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REVIEW

Epidural Corticosteroid Injections for Radiculopathy and Spinal Stenosis

A Systematic Review and Meta-analysis

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Background: Use of epidural corticosteroid injections is increasing.

Purpose: To review evidence on the benefits and harms of epidural corticosteroid injections in adults with radicular low back pain or spinal stenosis of any duration.

Data Sources: Ovid MEDLINE (through May 2015), Cochrane Central Register of Controlled Trials, Cochrane Database of Systematic Reviews, prior systematic reviews, and reference lists.

Study Selection: Randomized trials of epidural corticosteroid injections versus placebo interventions, or that compared epidural injection techniques, corticosteroids, or doses.

Data Extraction: Dual extraction and quality assessment of individual studies, which were used to determine the overall strength of evidence (SOE).

Data Synthesis: 30 placebo-controlled trials evaluated epidural corticosteroid injections for radiculopathy, and 8 trials were done for spinal stenosis. For radiculopathy, epidural corticosteroids were associated with greater immediate-term reduction in pain (weighted mean difference on a scale of 0 to 100, −7.55 [95% CI, −11.4 to −3.74]; SOE, moderate), function (standardized mean difference after exclusion of an outlier trial, −0.33 [CI, −0.56 to −0.09]; SOE, low), and short-term surgery risk (relative risk, 0.62 [CI, 0.41 to 0.92]; SOE, low). Effects were below predefined minimum clinically important difference thresholds, and there were no longer-term benefits. Limited evidence showed no clear effects of technical factors, patient characteristics, or comparator interventions on estimates. There were no clear effects of epidural corticosteroid injections for spinal stenosis (SOE, low to moderate). Serious harms were rare, but harms reporting was suboptimal (SOE, low).

Limitations: The review was restricted to English-language studies. Some meta-analyses were based on small numbers of trials (particularly for spinal stenosis), and most trials had methodological shortcomings.

Conclusion: Epidural corticosteroid injections for radiculopathy were associated with immediate reductions in pain and function. However, benefits were small and not sustained, and there was no effect on long-term surgery risk. Limited evidence suggested no effectiveness for spinal stenosis.

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Low back pain is one of the most frequently encountered conditions in clinical practice (1–5). Although most low back pain is nonradicular, symptomatic spinal stenosis or herniated disc each occur in about 3% to 4% of patients (6). Epidural corticosteroid injections are most commonly performed for radiculopathy due to a herniated disc, but may also be given for spinal stenosis. Despite conflicting conclusions from systematic reviews (7–13) and discordant clinical practice guidelines (14–17), use of epidural injections has increased (18, 19).

Challenges in interpreting the evidence on epidural corticosteroid injections include variability in the methods used to select patients for inclusion, the injection techniques used, choice of comparators, and when and how outcomes are assessed (10, 20). The purpose of this systematic review is to synthesize the current evidence on the effects of epidural corticosteroid injections for radiculopathy and spinal stenosis.

METHODS

Detailed methods and data for this review, including the analytic framework, key questions, search strategies, inclusion criteria, study data extraction, and quality ratings, are available in the full report (21). The full report also addresses other types of injections, nonradicular and postsurgical back pain, and effects of epidural injections versus active comparators. The protocol was developed by using a standardized process (22) with input from experts and the public, and was posted on the Agency for Healthcare Research and Quality (AHRQ) Web site on 29 May 2014 (23). This article focuses on the effectiveness and harms of epidural corticosteroid injections for radiculopathy or spinal stenosis, and whether effectiveness estimates vary according to technical factors, patient characteristics, or type of placebo comparator.

We defined "placebo interventions" as epidural saline or local anesthetic injections without corticosteroid, a soft-tissue injection, or no injection, on the basis of the assumption that therapeutic effects in the epidural

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space are primarily related to the corticosteroid. Technical factors included the corticosteroid or local anesthetic used, medication doses, volume of injectate, number of levels injected, frequency and number of injections, use of imaging guidance, and route of administration. Patient characteristics included demographic (for example, age, sex, race) and clinical factors (for example, imaging findings, duration of symptoms, and presence of psychosocial factors or neurologic findings).

Data Sources and Searches

A research librarian searched MEDLINE, the Cochrane Central Register of Controlled Trials, and the Cochrane Database of Systematic Reviews from 2008 through May 2015. Studies published before 2008 were identified from prior reviews that we conducted (7, 24). We also reviewed reference lists and searched ClinicalTrials.gov.

Study Selection

Two investigators independently reviewed abstracts and full-text articles against prespecified eligibility criteria. We included randomized trials of adults undergoing epidural corticosteroid injections versus placebo interventions for radicular low back pain or spinal stenosis of any duration. We considered "sciatica" to be synonymous with radiculopathy. We included epidural injections performed via any approach, as well as transforaminal injections that did not necessarily enter the epidural space ("periradicular" injections). We also included studies that directly compared injection techniques, corticosteroids, and corticosteroid doses. Outcomes were pain, function, composite outcomes, subsequent surgery measured at least 5 days after the injection, and local and systemic harms. For harms, we also included large treatment series (sample size >1000 patients).

We excluded studies of back pain due to fracture, high-impact trauma, cancer, or infection.

Data Extraction and Quality Assessment

One investigator extracted details about the study design, patient sample, setting, interventions, and results. Another investigator verified extractions for accuracy. Two investigators independently assessed risk of bias ("quality") for each randomized trial as good, fair, or poor by using predefined criteria (25). Discrepancies were resolved through a consensus process.

Data Synthesis and Analysis

We conducted meta-analyses by using the Dersimonian–Laird random-effects method in Stata/IC 13.0 (StataCorp LP). Statistical heterogeneity was measured with the Cochran chi-square test and the I^2 statistic (26). When statistical heterogeneity was present, we repeated meta-analysis by using the profile likelihood method (27). All analyses were stratified by the approach used (transforaminal, interlaminar, or caudal). Outcomes were analyzed as immediate (5 days to ≤2 weeks), short-term (2 weeks to ≤3 months), intermediate-term (3 months to <1 year), and long-term (>1 year), using the longest-duration data available within each category. For continuous outcomes, pain scores were converted to a scale of 0 to 100 and pooled as weighted mean differences (WMDs); function was pooled as standardized mean differences (SMDs) unless all trials in an analysis reported the same functional outcome. We used pain scores for leg pain when available, and overall or back pain when leg pain was not reported. The mean difference was calculated from the change from baseline to follow-up; sensitivity analysis based on adjusted estimates (for example, analysis of covariance) or differences in follow-up scores gave similar results and are not reported further. We imputed missing SDs by using the mean value from other studies in that analysis.

For dichotomous outcomes, we pooled relative risks (RRs) for successful (as defined in the trials) pain, function, and composite outcomes and rates of subsequent surgery. To investigate whether certain placebo interventions might have therapeutic effects, we also performed separate pooled analyses on the placebo group response rates for continuous and dichotomous outcomes, stratified by the specific type of placebo comparator.

We performed sensitivity analyses excluding poor-quality and outlier studies, and subgroup analyses and meta-regression on the corticosteroid, corticosteroid dose (in prednisolone equivalents), the local anesthetic, the comparator, injectate volume, symptom duration, use of imaging correlation, use of fluoroscopic guidance, number of injections, exclusion of patients with prior surgery, year of publication, and blinding methods. For analyses with at least 10 studies, we created funnel plots and performed the Egger test for small sample effects (28).

We defined a minimum clinically important difference as an improvement in 15 points on a pain scale of 0 to 100, 10 points on the Oswestry Low Back Pain Disability Index (ODI), and 5 points on the Roland–Morris Disability Questionnaire (RDQ) (29).

We assessed the overall strength of each body of evidence as high, moderate, low, or insufficient on the basis of aggregate study quality, precision, consistency, and directness (22).

Role of the Funding Source

The AHRQ funded the review at the request of the Centers for Medicare & Medicaid Services, who assisted in developing the scope of the review and key questions. Neither organization had a role in study selection, quality assessment, or synthesis. The investigators are solely responsible for the content.

RESULTS

The literature search and selection is summarized in the Appendix Figure (available at www.annals.org). Database searches resulted in 202 potentially relevant articles. After full-text dual review, 59 trials and 4 observational studies met inclusion criteria for the interventions and comparisons addressed in this article.

Thirty trials (26 to 239 participants) compared epidural corticosteroid injections via various approaches with placebo interventions for radiculopathy (30–58), and 8 trials (29 to 386 participants) compared epidural corticosteroid injections with placebo interventions for spinal stenosis (**Appendix Table 1**, available at www.annals.org) (37, 40, 59–64). Duration of follow-up ranged from 1 week to 3 years. The trials primarily evaluated patients with chronic symptoms.

Four trials of epidural injections for radiculopathy (60 to 106 participants) (65–68) and 1 trial of spinal stenosis (70 participants) (69) evaluated effects of one corticosteroid versus another, and 6 trials (33 to 60 participants) evaluated corticosteroid dose effects (70–75). Eleven trials (30 to 239 participants) directly compared alternative epidural injection techniques (46, 76–85). Two trials compared effects of different patient evaluation and selection methods involving imaging (86, 87).

Five trials were rated as good-quality (36, 43, 44, 59, 84), 40 trials as fair-quality, and 14 trials as poor-quality. Methodological shortcomings included failure to report adequate randomization or allocation concealment methods; inadequate blinding of outcome assessors, injectionists, or patients; high or unclearly reported attrition; and failure to specify primary outcomes.

Effectiveness

Radiculopathy

Epidural corticosteroid injections were associated with greater immediate reduction in pain intensity compared with placebo interventions (6 trials; WMD on a scale of 0 to 100, −7.55 [95% CI, −11.4 to −3.74]; I^2 = 30%; strength of evidence [SOE], moderate) (33, 38, 41, 44, 45, 57) (**Figure 1** of the **Supplement**, available at www.annals.org), but differences were smaller and not statistically significant at longer follow-up (SOE, low to moderate) (**Appendix Table 2**, available at www.annals.org. and **Figures 2** to **4** of the **Supplement**). For immediate functional improvement, effects favored epidural corticosteroids, but the difference was not statistically significant (4 trials; SMD, −0.75 [CI, −1.62 to 0.11]; I^2 = 94%; SOE, low) (33, 44, 54, 57) (**Figure 5** of the **Supplement**). Statistical heterogeneity was substantial owing to an outlier trial (54) that reported a much stronger effect than the other trials (SMD, −1.90 [CI −2.25 to −1.55] vs. −0.24 to −0.52, respectively). Effects were smaller but statistically significant when this trial was excluded (3 trials; SMD, −0.33 [CI, −0.56 to −0.09]; I^2 = 0%). There were no statistically significant effects at other time points (SOE, low to moderate), with or without the outlier trial (**Figures 6** to **8** of the **Supplement**).

Epidural corticosteroid injections and placebo interventions did not differ in the likelihood of a successful outcome for pain (SOE, low to moderate), function (SOE, low), or a composite outcome (SOE, low to moderate) at any time point (**Appendix Table 1**, available at www.annals.org, and **Figures 9 to 17** of the **Supplement**). Epidural corticosteroid injections were associated with lower short-term risk for surgery than placebo interventions (8 trials; RR, 0.62 [CI, 0.41 to 0.92]; I^2 = 0%; SOE, low) (38, 39, 45, 46, 54, 57, 88) (**Figure 18** of the **Supplement**). The point estimate was similar but the difference no longer statistically significant when 3 poor-quality trials (38, 46) were excluded (5 trials; RR, 0.69 [CI, 0.42 to 1.13]). There was no difference in risk for long-term surgery (14 trials; RR, 0.97 [CI, 0.75 to 1.25]; I^2 = 23%; SOE, moderate) (30, 34, 36, 37, 40, 41, 43, 44, 50, 53, 55, 56, 58, 89) (**Figure 19** of the **Supplement**).

For outcomes other than short-term surgery, exclusion of poor-quality trials had little effect on findings. Year of publication (before or after 2000) or blinding of patients or outcomes assessors also had no effect. Funnel plots did not suggest small sample effects (**Figures 20** to **22** of the **Supplement**).

