

# Epidural injections with or without steroids in managing chronic low back pain secondary to lumbar spinal stenosis: a meta-analysis of 13 randomized controlled trials

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**Background:** Epidural injections of anesthetic with or without steroids are widely used for treating lumbar spinal stenosis, a common cause of chronic low back pain, but there is a lack of rigorous data comparing the effectiveness of epidural injections of anesthetic with and without steroids. This meta-analysis presents a current, comprehensive picture of how epidural injections of anesthetic with steroids compare with those using local anesthetic alone.

**Methods:** PubMed, Embase, Web of Science, and Cochrane Library databases were searched from their inception through February 5, 2015. Weight mean difference, risk ratio, and 95% confidence intervals were calculated. A random effects model or fixed effects model was used to pool the estimates, according to the heterogeneity between the included studies.

**Results:** We included 13 randomized controlled trials, involving 1,465 patients. Significant pain relief ( $\geq 50\%$ ) was demonstrated in 53.7% of patients administered with epidural injections of anesthetic with steroids (group 1) and in 56.4% of those administered with local anesthetic alone (group 2). Patients showed a reduction in numeric rating scale pain score of 3.7 and 3.6 in the two groups, respectively. Significant functional improvement was achieved in 65.2% of patients in group 1 and 63.1% of patients in group 2, with Oswestry Disability Index reductions of 13.8 and 14.5 points, respectively. The overall number of injections per year was  $3.2 \pm 1.3$  and  $3.4 \pm 1.2$  with average total relief per year of  $29.3 \pm 19.7$  and  $33.8 \pm 19.3$  weeks, respectively. The opioid intakes decreased from baseline by 12.4 and 7.8 mg, respectively. Among the outcomes listed, only total relief time differed significantly between the two groups.

**Conclusion:** Both epidural injections with steroids or with local anesthetic alone provide significant pain relief and functional improvement in managing chronic low back pain secondary to lumbar spinal stenosis, and the inclusion of steroids confers no advantage compared to local anesthetic alone.

**Keywords:** chronic low back pain, spinal stenosis, epidural injections, steroids, local anesthetics

## Introduction

Spinal stenosis is defined as a narrowing of spinal canal with encroachment on the neural structures by surrounding bone and soft tissue.<sup>1</sup> In the Framingham Study, prevalence of symptomatic lumbar spinal stenosis was estimated to be 27.2%.<sup>2</sup> The three most common causes of low back and leg pain are spinal stenosis, disc herniation, and degenerative spondylolisthesis, for which surgery is usually performed.<sup>1,3-5</sup> Moreover, in patients older than 65 years, lumbar spinal stenosis has been regarded as the most frequent indication for spinal surgery.<sup>4-6</sup> Numerous modalities of treatment,

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including surgery with or without fusion, interventional techniques, and conservative approaches have been applied in managing lumbar central spinal stenosis.<sup>4,7-9</sup>

Surgical interventions or epidural injections are commonly used for treatment of symptomatic spinal stenosis when conservative treatment fails.<sup>1,3-5,10,11</sup> In the Spine Patient Outcomes Research Trials (SPORT), Tosteson et al<sup>3</sup> found that patients who received surgical intervention for spinal stenosis without degenerative spondylolisthesis achieved significant improvement in all primary outcomes compared to those undergoing nonsurgical treatment. Moreover, in a systematic review that compared conservative care with surgery, surgery was shown to provide beneficial effects in managing pain and quality of life, but not ambulation.<sup>12</sup>

However, for patients with mild to moderate spinal stenosis, who are not candidates for surgery, or for those who do not respond well to surgery, epidural injections may be the only interventional treatment. Consequently, apart from surgical intervention, epidural injections are the most commonly performed intervention in the management of chronic low back pain secondary to central spinal stenosis.<sup>13,14</sup> Manchikanti et al conducted a trial that compared the effect of epidural injections with or without steroids in the treatment of spinal stenosis.<sup>15</sup> The authors found that 46% of the patients who were treated with local anesthetic and steroids achieved significant pain relief and an improvement in functional status of more than 50%, whereas the proportion of patients who improved after receiving only local anesthetic was 48%.<sup>15</sup> In another trial, pain relief and improved functional status were observed in 73% of the patients who received both steroids and local anesthetic, and in 72% of those who received local anesthetic alone.<sup>16</sup>

No meta-analysis has yet been conducted to compare the effectiveness of epidural injections of local anesthetic with or without steroids in the treatment of patients with spinal stenosis, leaving the relative effectiveness of these treatments open to question. To address this need, we performed a meta-analysis based on randomized controlled trials (RCTs).

