate recommendation.

Among the 21 included RCTs, 7 evaluated caudal epidural injections, 10 evaluated interlaminar epidural injections, and 13 evaluated transforaminal epidural injections. All 21 studies were included in the qualitative analysis. Conventional dual-arm meta-analysis of interlaminar epidural injections favored the local anesthetic-steroid combination over local anesthetic alone for pain relief at both 6 and 12 months. The difference in functional improvement did not reach statistical significance at either follow-up interval, and heterogeneity was high. Single-arm analysis expanded the number of eligible studies, with 4 to 6 transforaminal epidural injection trials demonstrating significant improvements in both pain and functional improvement when compared to baseline. Regarding the interlaminar approach, 8 trials were included and demonstrated significant improvements in pain and functional outcomes at both 6 and 12 months. Analysis of caudal epidural injections was limited to 4 eligible trials at the 6-month follow-up and 2 studies at 12 months. Despite the smaller number of studies, the findings consistently demonstrated significant efficacy of epidural steroid injections across all 3 approaches.

The qualitative synthesis yielded, one placebo-controlled trial (64) evaluating transforaminal epidural steroid injections with bupivacaine compared with normal saline and reported no overall effectiveness. Karppinen et al (64) conducted this trial in 2001, randomizing 80 patients to receive methylprednisolone with bupivacaine and 80 patients to receive sodium chloride solution. At the 3-month follow-up, treatment outcomes favored saline for back pain, and at 6 months, saline remained superior for both back pain and leg pain. By 12 months, no significant treatment differences were observed between the groups. Although this study is generally considered negative, the investigators subsequently performed subgroup analyses, adjusting between-group treatment differences at each follow-up by evaluating the proportion of patients achieving at least 75% improvement in leg pain and by applying an area-under-the-curve analysis of treatment efficacy (81). Cost-effectiveness was estimated by dividing total treatment costs by the number of responders. These analyses demonstrated that, among patients with contained disc herniations, steroid injections produced significant short-term improvements in leg pain.

Furthermore, for symptomatic L3-L5 lesions, steroids were superior to saline with respect to leg pain, disability, and straight-leg raise during the short-term follow-up. At one-year, steroid treatment appeared to reduce the need for surgery in patients with contained herniations, resulting in a cost savings of $12,666 per responder compared with saline. In contrast, among patients with extruded disc herniations, steroid treatment appeared to increase the rate of surgery and was associated with higher treatment costs, amounting to $4,445 more per responder. Nevertheless, this study used an inappropriate placebo design, limiting the validity of its primary conclusions. In effect, the authors' subsequent subgroup and cost-effectiveness analyses contradicted the findings reported in the primary analysis.

The second RCT, conducted by Murakibhavi and Khemka (60) in 2011, compared 50 patients treated with conservative management with 52 patients who received caudal epidural injections containing lidocaine and methylprednisolone. At the 6-month follow-up, 24% of patients in the conservative management group demonstrated improvement compared with 80% of patients treated with caudal epidural injections.

The remaining 19 studies evaluated a variety of treatment comparisons, including local anesthetic alone versus local anesthetic with steroids; non-particulate versus particulate steroids; caudal, interlaminar, and transforaminal techniques; preganglionic versus postganglionic approaches; trigger point injections versus epidural steroid injections; and caudal epidural injections versus endoscopic decompression in non-surgical patients. Overall, these studies demonstrated positive outcomes for both short-term and long-term follow-up.

Among the 13 trials evaluating transforaminal epidural injections, one was a placebo-controlled trial by Karppinen et al. (64), with a subsequent cost-utility analysis (81). Of the remaining 12 trials, 6 (68,71,72,74,75,78) reported long-term outcomes, all demonstrating positive results at one-year. The remaining studies had shorter follow-up durations but also reported favorable short-term outcomes. Among these studies, one trial (65) compared lidocaine alone with lidocaine plus steroids, whereas 2 trials (66-68) compared bupivacaine alone with bupivacaine plus steroids. Overall, outcomes were similar for lidocaine alone and lidocaine with steroids. In contrast, in the trial by Riew et al (66), bupivacaine with steroids produced significantly superior outcomes compared with bupivacaine alone and reduced the need for surgery, with surgery

avoided in 71% of patients receiving steroids compared with 33% of those receiving bupivacaine alone.