Spinal Stenosis

One good-quality trial (386 participants) found fluoroscopically guided interlaminar or transforaminal epidural corticosteroid injections to be associated with greater improvement in the RDQ at 3 weeks compared with an epidural local anesthetic (difference on a scale of 0 to 24, −1.8 [CI, −2.8 to −0.9]), although the difference was smaller and no longer statistically significant at 6 weeks (−1.0 [CI, −2.1 to 0.1]). There were no differences in the likelihood of having a greater than 30% or greater than 50% improvement in the RDQ or pain scores at 6 weeks, or on improvement in pain intensity at 3 or 6 weeks (59).

Pooled analyses were consistent with the good-quality trial (**Appendix Table 3**, available at www.annals .org), with small, non–statistically significant effects on pain intensity (WMD, 0.62 to 3.73 points) at short- and intermediate-term follow-up (SOE, low to moderate)(**Figures 23** and **24** of the **Supplement**). Evidence on longer-term effects was sparse, and only 1 small trial (29 participants) evaluated effects on immediate pain intensity (WMD, −22.0 [CI, −36.0 to −8.00]; SOE, low)(61). There were no differences in functional improve-ment (**Figure 25** of the **Supplement**) or likelihood of experiencing a successful pain, function, or composite outcome at any time point, although estimates were based on few trials (SOE low, except for short-term function [moderate]). Findings were similar when poor-quality trials were excluded.

Technical Factors

Five head-to-head trials of transforaminal versus interlaminar epidural corticosteroid injections for radiculopathy found no differences in reduction in pain intensity or function at any time point (76–78, 80, 90) (**Appendix Table 4**, available at www.annals.org, and **Figures 26** to **29** of the **Supplement**). Findings were similar when trials were stratified according to whether lower doses of corticosteroid were administered with the transforaminal approach (77, 90) or equivalent doses were administered with both approaches (76, 78, 80), or when a trial in which transforaminal injections did not clearly enter the epidural space (78) was excluded. There were also no clear differences on any outcome when placebo-controlled trials were stratified

according to the approach used at any time point; however, estimates were imprecise (Appendix Table 5, available at www.annals.org).

A stratified analysis from a trial of epidural corticosteroid injections for spinal stenosis that permitted either the transforaminal or interlaminar approach found that only interlaminar corticosteroid injections were associated with greater improvement at 3 weeks on the RDQ (difference on a scale of 0 to 10, −2.5 [CI, −3.7 to −1.3]) and on leg pain (difference, −0.9 [CI, −1.5 to −0.3]) versus epidural local anesthetic (59). There was no effect of either approach on 6-week outcomes on the basis of the prespecified *P* value of 0.025 for subgroup analyses. Trials that compared alternative approaches (oblique interlaminar or lateral parasagittal) with standard interlaminar or transforaminal approaches for radiculopathy found no clear differences in pain, function, or other outcomes (46, 81–84). One fair-quality trial (239 participants) found the transforaminal ganglionic approach to be associated with a lower likelihood of overall "good" or "excellent" results compared with the preganglionic approach at 1 month (71% vs. 88%; RR, 0.80 [CI, 0.70 to 0.91]), although the difference was no longer present at longer (>6 month) follow-up (85).

Head-to-head trials found no clear differences in outcomes among corticosteroids (4 trials [65–68]) or among corticosteroid doses (7 trials [69–75]). However, some estimates were imprecise, trials varied in the corticosteroids and doses that were compared, some trials that compared corticosteroids evaluated nontherapeutically equivalent doses (65, 66), and routes of administration and duration of follow-up varied (Appendix Table 1). All trials evaluated patients with radiculopathy, except for 1 trial of patients with spinal stenosis (69).

No study directly compared epidural injections with versus without imaging guidance. One fair-quality trial (110 participants) found no differences between a caudal epidural injection with fluoroscopic plus Doppler guidance for chronic radicular pain versus fluoroscopic guidance alone in pain or ODI scores through 12 weeks (86). All placebo-controlled trials of the transforaminal approach used fluoroscopic guidance, and no trials of the interlaminar approach used fluoroscopic guidance. For spinal stenosis, there were no clear differences between trials that used or did not use fluoroscopic guidance, but analyses were limited by small numbers of trials. One good-quality trial of patients with radiculopathy (132 participants) found no difference between magnetic resonance imaging compared with history and physical examination alone to guide transforaminal or interlaminar epidural injections on any outcome through 3 months (87).

No trial directly compared the effectiveness of epidural corticosteroid injections according to the local anesthetic used, number of injections, or number of levels injected. One trial found that if a first epidural corticosteroid injection was not successful, subsequent injections in the following 6 weeks were no more effective (30), and another study found no association between the number of injections and treatment response (68).

Patient Characteristics

Five trials found no association between duration of symptoms and epidural corticosteroid injection responsiveness after adjustment for other potentially contributing factors (30, 36, 85, 86, 91). A sixth trial found longer symptom duration to be associated with less favorable outcomes (56).

Trials found no statistically significant interaction between age (36, 56, 85, 86), sex (36, 56, 85, 86), anxiety or depression (30, 56), opioid use (36), baseline function (30, 36), presence of neurologic abnormalities (30, 91), previous back episodes (30), or work status (30) on responsiveness to epidural corticosteroid injections. Three trials found no clear differences in estimates of effectiveness of injections for herniated disc versus spinal stenosis (37, 40, 86). Studies also found no clear effects of other specific imaging findings (56, 91, 92). No study evaluated effects of smoking status, body mass index, or use of opioid or other concomitant therapies.

In meta-regression, exclusion of patients with prior surgery, requiring imaging or presence of herniated disc for enrollment, or duration of symptoms did not affect the estimates of effectiveness, although results were limited by small numbers of trials.

Comparators

Three trials of epidural corticosteroid injections for radiculopathy found no clear differences in estimates of effectiveness on the basis of different placebo comparators (41, 43, 45). There were no clear differences on any outcome when placebo-controlled trials were stratified by the type of comparator, although some estimates were imprecise (Appendix Table 6, available at www.annals.org). There were also no clear differences between placebo comparators in the magnitude of improvement or proportion of responders (Table 1 of the Supplement).

Harms

In 30 placebo-controlled trials (2912 participants in total) of epidural corticosteroid injections for radiculopathy, 1 serious adverse event (a case of retroperitoneal hematoma in a patient receiving anticoagulation) (44) was reported. Methods for assessing harms were not well reported, and harms data were sparse. Thirteen trials did not report harms at all or reported no harms (32, 37, 39–42, 47, 48, 50, 51, 53, 58, 89).

Three trials of the transforaminal versus interlaminar approaches did not report adverse events (77, 80, 90). One trial reported 1 case of transient hypertension with the transforaminal approach (78), and 1 trial reported no adverse events (76). Trials that compared alternative versus standard approaches reported few adverse events (81–84).

Trials that compared corticosteroids did not report harms (66, 68) or reported no harms (65, 67). Harms were also poorly reported in 5 trials (452 participants)

of corticosteroid dose comparisons, although no serious adverse events were reported (70, 71, 73–75).

Eight placebo-controlled trials (821 participants in total) of epidural corticosteroid injections for spinal stenosis reported few harms, and no serious harms (37, 40, 59–64). One good-quality trial found transforaminal or interlaminar epidural corticosteroid injections to be associated with increased risk for at least 1 adverse event versus a local anesthetic injection (22% vs. 16%; RR, 1.39 [CI, 0.91 to 2.11]), but no difference in risk for serious adverse events (2.5% vs. 2.5%) (59). There was no clear difference in risk for adverse events between the interlaminar and transforaminal approaches. Among the other trials, 2 reported no harms (60) or no major harms (62), 2 did not report harms by treatment group (61, 62), and 3 did not report harms (37, 40, 64).

Large observational studies of epidural and other spinal injections found serious adverse events to be rare, although minor adverse events, such as local hematoma, bleeding, return of blood, and dural puncture, were more common (93–96). In the largest study, there were no cases of nerve damage, infection, abscess, or epidural hematoma after 2760 lumbar epidural injections under fluoroscopic guidance (94). Rates of profuse bleeding ranged from 0.2% to 0.8%, depending on the approach used. There were no cases of transient nerve-root irritation after 3985 caudal injections, 4 cases (0.28%) among 1450 interlaminar injections, and 60 cases (4.6%) among 1310 transforaminal injections.

DISCUSSION

Epidural corticosteroid injections for radiculopathy were associated with early improvements in some outcomes versus placebo interventions, but effects were small and unsustained, and epidural corticosteroid injections had no clear effects in patients with spinal stenosis. The strength of evidence ratings are summarized in Table 2 of the Supplement.

Evidence was most robust on effects in patients with chronic radiculopathy. The only statistically significant effects were on immediate (5 days to ≤2 weeks) improvement in pain (WMD on a scale of 0 to 100, −7.55 [CI, −11.4 to −3.74]), and short-term (>2 weeks to ≤3 months) surgery risk (RR, 0.62 [CI, 0.41 to 0.92]). Immediate effects on function were statistically significant only when an outlier trial (54) was excluded (SMD, −0.33 [CI, −0.56 to −0.09]). Effects were below predefined minimum clinically important difference thresholds (15 points on a pain scale of 0 to 100, 10 points on the ODI, and 5 points on the RDQ [29]), with a WMD for pain of −7.55, and effects on function in the nonoutlier trials of 5.1 and 7.6 points on the ODI (33, 44) and 1.3 points on the RDQ (57). Effects were not present at longer-term follow-up, and there were no effects on the likelihood of experiencing a successful pain, function, or composite outcome. Results were generally robust in sensitivity and stratified analyses.

Evidence for spinal stenosis was more limited, but showed no clear effects of epidural corticosteroid injections on pain or function. The only statistically significant effect was on immediate pain intensity, on the basis of a single small trial (29 participants) (61). Our analysis included a recent, well-conducted multicenter trial that was also the largest trial to date (59). This trial used a more pragmatic design in which injection approaches, corticosteroids, and doses varied, although there were no clear effects on the basis of such factors.

Our findings are consistent with those of several recent systematic reviews, despite variability in the studies included and methods used for data synthesis and meta-analysis (8–10, 24, 97, 98). Our review strengthens and extends the findings of these prior reviews through the inclusion of additional trials; evaluation of continuous as well as dichotomous outcomes at predefined time points; and additional analyses on technical factors, patient characteristics, comparators, and methodological factors. Other systematic reviews reported more positive conclusions regarding the effectiveness of epidural corticosteroids (11–13, 99, 100). However, some of these reviews relied on qualitative synthesis, included observational studies, classified improvement from baseline after an epidural injection as demonstrating effectiveness even when there was no difference versus a placebo intervention, or focused on "positive" trials when there was inconsistency.

Evidence on the effects of different approaches, corticosteroids, or doses on effectiveness of epidural corticosteroid injections was limited, but indicated no clear effects. There were also no clear effects from other patient or technical factors, such as use of imaging guidance, duration of symptoms, or injectate volume, on the basis of stratified and subgroup analyses. There were no clear differences in effectiveness and improvements were large across placebo comparators, suggesting that observed improvements represent the natural history or placebo effects, rather than a therapeutic effect of epidural local anesthetic, epidural saline, or soft-tissue injections. Although another systematic review found some evidence that epidural nonsteroid injections might be more effective than nonepidural injections, its conclusions were based on indirect comparisons that were highly discrepant with direct comparisons (20, 101).

The assessment and reporting of harms data was suboptimal, but indicate a low risk for serious harms. Serious neurologic complications have been reported after lumbar epidural injections, and there was a recent outbreak of serious fungal infections due to contaminated methylprednisolone (7, 102, 103). Although there have been reports of increased risk for neurologic complications with use of particulate corticosteroids for cervical epidural injections, no cases were reported in lumbar injection trials.