## Methods and materials

### Search strategy and study inclusion

We followed the preferred reported items for systematic and meta-analysis guideline (PRISMA) in this study.<sup>17</sup> A comprehensive literature search was conducted to identify all the published RCTs that compared epidural injection with or without steroids in the management of chronic low back pain in spinal stenosis. PubMed, Embase, Web of Science, and Cochrane Library databases were searched from their

inception through February 5, 2015. The following search terms were used: (“spinal stenosis” [MeSH Terms]) or (“spinal” [All Fields] and “stenosis” [All Fields]) or (“spinal stenosis” [All Fields]) and (“injections, epidural” [MeSH Terms]) or (“injections” [All Fields] and “epidural” [All Fields]) or (“epidural injections” [All Fields]) or (“epidural” [All Fields] and “injection” [All Fields]) or (“epidural injection” [All Fields]) and (“anesthetics, local” [Pharmacological Action] or “anesthetics, local” [MeSH Terms]) or (“anesthetics” [All Fields] and “local” [All Fields]) or (“local anesthetics” [All Fields]) or (“local” [All Fields] and “anesthetic” [All Fields]) or (“local anesthetic” [All Fields]) or (“anesthesia, local” [MeSH Terms]) or (“anesthesia” [All Fields] and “local” [All Fields]) or (“local anesthesia” [All Fields]) or (“local” [All Fields] and “anesthetic” [All Fields]) and (“steroids” [MeSH Terms] or “steroids” [All Fields] or “steroid” [All Fields]). We did not impose any language limitation in the search strategy. Reference lists of the included studies were also manually screened until no more potential studies could be found.

Studies that met the following selection criteria were included in this meta-analysis: 1) study design: RCT; 2) study subjects: patients diagnosed with spinal stenosis with radicular pain who had a history of chronic function-limiting low back pain and lower extremity pain; 3) study intervention: patients in the study arm received epidural injections of local anesthetic with steroids, whereas patients in the control arm received local anesthetic alone; 4) outcomes: pain relief, numeric rating scale (NRS) of the pain rating scores, functional improvement, Oswestry Disability Index (ODI) of functional ability, opioid intake, average number of injections per year, total relief per year, and weight changes.

### Data extraction and quality assessment

Two independent investigators (Nan Su and Hai Meng) extracted the following information from each included study: first author, year of publication, number of patients (intervention/control arms), baseline characteristics, number of patients with significant ( $\geq 50\%$ ) pain relief or improvement in functional status in each group, average number of injections per year in each group, total relief time per year in each group, opioid intake, and weight changes.

The methodological quality of all the included studies was assessed using the Jadad scale.<sup>18</sup> The scale consists of three items in the report of an RCT. The quality scale ranges from 0 to 5 points, with a higher score indicating a better quality study. Articles with a score of more than 2 are deemed to be of high quality.<sup>19</sup>

**Table 1** The literature search strategy for each database

Database	Search terms	Number of citations
PubMed	"Spinal stenosis" and "epidural injections of anesthetic" and "steroids"	52
Embase	"Spinal stenosis" and "epidural injections of anesthetic" and "steroids" (human and exclude Medline journal and Embase and randomized controlled trials and article)	264
Web of Science	Spinal stenosis*epidural injections of anesthetic*steroids	253
Cochrane Library database	"Spinal stenosis" and "epidural injections of anesthetic" and "steroids"	17