A total of 7 trials evaluating caudal epidural injections were included in this analysis. One controlled trial compared conservative management with treatment using local anesthetic and steroids (60), demonstrating an 80% improvement rate in the epidural injection group compared with 24% in the conservative management group. In addition, one study (59) compared lidocaine alone with lidocaine plus steroids and reported improvement at one year in 67% of patients treated with local anesthetic alone and 72% of those treated with local anesthetic plus steroids. However, when only responsive patients were analyzed, improvement was observed in 85% of patients receiving local anesthetic alone compared with 84% of those receiving local anesthetic with steroids. Overall, both treatment groups showed similar outcomes, although the steroid group had a longer average duration of pain relief. Other studies compared caudal, interlaminar, and transforaminal approaches, or caudal with transforaminal approaches, with improvements observed across all treatment groups. In one study (70), caudal epidural injections with local anesthetic and steroids were compared with endoscopic decompression, demonstrating significant improvement in both groups. Overall, the qualitative analysis showed positive findings from one active-controlled trial comparing local anesthetic alone with local anesthetic plus steroids (59) and one active-controlled trial comparing all 3 epidural techniques with one-year follow-up. The remaining studies reported positive outcomes over shorter follow-up periods.

For interlaminar epidural injections, 10 trials were included, all of which reported positive outcomes (61-63,69,71,72,74-77). Among these, 7 studies demonstrated sustained long-term improvement (61-63,72,75-77). There was substantial evidence supporting the effectiveness of local anesthetics alone; however, adding steroids to either lidocaine or bupivacaine resulted in greater pain relief compared with local anesthetics alone.

Of particular interest, Miller et al (28) published a randomized placebo-controlled trial evaluating long-acting dexamethasone viscous gel administered via transforaminal injection for lumbosacral radicular pain. This FDA-approved injectable dexamethasone viscous gel was developed to provide a safer formulation with prolonged local drug delivery. The randomized, double-blind, placebo-controlled, multicenter trial enrolled 401 patients with moderate-to-severe leg pain resulting from unilateral lumbar intervertebral disc herniation. Participants were randomized to receive transforaminal SP-102 or a sham intramuscular (IM) placebo injection and were followed for 24 weeks. Patients in both groups were eligible to receive repeat open-label SP-102 injections between 4 and 20 weeks if clinically indicated.

The primary and key secondary endpoints evaluated over the initial 4-week period demonstrated statistically significant pain relief with SP-102 compared with placebo, with a mean between-group difference of -0.52 (SE 0.163; $P = 0.002$) in the intent-to-treat population. Improvement in the Oswestry Disability Index averaged -3.38 (1.388), and the median time to repeat injection was 84 days for the SP-102 group compared with 58 days for the placebo group ($P = 0.001$). Most additional secondary endpoints also favored SP-102. No serious adverse events related to the study, medication, or procedure were reported, and there were no deaths or adverse events of special interest, including paraplegia, hematoma, or infection.

Despite its large sample size and multicenter design, this study did not meet the inclusion criteria for the present systematic review and meta-analysis because of its limited follow-up duration. Although statistically significant, the clinical benefit was modest, with pain scores improving by 1.81 points on an 11-point scale compared with 1.29 points in the placebo group. While the difference was statistically significant ($P = 0.002$), its clinical relevance remains questionable because it did not meet either a 50% reduction in pain or the predefined threshold of a 2-point reduction in pain intensity.

The findings of the present review are consistent with current clinical guidelines and multiple systematic reviews (5,8,10,17-20,24,26,32). Manchikanti et al (3) conducted a systematic review to determine whether epidural injection of sodium chloride solution serves as a true placebo or an active control. Using both conventional dual-arm and single-arm meta-analyses, they included 8 eligible trials, of which only 2 were performed under fluoroscopic guidance, and one utilized ultrasound guidance. Conventional dual-arm analysis demonstrated no significant differences between epidural sodium chloride solution and epidural steroids combined with sodium chloride solution. However, single-arm analyses showed that both epidural normal saline and epidural steroids with normal saline reduced pain by approximately 20%, although disability scores improved by only 10% to 12%. The authors concluded

that both epidural normal saline and epidural steroids with normal saline exert therapeutic effects beyond placebo, providing strong evidence that epidural normal saline is not an inert placebo and that both treatments are clinically effective.

In another systematic review and meta-analysis, Manchikanti et al (4) evaluated the effectiveness of epidural bupivacaine , with or without steroids, for low back and lower extremity pain. Four studies met the inclusion criteria. Both conventional dual-arm and single-arm meta-analyses demonstrated significant effectiveness for bupivacaine alone and bupivacaine combined with steroids. The authors concluded that epidurally administered bupivacaine functions as an active therapeutic agent rather than a placebo, providing Level I evidence, and that bupivacaine alone was nearly as effective as bupivacaine with steroids, representing Level II evidence. These findings clearly demonstrate that bupivacaine should not be considered a placebo. Consequently, reclassifying active-controlled trials using local anesthetics as placebo-controlled trials and subsequently concluding that local anesthetics are ineffective results in misleading interpretations and inappropriate conclusions.