Our review had limitations. We used the Dersimonian–Laird random-effects model to pool studies, which may result in overly narrow CIs when heterogeneity is present (27). Therefore, we repeated analyses by using the profile likelihood method, which resulted in similar findings. Some meta-analyses were based on small numbers of trials, and we used indirect comparisons to supplement direct evidence; both should be inter-

preted with caution (104). We also excluded non–English-language articles. The evidence was limited by the small numbers of trials for some analyses and methodological limitations in the available trials. Of 58 trials, only 5 were rated good-quality. We did not include case series and other uncontrolled studies on harms, which could provide additional information (105).

Additional research would clarify the benefits and harms of epidural corticosteroid injections. For radiculopathy, additional research is needed to determine whether such factors as the severity or duration of symptoms, presence of specific imaging findings, or presence of psychiatric comorbid conditions affect responsiveness to injections. Research is needed to determine whether injections are more effective when given in the context of a more comprehensive pain management approach. Additional trials that directly compare approaches, corticosteroids, doses, and use of imaging guidance are needed to augment limited data. For spinal stenosis, research is needed to determine whether there may be specific subgroups of patients who might benefit from epidural corticosteroids, who could be the target of future trials.

In conclusion, epidural corticosteroid injections for radiculopathy are associated with immediate improvements in pain and might be associated with immediate improvements in function, but benefits are small and are not sustained, and there is no effect on long-term surgery risk. Evidence did not suggest that effectiveness varies on the basis of the approach used, corticosteroid, dose, or comparator. Limited evidence suggested that epidural corticosteroid injections are not effective for spinal stenosis.

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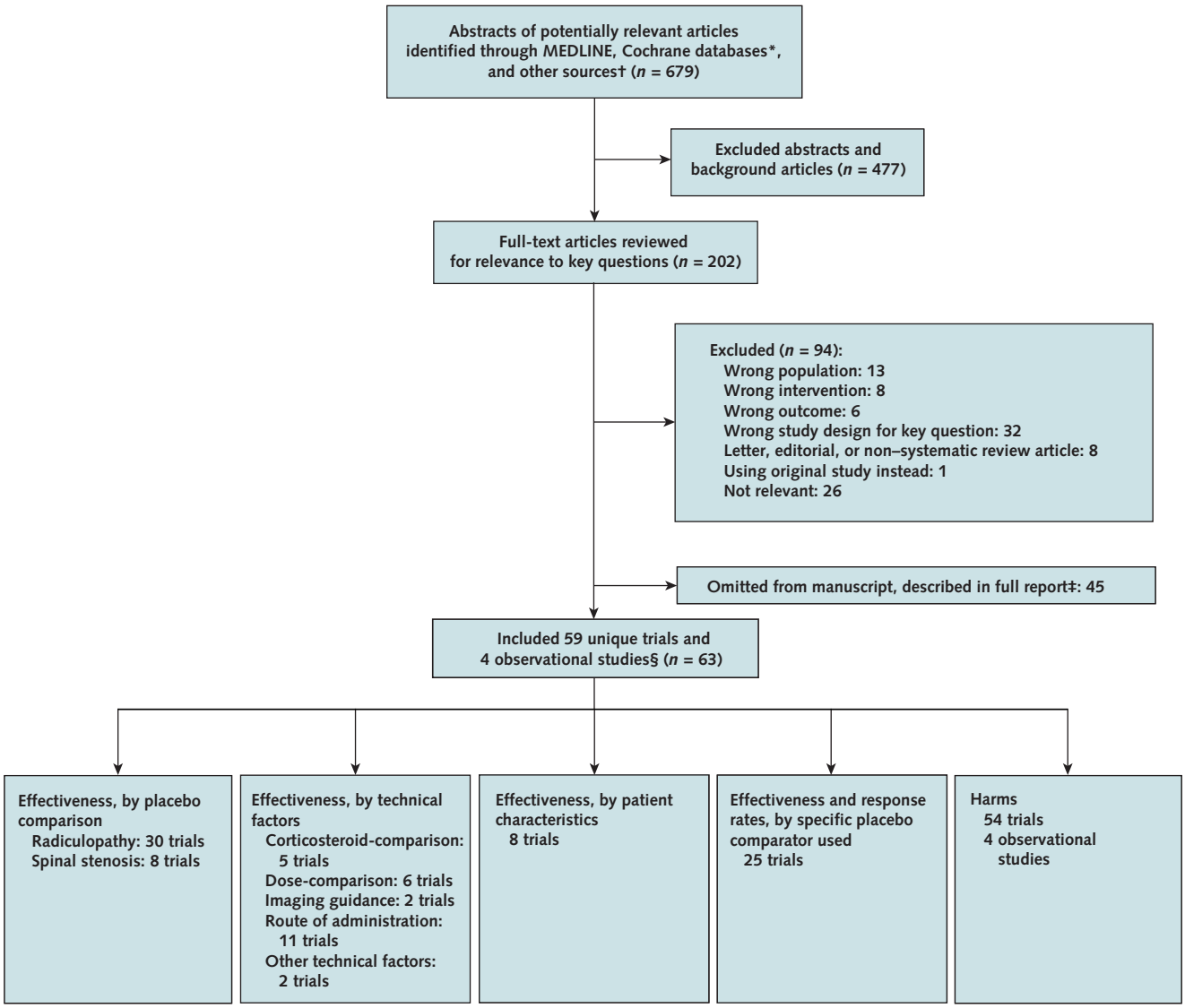
Appendix Figure. Summary of evidence search and selection.



* Cochrane Central Register of Controlled Trials and the Cochrane Database of Systematic Reviews.
† Reference lists of relevant articles and systematic reviews, among other sources.
‡ The full report (21) also addresses other types of injections, nonradicular and postsurgical back pain, and effects of epidural injections versus active comparators.
§ Some studies are included for more than 1 question.

Appendix Table 1. Trials of Epidural Corticosteroid Injections for Radicular Pain and Spinal Stenosis

Study, Year (Reference)	Duration of Follow-up	Comparison	Imaging Correlation	Participants, *n*	Type of Intervention	Patient Characteristics	Quality
Radicular pain							
Ackerman and Ahmad, 2007 (76)	24 wk	Approach	MRI; EMG evidence of S1 nerve root involvement	Randomized: 90 Analyzed: 90	A: Transforaminal epidural injection with 40 mg triamcinolone (1 mL) and saline (4 mL), with fluoroscopic guidance (*n* = 30) B: Interlaminar epidural injection with 40 mg triamcinolone (1 mL) and saline (4 mL), with fluoroscopic guidance (*n* = 30) C: Caudal epidural injection with 40 mg triamcinolone (1 mL) and saline (19 mL), with fluoroscopic guidance (*n* = 30)	A vs. B vs. C: Mean age: 34 vs. 39 vs. 36 y Men: 67% vs. 70% vs. 63% Baseline pain (0–10): 8.6 vs. 8.8 vs. 8.9 Baseline ODI (0–70): 30 vs. 33 vs. 37 Duration of symptoms: 35 vs. 33 vs. 38 d	Fair
Ahadian et al, 2011 (75)	12 wk	Dose	Not specified	Randomized: 98 Analyzed: 98	A: Transforaminal epidural injection with 12 mg dexamethasone (3 mL), with fluoroscopic guidance (*n* = 32) B: Transforaminal epidural injection with 8 mg dexamethasone (2 mL), with fluoroscopic guidance (*n* = 33) C: Transforaminal epidural injection with 4 mg dexamethasone (1 mL), with fluoroscopic guidance (*n* = 33)	A vs. B vs. C: Median age: 58 vs. 57 vs. 60 y Men: 53% vs. 70% vs. 88% Baseline pain (0–100): 73 vs. 71 vs. 68 Baseline ODI (0–50): 23 vs. 24 vs. 24 Duration of symptoms >2 y: 91% vs. 88% vs. 91%	Fair
Arden et al, 2005 (30); Price et al, 2005 (106)	12 mo	Epidural corticosteroid vs. placebo	Lumbar spine radiography	Randomized: 228 Analyzed: 228	A: Interlaminar epidural injection with 80 mg triamcinolone acetonide + 0.125% bupivacaine (10 mL) (*n* = 120) B: Soft-tissue injection of normal saline (2 mL) into interspinous ligament (*n* = 108)	A vs. B: Mean age: 43 vs. 44 y Men: 52% vs. 54% Baseline leg pain (0–100 VAS): 52 vs. 56 Baseline back pain (0–100 VAS): 40 vs. 44 Baseline ODI (0–100): 44 vs. 45 Duration of symptoms: Mean not reported (4 wk–18 mo by inclusion criteria); 38% vs. 35% acute (4 wk–4 mo)	Fair
Becker et al, 2007 (73)	22 wk	Epidural corticosteroid vs. other dose	MRI or CT showing herniation of nucleus pulposus or scarring after previous surgery	Randomized: 84 Analyzed: 83	A: Perineural epidural injection using oblique interlaminar approach with 10 mg triamcinolone + unspecified local anesthetic (1 mL), with fluoroscopic guidance (*n* = 24) B: Perineural epidural injection using oblique interlaminar approach with 5 mg triamcinolone + unspecified local anesthetic (1 mL), with fluoroscopic guidance (*n* = 24) C: Perineural epidural injection using oblique interlaminar approach with autologous conditioned serum (1 mL), with fluoroscopic guidance (*n* = 24)	A vs. B vs. C: Mean age: 54 y; reported no difference between groups Men: Reported no difference between groups; data not provided Baseline pain: not reported Baseline function: not reported Duration of symptoms: Reported no difference between groups; data not provided	Fair
Béliveau, 1971 (31)	1 wk	Epidural corticosteroid vs. placebo	Not specified	Randomized: 48 Analyzed: Unclear	A: Caudal epidural injection with 80 mg methylprednisolone (2 mL) + 0.5% procaine (40 mL) (*n* = 24) B: Caudal epidural injection with 0.5% procaine (42 mL) (*n* = 24)	A vs. B: Mean age: 41 y overall Men: 75% Baseline pain: not reported Baseline function: not reported Duration of symptoms: not reported	Poor
Breivik et al, 1976 (32)	Unclear	Epidural corticosteroid vs. placebo	Not specified	Randomized: 35 Analyzed: 35	A: Caudal epidural injection with 80 mg methylprednisolone and 0.25% bupivacaine (20 mL) (*n* = 16) B: Caudal epidural injection with 0.25% bupivacaine (20 mL) followed by 100 cc saline (*n* = 19)	A vs. B: Mean age: not reported; range 30–63 y Men: 50% vs. 47% Baseline pain: not reported Baseline function: not reported Duration of symptoms: not reported	Poor