## Statistical analysis

This meta-analysis was conducted based on the data from 13 randomized trials. Pain relief and functional status improvement were treated as dichotomous variables and were expressed as a risk ratio (RR) with a 95% confidence interval (CI). The NRS, ODI, total relief per year, opioid intake, average number of injections per year, and weight change were treated as continuous variables and were expressed as a weight mean difference (WMD) with 95% CI. Before the data were pooled, a Cochrane Q chi-square test and  $I^2$  statistic were used to test the heterogeneity between studies, in which a  $P$ -value of less than 0.1 or  $I^2$  value of more than 50% were considered indicators of significant heterogeneity.<sup>20</sup> A fixed effects model was used to pool the estimates when substantial heterogeneity existed;<sup>21</sup> otherwise a random effects model was preferred to summarize the data.<sup>22</sup> The presence of publication bias was assessed by using the Begg<sup>22</sup> and Egger test.<sup>23</sup> A  $P$ -value <0.05 was judged as statistically significant, except where otherwise specified. All analyses were performed using STATA version 12.0 (Stata Corporation, College Station, TX, USA).

## Results

### Identification of eligible studies

The initial search yielded 586 studies from the three databases (Table 1), of which 376 were excluded because of duplicate records. After the title and abstract review, 195 were excluded, leaving 15 for the full-text review. Of those remaining, two studies were excluded because one was a study protocol,<sup>24</sup> and the other<sup>25</sup> contained data redundant with that in a later, completed version of the study. Ultimately, 13 RCTs with a total of 1,465 patients that met the inclusion criteria were included in this meta-analysis.<sup>8,9,26–36</sup> A flowchart of the literature search strategy is shown in Figure 1.

### Study characteristics and quality assessment

The main characteristics of the 13 RCTs included in our analysis are summarized in Table 2. All these trials were

strictly selected according to the selection criteria. Trials were published between 1998 and 2004, all in peer-reviewed journals. Sample sizes in the included studies ranged from 19 to 400. Of the 13 studies, five<sup>8,27–30</sup> used the caudal route to administer anesthetic or steroids, three<sup>9,35,36</sup> used an interlaminar route, two used a transforaminal route, and the remaining three<sup>31,33,34</sup> did not report the administration route. In majority of the studies, the NRS was used to evaluate pain rating scores, and the ODI was used to measure functional ability, with lower scores indicating less severe symptoms. A 50% or greater reduction in NRS or ODI scores was considered as significant pain relief and improvement. The median Jadad score of the included studies was 4 (range from 4 to 5).

### Pain relief

Pain relief data were reported in nine studies.<sup>8,9,26–30,33,36</sup> Pooling these RCTs, significant pain relief was demonstrated in 51.5% of patients in both groups at 3 months, 56.6% in

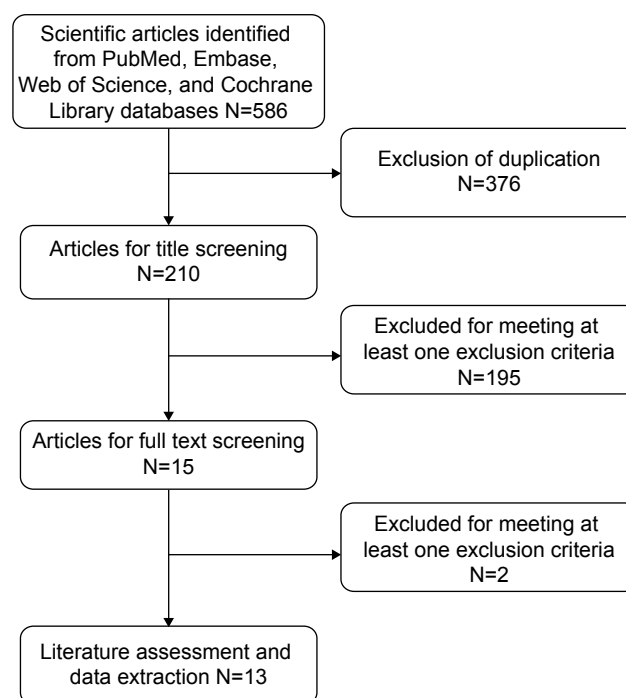
**Figure 1** Eligibility of studies for inclusion in systematic review.