Knezevic et al (5), in a systematic review and meta-analysis incorporating both dual-arm and single-arm analyses, evaluated the role of epidural lidocaine, with or without steroids, in the management of spinal pain. Fifteen studies met the inclusion criteria, including 4 evaluating caudal epidural injections, 2 evaluating lumbar transforaminal epidural injections, and 5 evaluating lumbar interlaminar epidural injections. The results demonstrated comparable improvements in pain and functional outcomes with epidural lidocaine administered alone or in combination with steroids for both short-term and long-term follow-up, providing Level II evidence. Once again, the single-arm analyses clearly demonstrated the therapeutic effects of both lidocaine alone and lidocaine with steroids, further supporting the conclusion that epidural lidocaine should not be considered a placebo.

Discordant conclusions reported in several systematic reviews (21,22,25) reflect multiple methodological challenges in the design and interpretation of RCTs, including differences in the epidural approach (transforaminal, interlaminar, or caudal), study design (active-control versus placebo-control), technical performance (with or without fluoroscopic guidance), procedural techniques, and outcome assessment methods (absolute differences between treatment groups versus MCID and the proportion of patients achieving clinically meaningful improvement). The IOM (41,82) identified numerous issues affecting the design and interpretation of systematic reviews, including study selection criteria (placebo-controlled versus active-controlled trials or the inappropriate reclassification of active-controlled trials as placebo-controlled), assessment of methodologic quality, outcome evaluation, and the influence of intellectual bias and conflicts of interest.

The IOM also emphasized the importance of recognizing and minimizing bias and conflicts of interest in the development of systematic reviews and clinical recommendations. It defined a conflict of interest as "a set of circumstances that creates a risk that a secondary interest will unduly influence professional judgement or actions regarding the primary interest." Although financial conflicts of interest are widely recognized, the IOM also identified secondary interests, including professional advancement, future funding opportunities, academic recognition, and the desire to benefit friends or colleagues, as potential sources of bias. Similar concerns have previously been described, highlighting hidden conflicts of interest not only among academic investigators but also within organizations that advise policymakers and develop evidence syntheses and clinical recommendations (1,18,19,27,41-59,82-85).

Similarly, the Institute for Translational Medicine and Therapeutics introduced the concept of "confluence" rather than "conflict of interest," recognizing that conflicts of interest exist within a complex ecosystem that requires a consistent and comprehensive approach to minimizing bias in academic clinical research (83). They further noted that the term "conflict of interest" may be viewed as pejorative and that disclosure policies have traditionally focused primarily on financial relationships. In contrast, in academic medicine, the pursuit of professional recognition and reputation may be as influential as financial gain. Several published systematic reviews are affected by intellectual bias and undisclosed confluence of interest, thereby diminishing the reliability and overall value of their conclusions.

Limitations

This review has several limitations. Few trials reported outcomes at 6 months or longer with appropriate outcome measures, and only one placebo-controlled trial met the inclusion criteria. Conventional dual-arm meta-analysis was feasible only for interlaminar epidural injections and included 3 trials with 287 patients. Heterogeneity was high in nearly all pooled

analyses. The single-arm analyses describe change from baseline within treated groups and cannot separate treatment effect from natural history. Disability was measured with different instruments and was converted to a common scale, standard deviations of change were imputed for most trials, and data from 5 trials were digitized from figures.

Conclusion

Epidural injections using local anesthetic with steroids demonstrated Level I evidence for both the transforaminal and interlaminar approaches, whereas local anesthetic alone demonstrated Level II evidence. In contrast, caudal epidural injections demonstrated Level II evidence for both local anesthetic with steroids and local anesthetic alone.

Author Contributions, Acknowledgments, and Disclosures

LM, NK, ADK, and JAH designed the study. All authors contributed to the preparation, review, and final approval of this article.

The authors wish to thank Melinda "Mindy" D. Adams, transcriptionist, for her assistance in the preparation of this manuscript. We would like to thank the editorial board of Pain Physician for their review and criticism, which helped improve the manuscript.

Generative artificial intelligence (Claude, Anthropic) used for language, editing, grammar, and readability improvement, article formatting, and reference formatting. It was not used to generate clinical content, scientific arguments, interpretation, or conclusions. All authors reviewed and verified the accuracy of all text, data and references.