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Appendix Table 1–Continued

Study, Year (Reference)	Duration of Follow-up	Comparison	Imaging Correlation	Participants, *n*	Type of Intervention	Patient Characteristics	Quality
Buchner et al, 2000 (33)	6 mo	Epidural corticosteroid vs. placebo	Herniated disk ≥5 mm confirmed by MRI	Randomized: 36 Analyzed: 36	A: Interlaminar epidural injection with 100 mg methylprednisolone in 0.25% bupivacaine (10 mL) (*n* = 17) B: No epidural injection (*n* = 19)	A vs. B: Mean age: 37 vs. 32 y Men: 47% vs. 79% Baseline pain (0–100): 84 vs. 81 Hannover Functional Ability Questionnaire: 39% vs. 40% Duration of symptoms (wk): median 8 vs. 8	Fair
Bush and Hillier, 1991 (34)	1 y	Epidural corticosteroid vs. placebo	Imaging findings not required	Randomized: 28 Analyzed: 23	A: Caudal epidural injection with 80 mg triamcinolone acetonide in normal saline with 0.5% procaine hydrochloride (total 25 mL) (*n* = 12) B: Caudal epidural injection with saline (25 mL) (*n* = 11)	A vs. B: Mean age: 38 vs. 37 y Men: 83% vs. 45% Baseline pain: not reported Baseline function: not reported Duration of symptoms: not reported	Fair
Candido et al, 2013 (81)	12 mo	Approach	MRI	Randomized:106 Analyzed: 100	A: Lumbar epidural steroid injection of 120 mg methylprednisolone acetate (2 mL) + 1 mL 1% lidocaine + 1 mL normal saline using a lateral parasagittal interlaminar approach, with fluoroscopic guidance (*n* = 50) B: Lumbar epidural steroid injection of 120 mg methylprednisolone acetate (2 mL)+ 1 mL 1% lidocaine + 1 mL normal saline using a midline interlaminar approach, with fluoroscopic guidance (*n* = 50)	A vs. B: Mean age: 49 v. 49 y Men: 48% vs. 40% (*P* = 0.5) Duration of symptoms: 14 vs. 14 mo Baseline pain at rest (mean, 0–10 NRS): 4.9 vs. 5.1 Baseline pain during movement (mean, 0–10 NRS): 7.6 vs. 7.2 Baseline function (mean ODI, 0–100): 44.9% vs. 40.6% (*P* not significant)	Fair
Candido et al, 2008 (83)	6 mo	Approach	Not specified	Randomized: 60 Analyzed: 57	A: Posterolateral interlaminar epidural injection with 80 mg methylprednisolone + lidocaine 1% (1 mL), with fluoroscopic guidance (*n* = 30) B: Transforaminal epidural injection with 80 mg methylprednisolone + lidocaine 1% (1 mL), with fluoroscopic guidance (*n* = 30)	A vs. B: Mean age: 52 vs. 52 y Men: 57% vs. 40% Baseline pain (0–10 VAS): 6.8 vs. 6.3 Baseline function: not reported Duration of symptoms <3 mo: 24% vs. 7.1%	Fair
Carette et al, 1997 (35)	3 mo	Epidural corticosteroid vs. placebo	CT evidence of herniated disk	Randomized: 158 Analyzed: 156	A: Interlaminar epidural injection with 80 mg methylprednisolone (2 mL) + isotonic saline (8 mL) (*n* = 78) B: Interlaminar epidural injection with isotonic saline (1 mL) (*n* = 80)	A vs. B: Mean age: 39 vs. 41 y Men: 72% vs. 59% Baseline pain (0–100): 66 vs. 62 Baseline ODI (0–100): 50 vs. 50 Duration of symptoms: 12.9 vs. 13.0 wk	Fair
Cocelli et al, 2009 (65)	6 mo	Epidural corticosteroid vs. epidural corticosteroid	Not specified	Randomized: 70 Analyzed: 70	A: Interlaminar epidural injection with 10 mg betamethasone diproprionate and 4 mg betamethasone sodium phosphate + 0.125% bupivacaine (total 20 mL) (*n* = 40) B: Interlaminar epidural injection with 80 mg triamcinolone acetonide + 0.125% bupivacaine (total 20 mL) (*n* = 40)	A vs. B: Mean age: 49 vs. 50 y Men: 25% vs. 40% Baseline pain (0–10 VAS): 9.5 vs. 9.3 Baseline ODI (0–100): 51 vs. 62 Duration of symptoms: 3 vs. 3 wk	Fair
Cohen et al, 2012 (36)	1 mo for primary outcomes	Epidural corticosteroid vs. placebo Epidural corticosteroid vs. other	MRI evidence of pathologic disc condition	Randomized: 84 Analyzed: 84	A: Transforaminal epidural injection with 60 mg methylprednisolone acetate in 2 mL sterile water and 0.5% bupivacaine (0.5 mL), with fluoroscopic guidance (*n* = 28) B: Transforaminal epidural injection with 4 mg etanercept in 2 mL sterile water and 0.5% bupivacaine (0.5 mL), with fluoroscopic guidance (*n* = 26) C: Transforaminal epidural injection with 2 mL sterile water and 0.5% bupivacaine (0.5 mL) , with fluoroscopic guidance (*n* = 30)	A vs. B vs. C: Mean age: 43 vs. 41 vs. 41 y Men: 79% vs. 69% vs. 63% Baseline leg pain (0–10): 5.71 vs. 6.62 vs. 6.31 Baseline back pain (0–10): 5.30 vs. 6.08 vs. 4.75 Baseline ODI (0–100): 42.93 vs. 41.12 vs. 40.87 Duration of symptoms: 2.61 vs. 2.67 vs. 2.82 mo	Good
Cohen et al, 2012 (87)	3 mo	Fluoroscopy vs. no fluoroscopy	MRI findings of lumbosacral radiculopathy	Randomized: 132 Analyzed: 132	A: Transforaminal epidural injection with 60 mg methylprednisolone, 0.25% bupivacaine (1 mL), and saline (0.5 mL) (total 3 mL) or interlaminar epidural injection with 60 mg methylprednisolone, 0.25% bupivacaine (1 mL), and saline (1.5 mL) (total 4 mL), with fluoroscopic guidance; treatment and level based on MRI findings (*n* = 67) B: Injection as above, on the basis of history and physical examination findings (*n* = 65)	A vs. B: Mean age: 51 vs. 53 Men: 42% vs. 45% Baseline leg pain (0–10 NRS): 6.6 vs. 6.7 Baseline back pain (0–10 NRS): 6.1 vs. 6.1 Baseline ODI (0–100): 44 vs. 45 Duration of symptoms: 1.5 vs. 1.6 y	Fair

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Appendix Table 1–Continued

Study, Year (Reference)	Duration of Follow-up	Comparison	Imaging Correlation	Participants, *n*	Type of Intervention	Patient Characteristics	Quality
Cuckler et al, 1985 (37)	13–30 mo	Epidural corticosteroid vs. placebo	Not required	Randomized: 73 Analyzed: 73	A: Interlaminar epidural injection with 80 mg methylprednisolone (2 mL) and 1% procaine (5 mL) (*n* = 42) B: Interlaminar epidural injection with saline (2 mL) and 1% procaine (5 mL) (*n* = 31)	A vs. B: Age: 49 vs. 50 y Men: 48% vs. 55% Baseline pain: not reported Baseline function: not reported Duration of symptoms: 17.3 vs. 13.8 mo	Fair
Datta and Upadhyay, 2011 (38)	3 mo	Epidural corticosteroid vs. placebo Epidural corticosteroid vs. epidural corticosteroid	CT evidence of herniated disc	Randomized: 207 Analyzed: 163	A: Caudal epidural injection with 80 mg methylprednisolone + 0.125% bupivacaine (10–15 mL) (*n* = 50) B: Caudal epidural injection with 80 mg triamcinolone + 0.125% bupivacaine (10-15 mL) (*n* = 52) C: Caudal epidural injection with 15 mg dexamethasone + 0.125% bupivacaine (10–15 mL) (*n* = 50) D: Caudal epidural injection with 0.125% bupivacaine (10–15 mL) (*n* = 55)	A vs. B vs. C vs. D: Mean age: 40 vs. 39 vs. 42 vs. 43 y Men: 92% vs. 94% vs. 90% vs. 91% Baseline pain (0–10 VAS): 7.5 vs. 7.4 vs. 7.3 vs. 7.2 Baseline RDQ (0–24): 21 vs. 22 vs. 21 vs. 22 Duration of leg pain: 16 vs. 17 vs. 16 vs. 16 wk	Poor
Dilke et al, 1973 (39)	3 mo	Epidural corticosteroid vs. placebo	Not required	Randomized: 100 Analyzed: 82	A: Interlaminar epidural injection with 80 mg methylprednisolone in saline (10 mL) B: Interspinous ligament injection with saline (1 mL)	A vs. B: Mean age: 39 vs. 42 y Men: 53% vs. 58% Baseline pain: not reported Baseline function: not reported Duration of symptoms >4 wk: 90% vs. 90%	Fair
el Zahaar, 1991 (40)	20–21 mo	Epidural corticosteroid vs. placebo	MRI or CT	Randomized: 63 Analyzed: Unclear	A: Caudal epidural injection with hydrocortisone (5 mL), 4% mepivacaine (4 mL), and saline (21 mL) (*n* = 37) B: Caudal epidural injection with 4% mepivacaine (4 mL) + saline (26 cc) (*n* = 26)	A vs. B: Mean age: 46 vs. 49 y Men: 54% vs. 65% Baseline pain: not reported Baseline function: not reported Duration of symptoms: 17 vs. 14 mo	Poor
Ghahreman et al, 2010 (41); Ghahreman and Bogduk, 2011 (91)	12 mo	Epidural corticosteroid vs. placebo	Required	Randomized: 150 Analyzed: 150	A: Transforaminal injection with 40 mg/mL triamcinolone (1.75 mL) + 0.5% bupivacaine (0.75 mL), with fluoroscopic guidance (*n* = 28) B: Transforaminal injection of 0.5% bupivacaine (2 mL), with fluoroscopic guidance (*n* = 27) C: Transforaminal injection of normal saline (2 mL), with fluoroscopic guidance (*n* = 37) D: Intramuscular injection of 40 mg/mL triamcinolone (1.75 mL), with fluoroscopic guidance (*n* = 28) E: Intramuscular injection of normal saline (2 mL), with fluoroscopic guidance (*n* = 30)	A vs. B vs. C vs. D vs. E: Median age: 49 vs. 44 vs. 43 vs. 49 vs. 46 y Men: 61% vs. 51% vs. 63% vs. 54% vs. 70% Baseline leg pain (median, 0–10): 7 vs. 7 vs. 7 vs. 7 vs. 8 Baseline RDQ score (median, 0–24): 17 vs. 17 vs. 19 vs. 17 vs. 15 Duration of symptoms: Mean not reported; range 2–560 wk	Good
Ghai et al, 2014 (84)	12 mo	Approach	MRI	Randomized: 62 Analyzed: 62	A: Parasagittal epidural injection with 80 mg methylprednisolone (2 mL) + normal saline (2 mL (*n* = 32)) B: Transforaminal epidural injection with 80 methylprednisolone (2 mL) + normal saline (2 mL), with fluoroscopic guidance (*n* = 30)	A vs. B: Mean age: 43 vs. 46 y Men: 53% vs. 63% Duration of symptoms: 25 vs. 30 mo Baseline pain (0–100 VAS): 73 vs. 74 Modified ODI (0–100): 31 vs. 29	Good
Ghai et al, 2013 (82)	6 mo	Approach	MRI performed in all patients	Randomized: 37 Analyzed: 37	A: Parasagittal interlaminar injection with 80 mg methylprednisolone (2 mL) + normal saline (2 mL), with fluoroscopic guidance (*n* = 19) B: Midline interlaminar injection with 80 mg methylprednisolone (2 mL) + normal saline (2 mL), with fluoroscopic guidance (*n* = 18)	A vs. B: Mean age: 41 vs. 42 y Men: 68% vs. 50% Baseline pain (0–100 VAS): 69 vs. 71 Modified ODI (0–100): 42 vs. 49 Duration of symptoms: 13 vs. 14 mo	Fair
Gharibo et al, 2011 (77)	10–16 d	Approach	Imaging correlation on CT or MRI	Randomized: 42 Analyzed: 38	A: Transforaminal epidural injection with 40 mg triamcinolone diacetate (1 mL) + 0.25% bupivacaine (1 mL) at two levels, with fluoroscopic guidance (*n* = 21) B: Interlaminar epidural injection with 80 mg triamcinolone diacetate (2 mL) + 0.25% bupivacaine (2 mL), with fluoroscopic guidance (*n* = 21)	A vs. B: Mean age: 48 vs. 51 y Men: 55% vs. 72% Baseline pain (0–10): 6.4 vs. 7.0 Baseline ODI (0–50): 38 vs. 38 Duration of symptoms: not reported	Fair