Table 2 Baseline characteristics of patients in the trials included in the meta-analysis

Study	Treatment regimen	Sample size	Age* (years)	Duration of pain* (months)	Onset of pain (gradual/injury)	Low back pain distribution (bilateral/left or right)	Epidural approach	Jadad score
Manchikanti et al <sup>18</sup>	Lidocaine + steroid	50	55.7±15.9	104.9±80.4	37/13	35/15	Caudal	4
Manchikanti et al <sup>19</sup>	Lidocaine	50	56.9±14.5	94.2±106.9	38/12	40/10	Interlaminar	5
	6 mL, 0.5% lidocaine + betamethasone	30	49.8±14.7	121±81.5	24/6	4/26		
Friedly et al <sup>26</sup>	6 mL, 0.5% lidocaine	30	53.9±11.4	138.1±89.4	25/5	2/28	Transforaminal	4
	Glucocorticoid + lidocaine	200	68±9.8	No report	No report	No report		
Manchikanti et al <sup>27</sup>	Lidocaine	200	68.1±10.2	No report	No report	No report	Caudal	4
	9 mL, 0.5% lidocaine + 1 mL steroid	20	60.4±14.08	75.4±69.39	18/2	14/6		
Manchikanti et al <sup>28</sup>	0.5% lidocaine	20	60.3±17.37	84.5±66.23	15/5	14/6	Caudal	4
	Lidocaine + betamethasone	25	61±12.5	164±127.9	18/7	4/21		
	Anesthetic	25	62±13.9	114±96.9	19/6	9/16		
Manchikanti et al <sup>29</sup>	9 mL, 0.5% lidocaine + 1 mL betamethasone	50	55.7±15.9	104.9±80.4	37/13	35/15	Caudal	5
Manchikanti et al <sup>30</sup>	0.5% lidocaine	50	56.9±14.5	94.2±106.9	38/12	40/10	Caudal	5
	9 mL, 0.5% lidocaine + 1 mL betamethasone	50	55.7±15.9	104.9±80.4	37/13	35/15		
Tafazal et al <sup>31</sup>	0.5% lidocaine	50	56.9±14.5	94.2±106.9	38/12	40/10	No report	4
Radcliff et al <sup>32</sup>	Bupivacaine + steroid	65	52.8	20 (7–23.5)	No report	No report		
	Bupivacaine	59	51.0	17.8 (6–24)	No report	No report	Transforaminal	4
Cuckler J <sup>33</sup>	Lidocaine + steroid	69	66±9.5	No report	No report	No report		
	Lidocaine	207	64.5±11.6	No report	No report	No report	No report	4
Ng et al <sup>34</sup>	Procaine + methylprednisolone	42	49.5±2.8	17.3±6.4	22/20	35/7		
	Procaine + saline solution	31	48.5±1.3	13.8±3.7	14/17	28/3	No report	4
Koc et al <sup>35</sup>	Bupivacaine + steroid	43	51.2±14.5	16.9 (6.25±19.5)	No report	No report		
	Bupivacaine	43	49.7±17.1	12 (6–18.5)	No report	No report	Intralaminar	4
Fukusaki et al <sup>36</sup>	Lidocaine + steroid	10	61.1±9.8	5.0±7.4	No report	No report		
	Lidocaine	9	53.1±8.3	5.7±4.9	No report	No report	Intralaminar	4
	8 mL, 1% mepivacaine +40 mg methylprednisolone	19	72±7	No report	No report	11/9		
	8 mL, 1% mepivacaine	18	69±9	No report	No report	8/10		

Note: \*Data are presented as mean ± standard deviation.

Abbreviation: SD, standard deviation.

both groups at 6 months, and 53.7% in group 1 and 56.4% in group 2 at 12 months. Meta-analysis of nine RCTs using a fixed effects model showed that there were no significant differences between the two groups in terms of pain relief at 3 months (RR =1.0, 95% CI: 0.9, 1.2;  $P=0.975$ ), 6 months (RR =1.0, 95% CI: 0.9, 1.1;  $P=1.000$ ), or 12 months (RR =1.0, 95% CI: 0.9, 1.2;  $P=1.000$ ) (Figure 2).