Conflict of Interest

Dr. Soin has several patents in non-opioid pain pharmaceuticals and neuromodulation (SCS and PNS) and artificial intelligence, has leadership roles: OHSIPP-CEO and ASIPP- Director, has stock options with Neuros Medical, has received equipment, materials, drugs, medical writing, gifts or other services from Avanos for research, and has other financial or nonfinancial interests with Alyea Therapeutics, Neuros Medical, Neuronoff, BioTronik Neuro, and Avanos.

Dr. Abd-Elsayed is a consultant for Medtronic, Curonix, Avanos, and Averitas.

Dr. Hirsch receives grants or contracts from the Neiman Health Policy Institute, participates in DSMB work for Regeltech, Arsenal, Rapid Medical, and volunteers as an ASIPP Board Member, JNIS Deputy Editor, and SNIS Chair of the health policy committee.

All other authors certify that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted article.

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Appendix Table 1. *Sources of risk of bias and the Cochrane Review rating system.*

Bias Domain	Source of Bias		Possible Answers
Selection	(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, preordered sealed envelopes, sequentially ordered vials, telephone call to a central office, and preordered list of treatment assignments.	Yes/No/Unsure
		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.	
Selection	(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
Performance	(3) Was the patient blinded to the intervention?	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
Performance	(4) Was the care provider blinded to the intervention?	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
Detection	(5) Was the outcome assessor blinded to the intervention?	Adequacy of blinding should be assessed for each primary outcome separately. This item should be scored "yes" if the success of blinding was tested among the outcome assessors and it was successful or:	Yes/No/Unsure
		• 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., cointerventions, 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	
Attrition	(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 (N.B. these percentages are arbitrary, not supported by literature).	Yes/No/Unsure
Attrition	(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 noncompliance and cointerventions.	Yes/No/Unsure
Reporting	(8) Are reports of the study free of suggestion of selective outcome reporting?	All the results from all prespecified 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

Appendix Table 1 cont. *Sources of risk of bias and the Cochrane Review rating system.*

Bias Domain	**Source of Bias**		**Possible Answers**
Selection	(9) Were the groups similar at baseline regarding the most important prognostic indicators?	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
Performance	(10) Were cointerventions avoided or similar?	If there were no cointerventions or they were similar between the index and control groups.	Yes/No/Unsure
Performance	(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 for 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
Detection	(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 primary outcome measures.	Yes/No/Unsure
Other	(13) Are other sources of potential bias unlikely?	Other types of biases. For example: • When the outcome measures were not valid. There should be evidence from a previous or present scientific study that the primary outcome can be considered valid in the context of the present. • Industry-sponsored trials. The conflict of interest (COI) statement should explicitly state that the researchers have had full possession of the trial process from planning to reporting without funders with potential COI having any possibility to interfere in the process. If, for example, the statistical analyses have been done by a funder with a potential COI, usually "unsure" is scored.	Yes/No/Unsure

Adapted and modified from: Furlan AD et al; Editorial Board of the Cochrane Back, Neck Group. 2015 Updated method guideline for systematic reviews in the Cochrane Back and Neck Group. *Spine (Phila Pa 1976)* 2015; 40:1660-1673 (52).

Appendix Table 2. *Item checklist for assessment of randomized controlled trials of interventional pain management techniques utilizing IPM – QRB.*

		Scoring
I.	TRIAL DESIGN AND GUIDANCE REPORTING	
1.	CONSORT or SPIRIT	
	Trial designed and reported without any guidance	0
	Trial designed and reported utilizing minimum criteria other than CONSORT or SPIRIT criteria or trial was conducted prior to 2005	1
	Trial implies it was based on CONSORT or SPIRIT without clear description with moderately significant criteria for randomized trials or the trial was conducted before 2005	2
	Explicit use of CONSORT or SPIRIT with identification of criteria or trial conducted with high level reporting and criteria or conducted before 2005	3
II.	DESIGN FACTORS	
2.	Type and Design of Trial	
	Poorly designed control group (quasi selection, convenient sampling)	0
	Proper active-control or sham procedure with injection of active agent	2
	Proper placebo control (no active solutions into active structures)	3
3.	Setting/Physician	
	General setting with no specialty affiliation and general physician	0
	Specialty of anesthesia/PMR/neurology/radiology/ortho, etc.	1
	Interventional pain management with interventional pain management physician	2
4.	Imaging	
	Blind procedures	0
	Ultrasound	1
	CT	2
	Fluoro	3
5.	Sample Size	
	Less than 50 participants in the study without appropriate sample size determination	0
	Sample size calculation with less than 25 patients in each group	1
	Appropriate sample size calculation with at least 25 patients in each group	2
	Appropriate sample size calculation with 50 patients in each group	3
6.	Statistical Methodology	
	None or inappropriate	0
	Appropriate	1
III.	PATIENT FACTORS	
7.	Inclusiveness of Population	
7a.	For epidural procedures:	
	Poorly identified mixed population	0
	Clearly identified mixed population	1
	Disorders specific trials (i.e. well defined spinal stenosis and disc herniation, disorder specific, disc herniation or spinal stenosis or post surgery syndrome)	2
7b.	For facet or sacroiliac joint interventions:	
	No diagnostic blocks	0
	Selection with single diagnostic blocks	1
	Selection with placebo or dual diagnostic blocks	2
8.	Duration of Pain	