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Appendix Table 1–Continued

Study, Year (Reference)	Duration of Follow-up	Comparison	Imaging Correlation	Participants, *n*	Type of Intervention	Patient Characteristics	Quality
Habib et al, 2013 (72)	4 wk	Epidural injection with different doses of corticosteroid	Imaging findings not required	Randomized: 42 (21 vs. 21) Analyzed: 35 at 4 wk	A: Epidural injection with 80 mg methylprednisolone acetate; approach and other details not provided (*n* = 21) B: Epidural injection with 40 mg methylprednisolone acetate; approach and other details not provided (*n* = 21)	A vs. B: Mean age: 53 vs. 51 Men: 62% vs. 76% Duration of back pain: 2.9 vs. 3.4 y Baseline VAS (0–100): 80 vs. 78	Poor
Helliwell et al, 1985 (42)	3 mo	Epidural corticosteroid vs. placebo	Radiograph of lumbar spine	Randomized: 39 Analyzed: 39	A: Interlaminar epidural injection with 80 mg methylprednisolone in saline (10 mL) (*n* = 20) B: Interspinous ligament injection with saline (5 mL) (*n* = 19)	A vs. B: Mean age: 45 vs. 47 y Men: 25% vs. 20% Baseline pain: not reported Baseline function: not reported Duration of symptoms: 8.5 vs. 13 mo	Poor
Iversen et al, 2011 (43)	1 y	Epidural corticosteroid vs. placebo Epidural corticosteroid vs. other	MRI or CT	Randomized: 116 Analyzed: 116	A: Caudal epidural injection with 40 mg triamcinolone in 0.9% saline (29 mL), with ultrasonography guidance (*n* = 37) B: Caudal epidural injection with 0.9% saline (30 mL), with ultrasonography guidance (*n* = 39) C: Subcutaneous injection superficial to the sacral hiatus and outside spinal canal with 0.9% saline (2 mL), with ultrasonography guidance (*n* = 40)	A vs. B vs. C: Mean age: 40 vs. 43 vs. 43 y Men: 54% vs. 62% vs. 60% Baseline back pain (0–100 VAS): 47 vs. 50 vs. 46 Baseline leg pain (0–100 VAS): 50 vs. 54 vs. 48 Baseline ODI (0–50): 32 vs. 31 vs. 26 Duration of leg pain: 42 vs. 57 vs. 27 wk	Good
Jeong et al, 2007 (85)	216–547 d	Approach	CT or MRI documentation of nerve root compression, based on consensus of 3 radiologists	Randomized: 239 Analyzed: 222	A: Ganglionic transforaminal epidural injection with 40 mg triamcinolone acetonide (1 mL) + 0.5% bupivacaine (0.5 cc), with fluoroscopic guidance (*n* = 127) B: Preganglionic transforaminal epidural injection with 40 mg triamcinolone acetonide (1 mL) and 0.5% bupivacaine (0.5 cc), with fluoroscopic guidance (*n* = 112)	A vs. B: Mean age: 50 vs. 49 y Men: 40% vs. 48% Spinal stenosis: 18% vs. 20% Herniated disc: 82% vs. 80% Duration of symptoms <6 mo: 64% vs. 56% Baseline pain: not reported Baseline function: not reported Duration of symptoms <6 mo: 64% vs. 56%	Fair
Kang et al, 2011 (74)	2 wk	Dose	Single-level disc herniation on MRI	Randomized: 160 Analyzed: 160	A: Transforaminal epidural injection with 40 mg triamcinolone + 1% lidocaine (total 3 mL), with fluoroscopic guidance (*n* = 40) B: Transforaminal epidural injection with 20 mg triamcinolone + 1% lidocaine (total 3 mL), with fluoroscopic guidance (*n* = 40) C: Transforaminal epidural injection with 10 mg triamcinolone + 1% lidocaine (total 3 mL), with fluoroscopic guidance (*n* = 40) D: Transforaminal epidural injection with 5 mg triamcinolone + 1% lidocaine (total 3 mL), with fluoroscopic guidance (*n* = 40)	A vs. B vs. C vs. D: Mean age: 47 vs. 53 vs. 52 vs. 53 y Men: 40% vs. 42% vs. 38% vs. 35% Baseline pain: 7.3 vs. 7.2 vs. 7.0 vs. 7.0 Baseline function: not reported Duration of symptoms: 37 vs. 33 vs. 42 vs. 33 d	Fair
Karppinen et al, 2001 (44, 92)	1 y	Epidural corticosteroid vs. placebo	MRI at baseline	Randomized: 163 Analyzed: 158	A: Transforaminal (periradicular) injection with 2–3 cc of methylprednisolone 40 mg/cc + bupivacaine 5 mg/cc, with fluoroscopic guidance (*n* = 78) B: Transforaminal (periradicular) injection with isotonic (0.9%) saline (2–3 cc), with fluoroscopic guidance (*n* = 80)	A vs. B: Mean age: 44 vs. 44 y Men: 64% vs. 58% Baseline leg pain (0–100 VAS): 71 vs. 75 Baseline back pain (0–100 VAS): 53 vs. 60 Baseline ODI (0–100): 43 vs. 44 Duration of symptoms: 2.4 vs. 2.6 mo	Good
Kennedy et al, 2014 (66)	6 mo	Epidural corticosteroid vs. epidural corticosteroid	MRI single level below L3 corresponding with symptoms	Randomized: 78 Analyzed: Unclear	A: Transforaminal epidural injection with 15 mg dexamethasone (1.5 mL) + 1% lidocaine (2 mL), with fluoroscopic guidance (*n* = 41) B: Transforaminal epidural injection with 60 mg triamcinolone (1.5 mL) + 1% lidocaine (2 mL), with fluoroscopic guidance (*n* = 37)	A vs. B: Mean age: 36 vs. 36 y Men: 66% vs. 65% Baseline pain (0–10): 6.3 vs. 6.5 Baseline ODI (0–100): 46 vs. 42 Duration of symptoms: 10 vs. 8.6 wk	Fair

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Appendix Table 1–Continued

Study, Year (Reference)	Duration of Follow-up	Comparison	Imaging Correlation	Participants, *n*	Type of Intervention	Patient Characteristics	Quality
Kim and Brown, 2011 (67)	1–2 mo	Epidural corticosteroid vs. epidural corticosteroid	Lumbar radicular symptoms below the knee corresponding to MRI findings	Randomized: 61 Analyzed: 60	A: Interlaminar epidural injection with 15 mg dexamethasone phosphate, 0.25% bupivacaine (2 mL), and saline (total 10 mL), with fluoroscopic guidance (*n* = 30) B: Interlaminar epidural injection with 80 mg methylprednisolone acetate, 0.25% bupivacaine (2 mL), and saline (total 10 mL), with fluoroscopic guidance (*n* = 30)	A vs. B: Mean age: 66 vs. 64 y Men: 13% vs. 20% Baseline pain (0–100 VAS): 78 vs. 77 Baseline function: not reported	Fair
Klenerman et al, 1984 (45)	2 mo	Epidural corticosteroid vs. placebo	Not specified	Randomized: 74 Analyzed: 63	A: Epidural injection with 80 mg methylprednisolone + normal saline (20 mL total) (*n* = 19) B: Epidural injection with 0.25% bupivacaine (20 mL) (*n* = 16) C: Epidural injection with normal saline (20 mL) (*n* = 16) D: Interspinous ligament needling without injection (*n* = 12)	A vs. B: Age: not reported Men: not reported Baseline pain (0–100 VAS): 48 vs. 53 vs. 65 vs. 65 Baseline function: not reported Duration of symptoms: not reported (≤6 mo by inclusion criteria)	Fair
Kolsi et al, 2000 (78)	4 wk; 8 mo for surgery outcome	Approach	Impingement of disc on nerve root by CT or MRI	Randomized: 30 Analyzed: 30	A: Transforaminal nerve root injection with 3.75 mg cortivazol (1.5 mL) + 0.10 g lidocaine (2 mL), with fluoroscopic guidance (*n* = 17) B: Interlaminar epidural injection with 3.75 mg cortivazol (1.5 mL) + 0.10 g lidocaine (2 mL), with fluoroscopic guidance (*n* = 13)	A vs. B: Mean age: 45 vs. 40 y Men: 41% vs. 38% Baseline leg pain (0–10 VAS): 7.0 vs. 6.3 Baseline back pain (0–10 VAS): 3.9 vs. 4.2 Baseline RDQ (French version) (0–24): 16 vs. 15 Duration of symptoms: 3.7 vs. 4.4 mo	Fair
Kraemer et al, 1997, study 1 (46)	3 mo	Epidural corticosteroid vs. placebo	Disk protrusion with nerve root compression seen on MRI and/or CT	Randomized: 133 Analyzed: 133	A: Epidural perineural injection via oblique interlaminar approach with 10 mg triamcinolone + local anesthetic (1 mL; drug not specified) (*n* = 47) B: Interlaminar epidural steroid injection using conventional technique (medications and doses not reported) (*n* = 40) C: Paravertebral local anesthetic injection (medications and doses not reported) (*n* = 46)	A vs. B: Mean age: not reported Men: not reported Baseline pain: not reported Baseline function: not reported Duration of symptoms: not reported	Poor
Kraemer et al, 1997, study 2 (46)	3 mo	Epidural corticosteroid vs. placebo	Disk protrusion with nerve root compression seen on MRI and/or CT	Randomized: 49 Analyzed: 49	A: Epidural perineural injection via oblique interlaminar approach with 10 mg triamcinolone + saline (volume not reported) (*n* = 24) B: Epidural perineural injection via oblique interlaminar approach with saline alone + intramuscular injection with 10 mg triamcinolone (*n* = 25)	A vs. B: Mean age: not reported Men: not reported Duration of symptoms: not reported Baseline pain: not reported Baseline function: not reported Duration of symptoms: not reported	Fair
Manchikanti et al, 2014 (49)	24 mo	Epidural corticosteroid vs. placebo	Not specified	Randomized: 120 Analyzed: 120	A: Transforaminal epidural injection with 6 mg betamethasone (1 mL) + 0.5% lidocaine (5 mL), with fluoroscopic guidance (*n* = 60) B: Transforaminal epidural injection with 0.5% lidocaine (6 mL), with fluoroscopic guidance (*n* = 60)	A vs. B: Mean age: 43 vs. 43 y Men: 45% vs. 17% Baseline pain (0–10 NRS): 8.2 vs. 8.3 Baseline ODI (0–50): 28 vs. 30 Duration of symptoms: 104 vs. 98 mo	Poor
Manchikanti et al, 2014 (47) Manchikanti et al, 2013 (107, 108)	12 mo	Epidural corticosteroid vs. placebo	Not specified	Randomized: 120 Analyzed: 120	A: Interlaminar epidural injection with 6 mg betamethasone (1 mL) + 0.5% lidocaine (5 mL), with fluoroscopic guidance (*n* = 60) B: Interlaminar epidural injection with 0.5% lidocaine (6 mL), with fluoroscopic guidance (*n* = 60)	A vs. B: Mean age: 41 vs. 49 y Men: 62% vs. 38% Baseline pain (0–10 NRS): 8.0 vs. 8.2 Baseline ODI (0–50): 30 vs. 30 Duration of symptoms: 133 vs. 135 mo	Poor
Manchikanti et al, 2012 (48), 2011 (109), and 2008 (110)	24 mo	Epidural corticosteroid vs. placebo	Not specified	Randomized: 120 Analyzed: 120	A: Caudal epidural injection with 6 mg betamethasone or 40 mg methylprednisolone + 0.5% lidocaine (9 mL), with fluoroscopic guidance (*n* = 60) B: Caudal epidural injection with 0.5% lidocaine (10 mL), with fluoroscopic guidance (*n* = 60)	A vs. B: Mean age: 43 vs. 49 y Men: 38% vs. 32% Baseline pain (0–10 NRS): 7.8 vs. 8.1 Baseline ODI (0–50): 28 vs. 29 Duration of pain: 81 vs. 93 mo	Fair