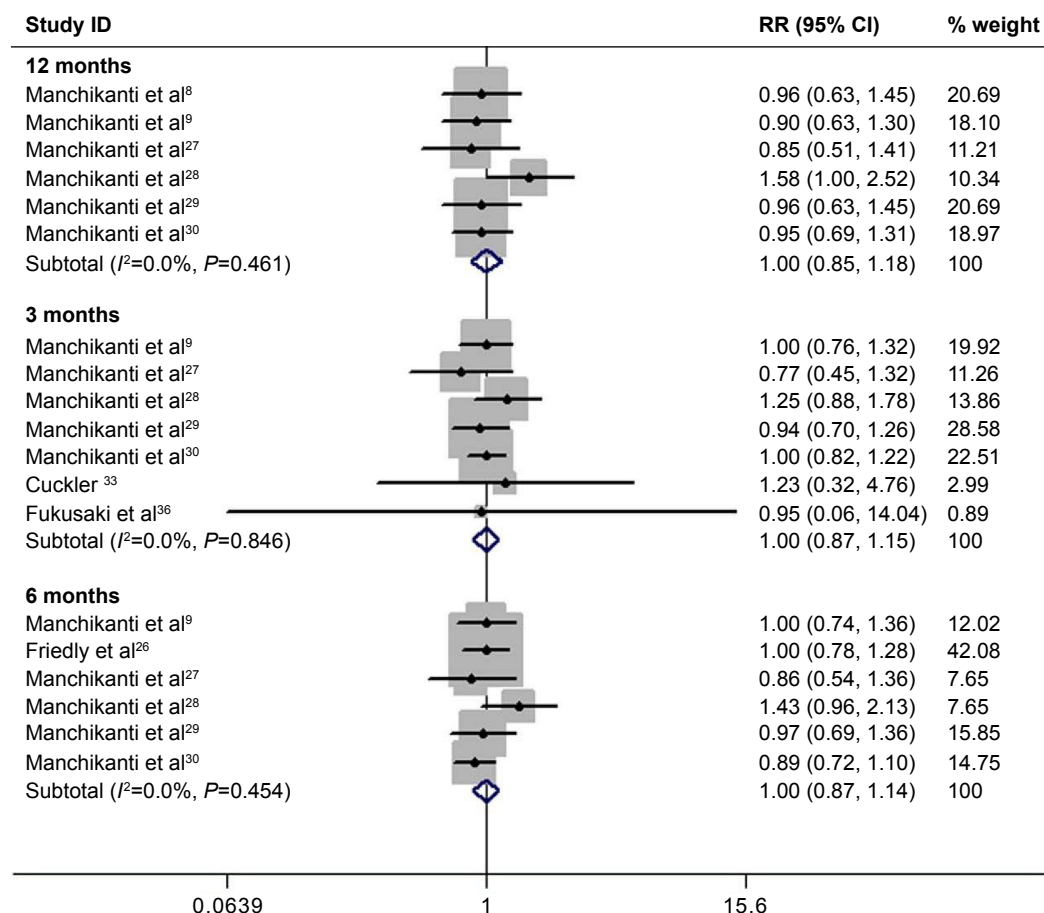
Data of NRS pain scores were available from ten studies.<sup>8,9,26–31,33,35</sup> Pooled estimates indicated that in group 1, patients at 3, 6, and 12 months had a 5.3 score reduction (WMD =−5.3, 95% CI: −6.7, −3.8;  $P=0.000$ ), 4.0 score reduction (WMD =−4.0, 95% CI: −5.0, −3.0;  $P=0.000$ ), and 3.7 score reduction (WMD =−3.7, 95% CI: −4.0, −3.4;  $P=0.000$ ), respectively; whereas, patients in group 2 had a 4.9 score reduction (WMD =−4.9, 95% CI: −6.4, −3.3;  $P=0.000$ ), 4.5 score reduction (WMD =−4.5, 95% CI: −5.8, −3.1;  $P=0.000$ ), and 3.6 score reduction (WMD =−3.6, 95% CI: −4.4, −2.8;  $P=0.000$ ), respectively. However, there were no significant differences in terms of NRS pain scores between the two groups at 3 months (WMD =−0.2, 95%

CI: −0.8, 0.5;  $P=0.586$ ), 6 months (WMD =−0.2, 95% CI: −1.0, 0.6;  $P=0.607$ ), or 12 months (WMD =−0.3, 95% CI: −1.3, 0.6;  $P=0.490$ ) (Figure 3).