Appendix Table 2 cont. *Item checklist for assessment of randomized controlled trials of interventional pain management techniques utilizing IPM – QRB.*

		Scoring
	Less than 3 months	0
	3 to 6 months	1
	> 6 months	2
9.	Previous Treatments	
	Conservative management, including drug therapy, exercise therapy, physical therapy, etc.	
	Were not utilized	0
	Were utilized sporadically in some patients	1
	Were utilized in all patients	2
10.	Duration of Follow-up with Appropriate Interventions	
	Less than 3 months or 12 weeks for epidural or facet joint procedures, etc. and 6 months for intradiscal procedures and implantables	0
	3 to 6 months for epidural or facet joint procedures, etc., or 1 year for intradiscal procedures or implantables	1
	6 months to 18 months for epidurals or facet joint procedures, etc., and 2 years or longer for discal procedures and implantables	2
	18 months or longer for epidurals and facet joint procedures, etc., or 5 years or longer for discal procedures and implantables	3
IV.	OUTCOMES	
11.	Outcomes Assessment Criteria for Significant Improvement	
	No descriptions of outcomes OR < 20% change in pain rating or functional status	0
	Pain rating with a decrease of 2 or more points or more than 20% reduction OR functional status improvement of more than 20%	1
	Pain rating with decrease of ≥ 2 points AND 20% change or functional status improvement of ≥ 20%	2
	Pain rating with a decrease of 3 or more points or more than 50% reduction OR functional status improvement with a 50% or 40% reduction in disability score	2
	Significant improvement with pain and function ≥ 50% or 3 points and 40% reduction in disability scores	4
12.	Analysis of all Randomized Participants in the Groups	
	Not performed	0
	Performed without intent-to-treat analysis without inclusion of all randomized participants	1
	All participants included with or without intent-to-treat analysis	2
13.	Description of Drop Out Rate	
	No description of dropouts, despite the reporting of incomplete data or ≥ 20% withdrawal	0
	Less than 20% withdrawal in one year in any group	1
	Less than 30% withdrawal at 2 years in any group	2
14.	Similarity of Groups at Baseline for Important Prognostic Indicators	
	Groups dissimilar with significant influence on outcomes with or without appropriate randomization and allocation	0
	Groups dissimilar without influence on outcomes despite appropriate randomization and allocation	1
	Groups similar with appropriate randomization and allocation	2
15.	Role of Co-Interventions	
	Co-interventions were provided but were not similar in the majority of participants	0
	No co-interventions or similar co-interventions were provided in the majority of the participants	1

Appendix Table 2 cont. *Item checklist for assessment of randomized controlled trials of interventional pain management techniques utilizing IPM – QRB.*

		Scoring
V.	RANDOMIZATION	
16.	Method of Randomization	
	Quasi randomized or poorly randomized or not described	0
	Adequate randomization (coin toss, drawing of balls of different colors, drawing of ballots)	1
	High quality randomization (Computer generated random sequence, pre-ordered sealed envelopes, sequentially ordered vials, telephone call, pre-ordered list of treatment assignments, etc.)	2
VI.	ALLOCATION CONCEALMENT	
17.	Concealed Treatment Allocation	
	Poor concealment of allocation (open enrollment) or inadequate description of concealment	0
	Concealment of allocation with borderline or good description of the process with probability of failure of concealment	1
	High quality concealment with strict controls (independent assignment without influence on the assignment sequence)	2
VII.	BLINDING	
18.	Patient Blinding	
	Patients not blinded	0
	Patients blinded adequately	1
19.	Care Provider Blinding	
	Care provider not blinded	0
	Care provider blinded adequately	1
20.	Outcome Assessor Blinding	
	Outcome assessor not blinded or was able to identify the groups	0
	Performed by a blinded independent assessor with inability to identify the assignment-based provider intervention (i.e., subcutaneous injection, intramuscular distant injection, difference in preparation or equipment use, numbness and weakness, etc.)	1
VIII.	CONFLICTS OF INTEREST	
21.	Funding and Sponsorship	
	Trial included industry employees	-3
	Industry employees involved; high levels of funding with remunerations by industry or an organization funded with conflicts	-3
	Industry or organizational funding with reimbursement of expenses with some involvement	0
	Industry or organization funding of expenses without involvement	1
	Funding by internal resources only with supporting entity unrelated to industry	2
	Governmental funding without conflict such as NIH, NHS, AHRQ	3
22.	Conflicts of Interest	
	None disclosed with potential implied conflict	0
	Marginally disclosed with potential conflict	1
	Well disclosed with minor conflicts	2
	Well disclosed with no conflicts	3
	Hidden conflicts with poor disclosure	–1
	Misleading disclosure with conflicts	–2
	Major impact related to conflicts	–3
TOTAL		48