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Appendix Table 1–Continued

Study, Year (Reference)	Duration of Follow-up	Comparison	Imaging Correlation	Participants, *n*	Type of Intervention	Patient Characteristics	Quality
Mathews et al, 1987 (50)	1 y	Epidural corticosteroid vs. placebo	Not specified	Randomized: 57 Analyzed: 57	A: Caudal epidural injection with 80 mg methylprednisolone (2 mL) and 0.125% bupivacaine (20 mL) (*n* = 23) B: Soft tissue injection at sacral hiatus or tender point with lignocaine (2 mL, concentration not reported) (*n* = 34)	A vs. B: Median age: 38 vs. 41 y Men: 83% vs. 71% Baseline pain: not reported Baseline function: not reported Median duration of symptoms: 4 vs. 4 wk	Fair
McCahon et al, 2011 (70)	12 wk	Dose	Not specified	Randomized: 38 Analyzed: 33	A: Caudal epidural injection with 80 mg methylprednisolone acetate (2 mL), 0.25% levobupivacaine (10 mL), and saline (8 mL) (*n* = 19) B: Caudal epidural injection with 40 mg methylprednisolone acetate (1 mL), 0.25% levobupivacaine (10 mL), and saline (9 mL) (*n* = 19)	A vs. B: Mean age: 56 y Men: 39% Baseline leg pain (0–100 VAS): 57 vs. 54 Baseline back pain (0–100 VAS): 67 vs. 66 Baseline ODI (0–100): 55 vs. 54 Duration of symptoms: 19 y	Fair
Owlia et al, 2007 (71)	3 mo	Dose	MRI showing disc herniation with or without canal stenosis	Randomized: 84 Analyzed: 84	A: Interlaminar epidural injection with 80 mg methylprednisolone acetate (8–10 mL) + 2% lidocaine (2–4 mL), with fluoroscopic guidance (*n* = 43) B: Interlaminar epidural injection with 40 mg methylprednisolone acetate (8–10 mL) + 2% lidocaine (2–4 mL), with fluoroscopic guidance (*n* = 41)	A vs. B: Mean age: 38 vs. 36 y Men: 51% vs. 66% Baseline pain: not reported Limitation in daily activities: 28% vs. 49% Duration of symptoms: 12 vs. 9 wk	Poor
Park et al, 2010 (68)	1 mo	Epidural corticosteroid vs. epidural corticosteroid	MRI showing nerve root compromise	Randomized: 106 Analyzed: 106	A: Transforaminal injection with 7.5 mg dexamethasone + 1% lidocaine (1 mL), with fluoroscopic guidance (*n* = 53) B: Transforaminal injection with 40 mg triamcinolone acetonide + 1% lidocaine (1 mL), with fluoroscopic guidance (*n* = 53)	A vs. B: Mean age: 56 vs. 62 y Men: 49% vs. 45% Baseline pain (0–10 VAS): 7.5 vs. 8.3 Baseline ODI (0–100: 52 vs. 58 Duration of symptoms: not reported	Fair
Park et al, 2013 (86)	12 wk	Ultrasongraphy plus fluoroscopy vs. fluoroscopy alone	Not required	Randomized: 120 Analyzed: 110	A: Caudal epidural injection with 10 mg dexamethasone (2 mL) + 0.5% lidocaine (13 mL) and 5 mL of iodinated contrast, with Doppler ultrasonography and fluoroscopy guidance (*n* = 60) B: Caudal epidural injection with 10 mg dexamethasone (2 mL) + 0.5% lidocaine (13 mL) with 5 mL of iodinated contrast, with fluoroscopic guidance (*n* = 60)	A vs. B: Mean age: 57 vs. 58 y Men: 29% vs. 44% Baseline pain (0–10 NRS): 6.4 vs. 6.4 Baseline ODI (0–100): 51 vs. 52 Duration of symptoms: 6.6 vs. 7.0 mo	Fair
Rados et al, 2011 (90)	24 wk	Approach	MRI and EMG	Randomized: 70 Analyzed: 64	A: Transforaminal epidural injection with 40 mg methylprednisolone + 0.5% lidocaine (3 mL), with fluoroscopic guidance (*n* = 35) B: Interlaminar epidural injection with 80 mg methylprednisolone + 0.5% lidocaine (8 mL), with fluoroscopic guidance (*n* = 35)	A vs. B: Mean age: 49 vs. 49 y Men: 62% vs. 66% Baseline pain (0–10 VAS): 6.7 vs. 7.4 Baseline ODI (0–100): 53 vs. 52 Duration of symptoms: not reported; <1 y and >6 wk by inclusion criteria	Fair
Ridley et al, 1988 (51)	2 wk	Epidural corticosteroid vs. placebo	Not specified	Randomized: 39 Analyzed: 35	A: Interlaminar epidural injection with 80 mg methylprednisolone (2 mL) and saline (10 mL) (*n* = 19) B: Interspinous ligament injection with saline (2 mL) (*n* = 16)	A vs. B: Mean age: 40 vs. 39 y Men: 42% vs. 44% Baseline pain: not reported Baseline function: not reported Duration of symptoms >6 mo: 47% vs. 56%	Fair
Riew et al, 2000 (52) and 2006 (89)	Mean 23 mo; range 13 to 28 mo	Epidural corticosteroid vs. placebo	Disc herniation or spinal stenosis confirmed by MRI or CT	Randomized: 55 Analyzed: 55	A: Transforaminal nerve root injection with 6 mg betamethasone (1 mL) + 0.25% bupivacaine (1 mL), with fluoroscopic guidance (*n* = 28) B: Transforaminal nerve root injection with 0.25% bupivacaine (1 mL), with fluoroscopic guidance (*n* = 27)	A vs. B: Age: not reported (states no difference) Men: 49% overall (states no difference) Baseline pain: not reported Baseline function: not reported Duration of symptoms: not reported	Fair

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Appendix Table 1–Continued

Study, Year (Reference)	Duration of Follow-up	Comparison	Imaging Correlation	Participants, *n*	Type of Intervention	Patient Characteristics	Quality
Rogers et al, 1992 (53)	1 mo; 20–21 mo for surgery outcome	Epidural corticosteroid vs. placebo	Not specified	Randomized: 30 Analyzed: 30	A: Interlaminar epidural injection with 80 mg methylprednisolone (2 mL) + 2% lignocaine (14 mL) + saline (4 mL) (*n* = 15) B: Interlaminar epidural injection with 2% lignocaine (14 mL) + saline (6 mL) (*n* = 15)	A vs. B: Mean age: 42 vs. 41 y Men: 47% vs. 47% Baseline pain "severe" or "very severe": 87% vs. 67% Baseline function: not reported Duration of symptoms: 23 vs. 25 mo	Poor
Sayegh et al, 2009 (54)	1 y	Epidural corticosteroid vs. placebo	Disc degeneration or herniation on MRI	Randomized: 183 Analyzed: 151	A: Caudal epidural injection with betamethasone (2 mg/dL betamethasone dipropionate + 5 mg/dL betamethasone phosphate) (1 mL) + 2% lidocaine (12 mL) (*n* = 93) B: Caudal epidural injection with 2% lidocaine (12 mL) + water for injection (8 mL) (*n* = 90)	A vs. B: Mean age: 51 vs. 48 y Men: 65% vs. 70% Baseline pain: not reported Baseline ODI (0–100): 39 vs. 39 Duration of symptoms: 53 vs. 51 d	Fair
Snoek et al, 1977 (55)	8–20 mo	Epidural corticosteroid vs. placebo	Not specified	Randomized: 51 Analyzed: Unclear	A: Interlaminar epidural injection with 80 mg methylprednisolone (2 mL) (*n* = 27) B: Interlaminar epidural injection with saline (2 mL) (*n* = 24)	A vs. B: Mean age: 44 vs. 46 y Men: 48% vs. 54% Baseline pain: not reported Baseline function: not reported Duration of symptoms: 12 vs. 11 wk	Poor
Tafazal et al, 2009 (56); Ng et al, 2005 (88)	12 wk; 1 y for surgery outcome	Epidural corticosteroid vs. placebo	MRI diagnosis of lumbar disc herniation or foraminal stenosis	Randomized: 150 (74 vs. 76) Analyzed: 124 (65 vs. 59) at 3 mo	A: Transforaminal periradicular injection with 40 mg methylprednisolone + 0.25% bupivacaine (2 mL), with fluoroscopic guidance (*n* = 74) B: Transforaminal periradicular injection with 0.25% bupivacaine (2 mL), with fluoroscopic guidance (*n* = 76)	A vs. B: Mean age: 52 vs. 51 y Men: 60% vs. 54% Baseline leg pain (0–100 VAS): 73 vs. 76 Baseline back pain (0–100 VAS): 44 vs. 48 Baseline ODI (0–100): 43 vs. 47 Duration of symptoms: 20 vs. 18 mo	Fair
Thomas et al, 2003 (80)	6 mo	Approach	Disc herniation confirmed by CT or MR	Randomized: 31 Analyzed: 22	A: Transforaminal injection with 5 mg dexamethasone acetate (2 mL), with fluoroscopic guidance (*n* = 15) B: Interlaminar epidural injection with 5 mg dexamethasone acetate (2 mL), with fluoroscopic guidance (*n* = 16)	A vs. B: Mean age: 50 vs. 51 y Men: 53% vs. 31% Baseline leg pain (0–100 VAS): 74 vs. 72 Baseline RDQ (0–24): 12 vs. 14 Duration of symptoms: 6.5 vs. 6.8 wk	Fair
Valat et al, 2003 (57)	35 d	Epidural corticosteroid vs. epidural corticosteroid	Not specified	Randomized: 85 Analyzed: 63	A: Interlaminar epidural injection with 50 mg prednisolone acetate (2 mL) (*n* = 43) B: Interlaminar epidural injection with saline (2 mL) (*n* = 42)	A vs. B: Mean age: 44 vs. 38 y Men: 60% vs. 62% Baseline pain (0–100 VAS): 58 vs. 58 Baseline RDQ (0–24): 15 vs. 14 Duration of symptoms: 15 vs. 17 d	Fair
Wilson-MacDonald et al, 2005 (58)	2 y	Epidural corticosteroid vs. placebo	MRI showing disc prolapse and/or spinal stenosis	Randomized: 93 Analyzed: 72	A: Interlaminar epidural steroid injection with 80 mg methylprednisolone (2 mL) + 40 mg 0.5% bupivacaine (8 mL) (*n* = 44) B: Intramuscular/interspinous ligament injection with 80 mg methylprednisolone (2 mL) + 40 mg 0.5% bupivacaine (8 mL) (*n* = 48)	A vs. B: Mean age: 49 vs. 49 y Men: 40% (entire cohort) Baseline pain: not reported Baseline ODI (0–100): 44 vs. 40 Duration of symptoms: not reported; >6 wk for all	Fair
Spinal stenosis							
Cuckler et al, 1985 (37)	Mean 20–21 mo	Epidural corticosteroid vs. placebo	Required (myelography, CT, or epidural venography consistent with symptoms and neurologic findings)	Spinal stenosis subgroup Randomized: 37 Analyzed: 37	A: Interlaminar epidural injection with 80 mg methylprednisolone (2 mL) and 1% procaine (5 mL) (*n* = 23) B: Interlaminar epidural injection with saline (2 mL) and 1% procaine (5 mL) (*n* = 14)	A vs. B: Age: 49 vs. 50 y Men: 48% vs. 55% Baseline pain: not reported Baseline function: not reported Duration of symptoms: mean 14–17 mo	Fair
el Zahaar, 1991 (40)	Mean 20–21 mo	Epidural corticosteroid vs. placebo	Required (myelography or CT consistent with symptoms and neurologic findings)	Spinal stenosis subgroup Randomized: 30 Analyzed: 30	A: Caudal epidural injection with hydrocortisone (5 mL), 4% mepivacaine (4 mL), and saline (21 mL) (*n* = 18) B: Caudal epidural injection with 4% mepivacaine (4 mL) + saline (26 cc) (*n* = 12)	A vs. B: Mean age: 46 vs. 49 y Men: 54% vs. 65% Baseline pain: not reported Baseline function: not reported Duration of symptoms: 17 vs. 14 mo	Poor