## Functional assessment

Seven studies reported data on functional assessment.<sup>8,9,26–30</sup> The pooled estimates showed that in group 1 and group 2, 42.7% and 40.3% of patients at 3 months, 58.5% and 60.0% of patients at 6 months, and 65.2% and 63.1% of patients at 12 months, respectively, achieved a significant functional improvement. However, no significant differences of functional improvement were found between the two groups at 3 months (RR =1.0, 95% CI: 0.9, 1.2;  $P=0.669$ ), 6 months (RR =1.0, 95% CI: 0.9, 1.2;  $P=1.000$ ), or 12 months (RR =1.0, 95% CI: 0.8, 1.1;  $P=0.761$ ) (Figure 4).

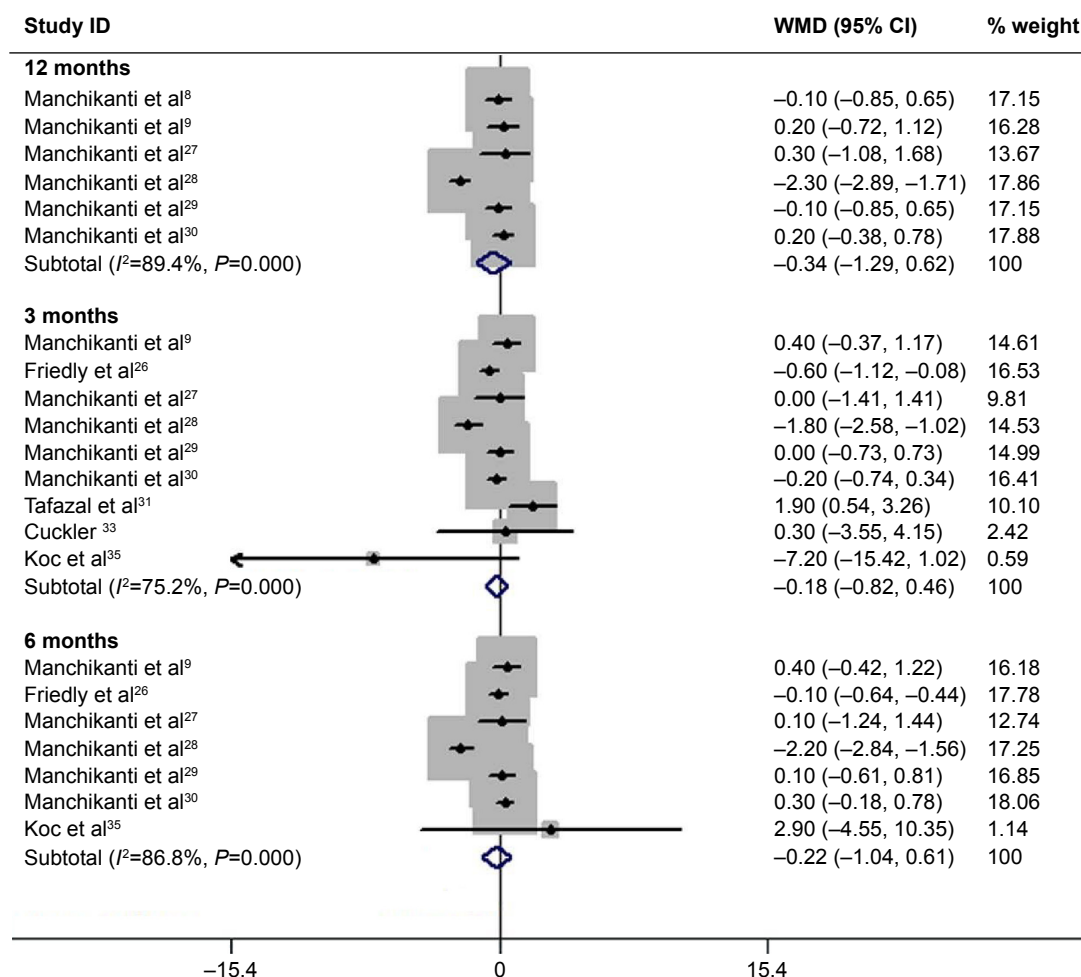
Data on ODI were available from ten studies.<sup>8,9,26–32,34</sup> Pooled estimates suggest that in group 1, patients at 3, 6, and 12 months had a 13.2 point reduction (WMD =−13.2, 95% CI: −18.6, −7.7;  $P=0.000$ ), 12.1 point reduction (WMD =−12.1, 95% CI: −19.5, −4.8;  $P=0.001$ ), and 13.8 point reduction