Source: Manchikanti L, et al. Assessment of methodologic quality of randomized trials of interventional techniques: Development of an interventional pain management-specific instrument. *Pain Physician* 2014; 17:E263-E290 (53).

Appendix Table 3. *Methodological quality assessment of randomized trials of epidural injections in lumbar disc herniation utilizing Cochrane review criteria.*

	Manchikanti et al (59)	Ackerman & Ahmad (69)	Dashfield et al (70)	Murakibhavi & Khemka (60)	Kamble et al (71)	Pandey (72)	Singh et al (73)	Manchikanti et al (61)
Randomization adequate	Y	N	Y	Y	Y	N	N	Y
Concealed treatment allocation	Y	N	Y	N	Y	N	N	Y
Patient blinded	Y	N	Y	Y	Y	N	N	Y
Care provider blinded	Y	N	N	N	N	N	N	Y
Outcome assessor blinded	N	N	N	N	Y	N	N	N
Drop-out rate described	Y	Y	Y	Y	N	Y	Y	Y
All randomized participants analyzed in the group	Y	Y	Y	Y	N	Y	Y	Y
Reports of the study free of suggestion of selective outcome reporting	Y	Y	Y	Y	Y	Y	Y	Y
Groups similar at baseline regarding most important prognostic indicators	Y	Y	Y	N	Y	Y	Y	N
Co-interventions avoided or similar	Y	Y	N	N	Y	Y	Y	Y
Compliance acceptable in all group	Y	Y	Y	Y	U	Y	Y	Y
Time of outcome assessment in all groups similar	Y	Y	Y	Y	Y	Y	Y	Y
Are other sources of potential bias likely	Y	Y	Y	Y	Y	Y	Y	Y
Score	12/13	8/13	10/13	8/13	9/13	8/13	8/13	11/13

	Ghai et al (62)	Ökmen & Ökmen (63)	Rados et al (74)	Ghai et al (75)	Candido et al (76)	Amr (77)	Karppinen et al (64)	Manchikanti et al (65)
Randomization adequate	Y	Y	Y	Y	Y	Y	Y	Y
Concealed treatment allocation	Y	Y	N	Y	Y	Y	Y	Y
Patient blinded	Y	Y	N	N	N	Y	Y	Y
Care provider blinded	N	Y	N	N	N	Y	Y	Y
Outcome assessor blinded	N	Y	N	N	N	Y	Y	N
Drop-out rate described	N	Y	Y	Y	Y	Y	Y	Y
All randomized participants analyzed in the group	Y	N	Y	Y	Y	N	Y	Y
Reports of the study free of suggestion of selective outcome reporting	Y	Y	Y	Y	Y	Y	Y	Y
Groups similar at baseline regarding most important prognostic indicators	Y	Y	Y	Y	Y	Y	Y	N
Co-interventions avoided or similar	Y	Y	Y	Y	Y	Y	Y	Y
Compliance acceptable in all group	Y	Y	Y	Y	Y	Y	Y	Y
Time of outcome assessment in all groups similar	Y	Y	Y	Y	Y	Y	Y	Y
Are other sources of potential bias likely	Y	Y	Y	Y	Y	Y	Y	Y
Score	10/13	12/13	9/13	10/13	10/13	12/13	13/13	11/13

Appendix Table 3 (cont.). *Methodological quality assessment of randomized trials of epidural injections in lumbar disc herniation utilizing Cochrane review criteria.*