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Appendix Table 1–Continued

Study, Year (Reference)	Duration of Follow-up	Comparison	Imaging Correlation	Participants, *n*	Type of Intervention	Patient Characteristics	Quality
Friedly et al, 2014 (59)	6 wk	Epidural corticosteroid vs. placebo	Required (MRI or CT with central canal stenosis)	Randomized: 400 (200 vs. 200) Analyzed: 386 (193 vs. 193)	A: Interlaminar (*n* = 143) or transforaminal (*n* = 57) injection with 1–3 mL triamcinolone (60–120 mg), betamethasone (6–12 mg), dexamethasone (8–10 mg), or methylprednisolone (60–120 mg) + 0.25%–1% lidocaine (3 mL), with fluoroscopic guidance (*n* = 200) B: Interlaminar (*n* = 139) or transforaminal (*n* = 61) injection with 0.25%–1% lidocaine, with fluoroscopic guidance (2–6 mL) (*n* = 200)	A vs. B: Mean age: 68 vs. 68 y Men: 42% vs. 48% Baseline leg pain (0–10 NRS): 7.2 vs. 7.2 Baseline RDQ (0–24): 16 vs. 16 Duration of symptoms: 12%–20% had symptoms <3 mo, 21%–34% for >5 y	Good
Fukusaki et al, 1998 (60)	3 mo	Epidural corticosteroid vs. placebo	Required (CT or MRI with central or lateral spinal canal stenosis)	Randomized: 53 Analyzed: 53	A: Interlaminar epidural injection with 40 mg methylprednisolone and 1% mepivacaine (8 mL) (*n* = 19) B: Interlaminar epidural injection with 1% mepivacaine (8 mL) (*n* = 18) C: Interlaminar epidural injection with normal saline (8 mL) (*n* = 16)	A vs. B: Mean age: 72 vs. 69 vs. 70 y Men: 68% vs. 72% vs. 75% Baseline pain: not reported Baseline function: not reported Duration of symptoms: not reported	Poor
Huda et al, 2010 (69)	6 mo	Steroid vs. steroid	Not specified	Randomized: 70 Analyzed: 70	A: Caudal epidural injection with 80 mg methylprednisolone (2 mL) + 0.125% bupivacaine (5 mL) and normal saline (13 mL) (*n* = 35) B: Caudal epidural injection with 80 mg triamcinolone acetate (80 mg) + 0.125% bupivacaine (5 mL) and normal saline (13 mL) (*n* = 35)	A vs. B: Mean age: 45 vs. 42 y Men: 54% vs. 66% Baseline pain (0–10 VAS): 6.4 vs. 6.3 Baseline function: not reported Duration of symptoms: 18 vs. 17 mo	Fair
Koc et al, 2009 (61)	6 mo	Epidural corticosteroid vs. placebo Epidural corticosteroid vs. other	Required (MRI with spinal canal stenosis)	Randomized: 33 Analyzed: 29	A: Interlaminar epidural injection with 60 mg triamcinolone acetonide (1.5 mL), 15 mg 0.5% bupivacaine (3 mL), and 0.9% physiologic saline (5.5 mL), with fluoroscopic guidance (*n* = 10) B: Physical therapy 5 days/wk for 2 wk, including ultrasonography for 10 minutes, hot pack for 20 minutes, and TENS for 20 minutes (*n* = 10) C: No injection or physical therapy (*n* = 9)	A vs. B vs. C: Mean age: 61 vs. 63 vs. 53 y Men: 80% vs. 50% vs. 89% Baseline pain (0–100 VAS): 56 vs. 54 vs. 59 Baseline Roland–Morris Disability Index (estimated from graph): 18 vs. 19 vs. 15 Duration of symptoms: 5.0 vs. 5.7 vs. 5.7 mo	Fair
Manchikanti et al, 2012 (62)	12 mo	Epidural corticosteroid vs. placebo	Not specified	Randomized: 120 Analyzed: 60, including 6 (3 vs. 30) with missing data (preliminary analysis)	A: Interlaminar epidural injection with betamethasone (1 mL; dose not specified) + 0.5% lidocaine (5 mL), with fluoroscopic guidance (*n* = 30) B: Interlaminar epidural injection with 0.5% lidocaine (6 mL), with fluoroscopic guidance (*n* = 30)	A vs. B: Mean age: 50 vs. 54 y Men: 63% vs. 40% Baseline pain (0–10 NRS): 8.1 vs. 8.1 Baseline ODI (0–50): 29 vs. 31 Duration of symptoms: 121 vs. 138 mo	Fair
Manchikanti et al, 2012 (63, 111) and 2008 (112)	24 mo	Epidural corticosteroid vs. placebo	Not specified	Randomized: 100 Analyzed: 100, including 29 (14 vs. 15) with missing data	A: Caudal epidural injection with betamethasone 6 mg (1 mL) + lidocaine 0.5% (9 mL) with fluoroscopic guidance (*n* = 50) B: Caudal epidural injection with lidocaine 0.5% (10 mL) with fluoroscopic guidance (*n* = 50)	A vs. B: Mean age: 56 vs. 57 y Men: 50% vs. 32% Baseline pain (NRS 0–10): 7.6 vs. 7.9 Baseline ODI (0–50): 28 vs. 40 Duration of symptoms: 105 vs. 94 mo	Fair
Nam and Park, 2011 (64)	3 mo	Epidural corticosteroid vs. placebo	Required (spinal stenosis on CT or MRI)	Randomized: 48 Analyzed: 36	A: Transforaminal epidural injection with 20 mg triamcinolone (0.5 mL) + 0.5% lidocaine (1.5 mL), with fluoroscopic guidance (*n* = 17) B: Transforaminal epidural injection with 0.5% lidocaine (2 mL), with fluoroscopic guidance (*n* = 19)	A vs. B: Mean age: 75 vs. 71 y Men: 24% vs. 26% Baseline pain (0–10 VAS): 7.3 vs. 7.4 Baseline ODI (0–100): 63 vs. 63 Duration of symptoms: 7.7 vs. 6.7 mo	Poor

CT = computed tomography; EMG = electromyography; L = angular momentum; MRI = magnetic resonance imaging; NRS = numeric rating scale; ODI = Oswestry Disability Index; RDQ = Roland–Morris Disability Questionnaire; TENS = transcutaneous electrical nerve stimulation; VAS = visual analogue scale.

Appendix Table 2. Pooled Results: Epidural Corticosteroid Injections Versus Placebo Interventions for Radiculopathy

Outcome	Estimate (95% CI)	Trials, *n* (Reference)	I^2 Value, %
Pain			
Mean improvement (WMD)*			
Immediate follow-up	−7.55 (−11.4 to −3.74)	6 (33, 38, 41, 44, 45, 57)	30
Short-term follow-up	−3.61 (−8.45 to 1.23)	15 (30, 33–36, 38, 42–45, 47–49, 56, 57)	83
Intermediate-term follow-up	0.71 (−5.50 to 6.92)	5 (33, 44, 47–49)	7
Long-term follow-up	0.13 (−2.39 to 2.65)	7 (30, 34, 43, 44, 47–49)	0
Successful composite outcomes (RR)			
Short-term follow-up	1.21 (0.98 to 1.49)	8 (30, 36, 39, 41, 47, 48, 50, 88)	67
Intermediate-term follow-up	1.12 (0.93 to 1.36)	3 (36, 47, 48)	41
Long-term follow-up	1.10 (0.94 to 1.28)	4 (30, 37, 47, 48)	0
Function			
Mean improvement (SMD)			
Immediate follow-up	−0.75 (−1.62 to 0.11)	4 (33, 44, 54, 57)	94
Short-term follow-up	−0.14 (−0.43 to 0.15)	13 (30, 33–36, 43, 44, 47–49, 54, 56, 57)	87
Intermediate-term follow-up	−0.22 (−0.61 to 0.18)	6 (33, 44, 47–49, 54)	85
Long-term follow-up	−0.17 (−0.47 to 0.12)	8 (30, 34, 43, 44, 47–49, 54)	82
Successful composite outcomes (RR)			
Short-term follow-up	0.98 (0.77 to 1.26)	7 (30, 35, 38, 47–49, 88)	73
Intermediate-term follow-up	1.09 (0.86 to 1.38)	3 (47–49)	71
Long-term follow-up	1.07 (0.93 to 1.24)	4 (30, 47–49)	0
Surgery (RR)			
Short-term follow-up	0.62 (0.41 to 0.92)	8 (38, 39, 45, 46, 54, 57, 88)†	0
Intermediate-term follow-up	0.56 (0.12 to 2.68)	1 (33)	–
Long-term follow-up	0.97 (0.75 to 1.25)	14 (30, 34, 36, 37, 40, 41, 43, 44, 50, 53, 55, 56, 58, 89)	23
Successful composite outcomes (RR)			
Immediate follow-up	1.05 (0.87 to 1.27)	2 (31, 48)	0
Short-term follow-up	1.13 (0.98 to 1.32)	9 (33, 35, 36, 42, 45, 46, 53, 57)†	3.5
Intermediate-term follow-up	0.71 (0.34 to 1.48)	1 (36)	–
Long-term follow-up	1.04 (0.81 to 1.34)	2 (40, 48)	0

RR = relative risk; SMD = standardized mean difference; WMD = weighted mean difference.
* Scale of 0 to 100.
† One publication reported 2 trials (46).

Appendix Table 3. Pooled Results: Epidural Corticosteroid Injections Versus Placebo Interventions for Spinal Stenosis

Outcome	Estimate (95% CI)	Trials, *n* (Reference)	I^2 Value, %
Pain			
Mean improvement (WMD)*			
Immediate follow-up	−22.0 (−36.0 to −8.00)	1 (61)	–
Short-term follow-up	0.62 (−2.87 to 4.11)	5 (59, 61–64)	0
Intermediate-term follow-up	3.73 (−0.81 to 8.26)	3 (62, 63)	0
Long-term follow-up	4.00 (−2.87 to 10.9)	1 (63)	–
Successful composite outcomes (RR)			
Short-term follow-up	0.98 (0.84 to 1.15)	3 (59, 62, 63)	0
Intermediate-term follow-up	0.98 (0.78 to 1.24)	2 (62, 63)	0
Long-term follow-up	0.97 (0.74 to 1.28)	3 (37, 62, 63)	0
Function			
Mean improvement			
Immediate follow-up (SMD)	−0.32 (−0.85 to 0.22)	2 (61, 64)	0
Short-term follow-up (SMD)	−0.03 (−0.31 to 0.26)	5 (59, 61–64)	60
Intermediate-term follow-up (WMD)*	2.81 (−0.44 to 6.06)	3 (61–63)	0
Long-term follow-up (WMD)*	2.78 (−1.24 to 6.79)	2 (62, 63)	0
Successful composite outcomes (RR)			
Short-term follow-up	0.91 (0.70 to 1.18)	3 (59, 62, 63)	37
Intermediate-term follow-up	0.96 (0.74 to 1.25)	2 (62, 63)	0
Long-term follow-up	0.95 (0.71 to 1.26)	2 (62, 63)	0
Surgery (RR)			
Long-term follow-up	0.76 (0.38 to 1.54)	1 (40)	–
Successful composite outcomes (RR)			
Short-term follow-up	1.18 (0.55 to 2.55)	2 (63, 64)	80
Intermediate-term follow-up	0.93 (0.63 to 1.35)	1 (63)	–
Long-term follow-up	1.16 (0.76 to 1.78)	2 (40, 63)	0

RR = relative risk; SMD = standardized mean difference; WMD = weighted mean difference.
* Scale of 0 to 100.