**Figure 2** Comparison of pain relief improvements between epidural injections with or without steroids for patients with lumbar spinal stenosis.

**Abbreviations:** RR, risk ratio; CI, confidence interval.





**Figure 3** Comparison of NRS pain scores between epidural injections with or without steroids for patients with lumbar spinal stenosis.

**Note:** Weights are from random effects analysis.

**Abbreviations:** NRS, numeric rating scale; WMD, weight mean difference; CI, confidence interval.

(WMD = -13.8, 95% CI: -16.2, -11.5;  $P=0.000$ ), respectively; whereas, patients in group 2 had a 12.9 point reduction (WMD = -12.9, 95% CI: -18.6, -7.3;  $P=0.000$ ), 12.8 point reduction (WMD = -12.8, 95% CI: -20.2, -5.3;  $P=0.001$ ), and 14.5 point reduction (WMD = -14.5, 95% CI: -16.1, -12.8;  $P=0.000$ ), respectively. However, there were no significant differences in terms of ODI between the two groups at 3 months (WMD = -0.1, 95% CI: -0.2, 0.0;  $P=0.096$ ), 6 months (WMD = 0.1, 95% CI: 0.0, 0.2;  $P=0.123$ ), or 12 months (WMD = -0.3, 95% CI: -1.0, 0.4;  $P=0.439$ ) (Figure 5).