	Riew et al (66,67)	Tafazal et al (68)	Vad et al (78)	Jeong et al (79)	Kennedy et al (80)
Randomization adequate	U	Y	U	U	Y
Concealed treatment allocation	U	Y	N	U	Y
Patient blinded	Y	Y	N	Y	N
Care provider blinded	N	Y	N	N	N
Outcome assessor blinded	Y	N	U	Y	N
Drop-out rate described	Y	Y	N	Y	Y
All randomized participants analyzed in the group	Y	N	N	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	U	Y	Y	Y	Y
Co-interventions avoided or similar	Y	Y	Y	Y	Y
Compliance acceptable in all group	Y	Y	U	Y	Y
Time of outcome assessment in all groups similar	Y	Y	Y	Y	Y
Are other sources of potential bias likely	Y	Y	Y	Y	Y
Score	9/13	11/13	5/13	10/13	10/13

Y = Yes; N = No; U = Unclear

Adapted from: Manchikanti L et al. Epidural injections for lumbar radiculopathy or sciatica: A comparative systematic review and meta-analysis of Cochrane reviews. Pain Physician 2021; 24:E539-E554 (18).

Source: Furlan AD, Malmivaara A, Chou R, Maher CG, Deyo RA, Schoene M, Bronfort G, van Tulder MW; Editorial Board of the Cochrane Back, Neck Group. 2015 Updated Method Guideline for Systematic Reviews in the Cochrane Back and Neck Group. *Spine (Phila Pa 1976)* 2015; 40:1660-1673 (50).

Appendix Table 4. *Methodologic quality assessment of randomized trials of epidural injections in lumbar disc herniation utilizing IPM – QRB.*

		Manchikanti et al (59)	Ackerman & Ahmad (69)	Dashfield et al (70)	Murakibhavi & Khemka (60)	Kamble et al (71)	Pandey (72)	Singh et al (73)	Manchikanti et al (61)
I.	TRIAL DESIGN AND GUIDANCE REPORTING								
1.	CONSORT or SPIRIT	3	0	1	2	0	0	1	3
II.	DESIGN FACTORS								
2.	Type and Design of Trial	2	2	2	2	2	2	2	2
3.	Setting/Physician	2	2	2	1	2	2	2	2
4.	Imaging	3	3	3	3	2	2	3	3
5.	Sample Size	3	1	1	2	2	1	2	3
6.	Statistical Methodology	1	1	1	1	1	1	1	1
III.	PATIENT FACTORS								
7.	Inclusiveness of Population	2	2	1	2	2	2	2	2
8.	Duration of Pain	2	1	2	1	1	2	2	2
9.	Previous Treatments	2	0	0	0	2	2	2	2
10.	Duration of Follow-up with Appropriate Interventions	3	2	2	1	1	2	1	3
IV.	OUTCOMES								
11.	Outcomes Assessment Criteria for Significant Improvement	4	1	2	4	2	2	2	4
12.	Analysis of all Randomized Participants in the Groups	2	2	2	2	2	2	2	2
13.	Description of Drop Out Rate	2	2	2	2	0	2	2	2
14.	Similarity of Groups at Baseline for Important Prognostic Indicators	1	1	1	0	1	1	1	1
15.	Role of Co-Interventions	1	1	1	0	1	1	1	1
V.	RANDOMIZATION								
16.	Method of Randomization	2	0	2	0	2	0	0	2
VI.	ALLOCATION CONCEALMENT								
17.	Concealed Treatment Allocation	2	0	2	2	2	0	0	2
VII.	BLINDING								
18.	Patient Blinding	1	0	1	1	1	0	0	1
19.	Care Provider Blinding	1	0	0	0	0	0	0	1
20.	Outcome Assessor Blinding	0	0	0	0	1	0	0	0

Appendix Table 4 cont. *Methodologic quality assessment of randomized trials of epidural injections in lumbar disc herniation utilizing IPM – QRB.*

		Manchikanti et al (59)	**Ackerman & Ahmad (69)**	**Dashfield et al (70)**	**Murakibhavi & Khemka (60)**	**Kamble et al (71)**	**Pandey (72)**	**Singh et al (73)**	**Manchikanti et al (61)**
VIII.	CONFLICTS OF INTEREST								
21.	Funding and Sponsorship	2	1	2	0	2	2	2	2
22.	Conflicts of Interest	3	3	3	1	3	3	2	3
TOTAL		44	25	33	27	32	29	30	44