Appendix Table 4. Pooled Results: Transforaminal Versus Interlaminar Epidural Corticosteroid Injections

Outcome	Estimate (95% CI)	Trials, *n* (Reference)	I^2 Value, %
Pain			
Mean improvement (WMD)*			
Immediate follow-up	−10.1 (−24.8 to 4.63)	5 (76–78, 80, 90)	83
Short-term follow-up	−1.29 (−12.6 to 10.1)	3 (78, 80, 90)	54
Intermediate-term follow-up	−11.3 (−44.8 to 22.2)	2 (80, 90)	87
Successful composite outcomes (RR)			
Short-term follow-up	No studies	–	–
Intermediate-term follow-up	1.18 (0.77 to 1.79)	1 (90)	–
Long-term follow-up	No studies	–	–
Function			
Mean improvement			
Immediate follow-up (SMD)	0.03 (−0.48 to 0.53)	4 (76, 77, 80, 90)	68
Short-term follow-up (SMD)	0.39 (−0.36 to 1.13)	3 (78, 80, 90)	74
Intermediate-term follow-up (WMD)*	−4.60 (−8.85 to −0.35)	1 (80)	–
Long-term follow-up (WMD) *	−2.00 (−8.77 to 4.77)	1 (90)	–
Successful composite outcomes (RR)	No studies	–	–
Surgery (RR)			
Short-term follow-up	0.49 (0.15 to 1.54)	1 (46)	–
Intermediate-term follow-up	1.08 (0.45 to 2.60)	2 (78, 80)	0
Successful composite outcomes (RR)			
Short-term follow-up	1.30 (0.91 to 1.85)	1 (46)	–
Intermediate-term follow-up	3.00 (0.90 to 10.0)	1 (76)	–

RR = relative risk; SMD = standardized mean difference; WMD = weighted mean difference.
* Scale of 0 to 100.

Appendix Table 5. Epidural Corticosteroid Injections Versus Placebo Interventions, by Approach

Outcome	Approach		
	Transforaminal	**Interlaminar**	**Caudal**
Pain			
Mean improvement (WMD)*			
Immediate follow-up	−13.3 (−19.9 to −6.77); I^2 = 5.8%; 2 trials (41, 44)	−3.52 (−10.2 to 3.19); I^2 = 0%; 3 trials (33, 45, 57)	−6.34 (−8.75 to −3.93); 1 trial (38)
Short-term follow-up	−0.56 (−4.52 to 3.41); I^2 = 0%; 4 trials (36, 44, 49, 56)	−3.62 (−11.9 to 4.70); I^2 = 81%; 7 trials (30, 33, 35, 42, 45, 47, 57)	−5.69 (−15.9 to 4.56); I^2 = 88%; 4 trials (34; 38; 43; 48)
Intermediate-term follow-up	7.72 (−2.34 to 17.8); I^2 = 79%; 2 trials (44, 49)	−4.38 (−8.56 to −0.21); I^2 = 0%; 2 trials (33, 47)	−3.00 (−8.74 to 2.74); 1 trial (48)
Long-term follow-up	3.29 (−0.82 to 7.39); I^2 = 0%; 2 trials (44, 49)	−0.88 (−5.18 to 3.43); I^2 = 0%; 2 trials (30, 47)	−2.86 (−7.61 to 1.89); I^2 = 0%; 3 trials (34; 43; 48)
Successful composite outcomes (RR)			
Short-term follow-up	1.52 (0.68 to 3.41); I^2 = 86%; 3 trials (36, 41, 88)	1.09 (0.90 to 1.33); I^2 = 29%; 3 trials (30, 39, 47)	1.07 (0.90 to 1.27); I^2 = 0%; 2 trials (48, 50)
Intermediate-term follow-up	0.71 (0.34 to 1.48); 1 trial (36)	1.26 (1.04 to 1.53); 1 trial (47)	1.07 (0.89 to 1.28); 1 trial (48)
Long-term follow-up	No studies	1.11 (0.92 to 1.33); I^2 = 0%; 3 trials (30, 37, 47)	1.08 (0.83 to 1.40); 1 trial (48)
Function			
Mean improvement (SMD)			
Immediate follow-up	−0.33 (−0.64 to −0.02); 1 trial (44)	−0.32 (−0.68 to 0.04); I^2 = 0%; 2 trials (33, 57)	−1.90 (−2.25 to −1.55); 1 trial (54)
Short-term follow-up	0.08 (−0.28 to 0.44); I^2 = 72%; 4 trials (36, 44, 49, 56)	−0.12 (−0.27 to 0.04); I^2 = 0%; 5 trials (30, 33, 35, 47, 57)	−0.28 (−1.18 to 0.62); I^2 = 94%; 4 trials (34, 43, 48, 54)
Intermediate-term follow-up	0.21 (−0.02 to 0.45); I^2 = 0%; 2 trials (44, 49)	−0.37 (−0.68 to −0.05); I^2 = 0%; 2 trials (33, 47)	−0.50 (−1.31 to 0.31); I^2 = 92%; 2 trials (48, 54)
Long-term follow-up	0.08 (−0.15 to 0.32); I^2 = 0%; 2 trials (44, 49)	−0.18 (−0.42 to 0.06); I^2 = 21%; 2 trials (30, 47)	−0.29 (−0.91 to 0.33); I^2 = 89%; 4 trials (34, 43, 48, 54)
Successful composite outcomes (RR)			
Short-term follow-up	0.79 (0.56 to 1.11); I^2 = 45%; 2 trials (49, 88)	0.96 (0.73 to 1.27); I^2 = 48%; 3 trials (30, 35, 47)	1.56 (0.45 to 5.43); I^2 = 94%; 2 trials (38, 48)
Intermediate-term follow-up	0.91 (0.72 to 1.15); 1 trial (49)	1.37 (1.10 to 1.70); 1 trial (47)	1.02 (0.82 to 1.28); 1 trial (48)
Long-term follow-up	0.87 (0.65 to 1.16); 1 trial (49)	1.13 (0.92 to 1.39); I^2 = 0%; 2 trials (30, 47)	1.17 (0.90 to 1.52); 1 trial (48)
Surgery (RR)			
Short-term follow-up	0.82 (0.29 to 2.32); I^2 = 0%; 3 trials (46, 88)†	0.62 (0.28 to 1.37); I^2 = 0%; 3 trials (39, 45, 57)	0.57 (0.34 to 0.97); I^2 = 5.4%; 2 trials (38, 54)
Long-term follow-up	0.89 (0.55 to 1.43); I^2 = 56%; 5 trials (36, 41, 44, 56, 89)	1.08 (0.80 to 1.46); I^2 = 0%; 5 trials (30, 37, 53, 55, 58)	0.69 (0.20 to 2.46); I^2 = 38%; 4 trials (34, 40, 43, 50)
Successful composite outcomes (RR)			
Immediate follow-up	No studies	No studies	1.05 (0.87 to 1.27); I^2 = 0%; 2 trials (31, 48)
Short-term follow-up	1.16 (0.79 to 1.71); I^2 = 0%; 3 trials (36, 46)†	1.16 (0.95 to 1.42); I^2 = 31%; 6 trials (33, 35, 42, 45, 53, 57)	No studies
Intermediate-term follow-up	0.71 (0.34 to 1.48); 1 trial (36)	No studies	No studies
Long-term follow-up	No studies	No studies	1.04 (0.81 to 1.34); I^2 = 0%; 2 trials (40, 48)

RR = relative risk; SMD = standardized mean difference; WMD = weighted mean difference.
* Scale of 0 to 100.
† One publication reported 2 trials (46).

Appendix Table 6. Epidural Corticosteroid Injections Versus Placebo Interventions, by Type of Placebo Comparator

Outcome	Placebo Comparator		
	Epidural Local Anesthetic	Epidural Saline	Soft-Tissue Injection
Pain			
Mean improvement (WMD)*			
Immediate follow-up	−9.64 (−18.8 to −0.51); I^2 = 61%; 3 trials (38, 41, 45)	−6.66 (−15.8 to 2.54); I^2 = 66%; 4 trials (41, 44, 45, 57)	−12.1 (−21.4 to −2.79); I^2 = 0%; 2 trials (41, 45)
Short-term follow-up	−3.71 (−9.97 to 2.56); I^2 = 87%; 6 trials (38, 45, 47–49, 56)	0.51 (−7.21 to 8.23); I^2 = 58%; 7 trials (34–36, 43–45, 57)	1.35 (−17.0 to 19.7); I^2 = 90%; 4 trials (30, 42, 43, 45)
Intermediate-term follow-up	−1.37 (−5.77 to 3.03); I^2 = 57%; 3 trials (47–49)	13.3 (5.60 to 21.0); 1 trial (44)	No studies
Long-term follow-up	−0.56 (−4.21 to 3.09); I^2 = 34%; 3 trials (47–49)	1.50 (−4.54 to 7.54); I^2 = 0%; 3 trials (34, 43, 44)	1.47 (−5.55 to 8.49); I^2 = 0%; 2 trials (30, 43)
Successful composite outcomes (RR)			
Short-term follow-up	1.12 (0.85 to 1.47); I^2 = 68%; 4 trials (41, 47, 48, 88)	1.74 (0.72 to 4.24); I^2 = 73%; 2 trials (36, 41)	1.46 (0.89 to 2.37); I^2 = 75%; 4 trials (30, 39, 41, 50)
Intermediate-term follow-up	1.16 (0.98 to 1.37); I^2 = 37%; 2 trials (47, 48)	0.71 (0.34 to 1.48); 1 trial (36)	No studies
Long-term follow-up	1.09 (0.91 to 1.31); I^2 = 0%; 2 trials (47, 48)	1.70 (0.40 to 7.22); 1 trial (37)	1.09 (0.82 to 1.44); 1 trial (30)
Function			
Mean improvement (SMD)			
Immediate follow-up	−1.90 (−2.25 to −1.55); 1 trial (54)	−0.30 (−0.55 to −0.05); I^2 = 0%; 2 trials (44, 57)	No studies
Short-term follow-up	−0.28 (−0.97 to 0.41); I^2 = 95%; 5 trials (47–49, 54, 56)	−0.04 (−0.26 to 0.18); I^2 = 37%; 6 trials (34–36, 43, 44, 57)	0.01 (−0.21 to 0.24); I^2 = 0%; 2 trials (30, 43)
Intermediate-term follow-up	−0.30 (−0.78 to 0.18); I^2 = 87%; 4 trials (47–49, 54)	0.25 (−0.07 to 0.56); 1 trial (44)	No studies
Long-term follow-up	−0.34 (−0.87 to 0.20); I^2 = 90%; 4 trials (47–49, 54)	0.08 (−0.16 to 0.33); I^2 = 0%; 3 trials (34, 43, 44)	−0.07 (−0.29 to 0.16); I^2 = 0%; 2 trials (30, 43)
Successful composite outcomes (RR)			
Short-term follow-up	1.05 (0.76 to 1.45); I^2 = 81%; 5 trials (38, 47–49, 88)	0.90 (0.61 to 1.33); 1 trial (35)	0.71 (0.41 to 1.23); 1 trial (30)
Intermediate-term follow-up	1.09 (0.86 to 1.38); I^2 = 71%; 3 trials (47–49)	No studies	No studies
Long-term follow-up	1.07 (0.89 to 1.28); I^2 = 27%; 3 trials (47–49)	No studies	1.07 (0.72 to 1.58); 1 trial (30)
Surgery (RR)			
Short-term follow-up	0.58 (0.35 to 0.95); I^2 = 0%; 4 trials (38, 45, 54, 88)	0.49 (0.05 to 5.19); 1 trial (57)	0.66 (0.32 to 1.34); I^2 = 0%; 2 trials (39, 46)
Long-term follow-up	0.78 (0.48 to 1.26); I^2 = 34%; 5 trials (40, 41, 53, 56, 89)	1.07 (0.78 to 1.46); I^2 = 0%; 7 trials (34, 36, 37, 41, 43, 44, 55)	0.97 (0.44 to 2.10); I^2 = 48%; 4 trials (30, 41, 43, 50)
Successful composite outcomes (RR)			
Immediate follow-up	1.05 (0.87 to 1.27); I^2 = 0%; 2 trials (31, 48)	No studies	No studies
Short-term follow-up	1.38 (0.70 to 2.73); I^2 = 38%); 2 trials (45, 53)	1.05 (0.87 to 1.28); I^2 = 0%; 3 trials (35, 36, 45, 57)	1.21 (0.55 to 2.70); I^2 = 71%; 3 trials (42, 45, 46)
Intermediate-term follow-up	No studies	0.71 (0.34 to 1.48); 1 trial (36)	No studies
Long-term follow-up	1.04 (0.81 to 1.34); I^2 = 0%; 2 trials (40, 48)	No studies	No studies

RR = relative risk; SMD = standardized mean difference; WMD = weighted mean difference.
* Scale of 0 to 100.

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