		Ghai et al (62)	Ökmen & Ökmen (63)	Rados et al (74)	Ghai et al (75)	Candido et al (76)	Amr (77)	Karppinen et al (64)	Manchikanti et al (65)
I.	TRIAL DESIGN AND GUIDANCE REPORTING								
1.	CONSORT or SPIRIT	3	2	2	3	2	2	2	3
II.	DESIGN FACTORS								
2.	Type and Design of Trial	2	2	2	2	2	2	2	2
3.	Setting/Physician	2	2	3	2	2	3	1	2
4.	Imaging	3	3	3	3	3	3	3	3
5.	Sample Size	2	3	1	2	2	3	3	3
6.	Statistical Methodology	1	1	1	1	1	1	1	1
III.	PATIENT FACTORS								
7.	Inclusiveness of Population	2	2	1	2	2	2	2	2
8.	Duration of Pain	1	2	2	2	1	2	0	2
9.	Previous Treatments	1	2	0	2	2	2	0	2
10.	Duration of Follow-up with Appropriate Interventions	3	2	2	3	2	3	1	3
IV.	OUTCOMES								
11.	Outcomes Assessment Criteria for Significant Improvement	4	2	2	4	2	2	2	4
12.	Analysis of all Randomized Participants in the Groups	2	1	2	2	2	1	2	2
13.	Description of Drop Out Rate	0	2	2	2	2	2	1	2
14.	Similarity of Groups at Baseline for Important Prognostic Indicators	2	2	2	2	2	2	2	1
15.	Role of Co-Interventions	1	1	1	1	1	1	0	1
V.	RANDOMIZATION								
16.	Method of Randomization	2	2	2	2	2	2	2	2
VI.	ALLOCATION CONCEALMENT								
17.	Concealed Treatment Allocation	2	2	0	2	2	2	2	2
VII.	BLINDING								
18.	Patient Blinding	1	1	0	0	0	1	1	1
19.	Care Provider Blinding	0	0	0	0	0	1	1	1
20.	Outcome Assessor Blinding	0	1	0	0	0	1	1	0
VIII.	CONFLICTS OF INTEREST								
21.	Funding and Sponsorship	2	2	0	2	2	0	2	2
22.	Conflicts of Interest	3	3	2	3	3	0	3	3
TOTAL		39	40	30	42	37	38	34	44

Appendix Table 4 cont. *Methodologic quality assessment of randomized trials of epidural injections in lumbar disc herniation utilizing IPM – QRB.*

		Riew et al (66,67)	Tafazal et al (68)	Vad et al (78)	Jeong et al (79)	Kennedy et al (80)
I.	TRIAL DESIGN AND GUIDANCE REPORTING					
1.	CONSORT or SPIRIT	1	2	1	2	3
II.	DESIGN FACTORS					
2.	Type and Design of Trial	2	2	2	2	2
3.	Setting/Physician	1	1	1	1	2
4.	Imaging	3	3	2	3	3
5.	Sample Size	2	1	1	3	2
6.	Statistical Methodology	1	1	1	1	1
III.	PATIENT FACTORS					
7.	Inclusiveness of Population	2	1	2	1	2
8.	Duration of Pain	1	1	0	0	0
9.	Previous Treatments	2	2	0	0	2
10.	Duration of Follow-up with Appropriate Interventions	2	1	1	2	1
IV.	OUTCOMES					
11.	Outcomes Assessment Criteria for Significant Improvement	1	2	2	2	2
12.	Analysis of all Randomized Participants in the Groups	2	1	0	2	2
13.	Description of Drop Out Rate	2	1	0	2	1
14.	Similarity of Groups at Baseline for Important Prognostic Indicators	2	1	0	2	2
15.	Role of Co-Interventions	0	1	1	1	1
V.	RANDOMIZATION					
16.	Method of Randomization	1	2	0	1	2
VI.	ALLOCATION CONCEALMENT					
17.	Concealed Treatment Allocation	0	2	0	0	2
VII.	BLINDING					
18.	Patient Blinding	1	1	0	1	0
19.	Care Provider Blinding	1	1	0	0	0
20.	Outcome Assessor Blinding	0	0	0	1	0
VIII.	CONFLICTS OF INTEREST					
21.	Funding and Sponsorship	2	2	0	2	0
22.	Conflicts of Interest	3	3	2	2	0
TOTAL		32	32	16	31	30

Adapted from: Manchikanti L, et al. Epidural injections for lumbar radiculopathy or sciatica: A comparative systematic review and meta-analysis of Cochrane review. *Pain Physician* 2021; 24:E539-E554 (18).
Source: Manchikanti L, et al. Assessment of methodologic quality of randomized trials of interventional techniques: Development of an interventional pain management specific instrument. Pain Physician 2014; 17:E263-E290 (53).