## Opioid intake

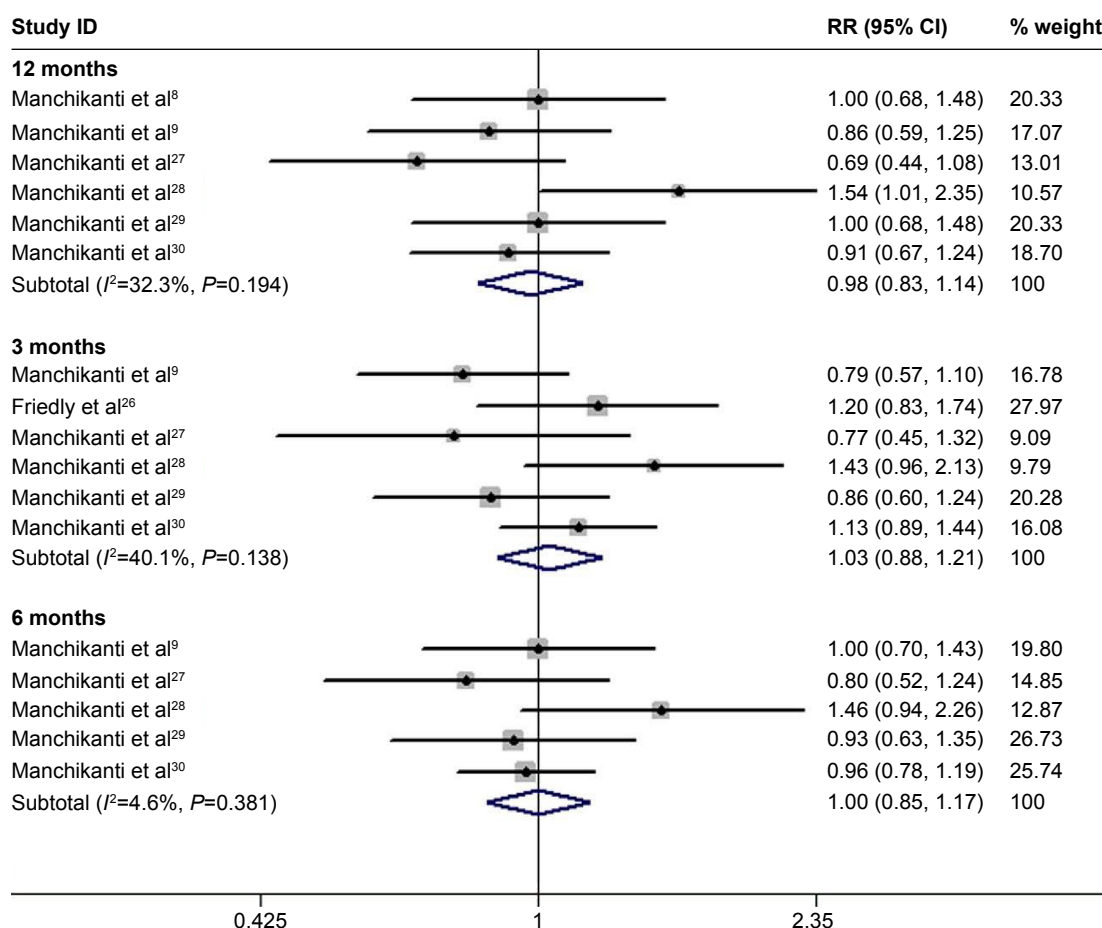
Six studies provided data on opioid intake.<sup>8,9,27-30</sup> Significant reductions from baseline were observed in group 1, by 11.8 mg (WMD = -11.8, 95% CI: -18.0, -5.6;  $P=0.000$ ), 12.3 mg (WMD = -12.3, 95% CI: -18.6, -6.0;  $P=0.001$ ), and 12.4 mg (WMD = -12.4, 95% CI: -18.7, -6.0;  $P=0.000$ ) at 3, 6, and 12 months, respectively; whereas in group 2, reductions

were 8.4 mg (WMD = -8.4, 95% CI: -14.0, -2.9;  $P=0.000$ ), 8.2 mg (WMD = -8.2, 95% CI: -13.8, -2.6;  $P=0.001$ ), and 7.8 mg (WMD = -7.8, 95% CI: -13.4, -2.2;  $P=0.000$ ), respectively. No significant differences between the two groups were found at 3 months (WMD = -0.0, 95% CI: -5.0, 4.9;  $P=0.096$ ), 6 months (WMD = 0.7, 95% CI: -3.7, 5.0;  $P=0.123$ ), or 12 months (WMD = 0.6, 95% CI: -3.6, 4.9;  $P=0.439$ ) (Figure 6).

## Therapeutic procedural characteristics

Six studies reported data on the frequency of injections.<sup>8,9,27-30</sup> Pooled estimates using a fixed effects model showed that there was no significant difference in the average number of injections per year between the two groups (WMD = -0.2, 95% CI: -0.4, 0.0;  $P=0.099$ ).

Six studies reported data on total relief time.<sup>8,9,27-30</sup> Pooled analysis using a fixed effects model indicated that patients in group 1 had 4.5 weeks of average total relief per year less



**Figure 4** Comparison of functional improvements between epidural injections with or without steroids for patients with lumbar spinal stenosis.

**Abbreviations:** RR, risk ratio; CI, confidence interval.

than those in group 2 (WMD = -4.5, 95% CI: -8.2, -0.7;  $P=0.019$ ).

Five studies reported data on changes in weight.<sup>8,9,27,29,30</sup> Pooled estimates using a fixed effects model showed that there was no significant difference in weight change between the two groups (WMD = 1.7, 95% CI: -0.2, 3.5;  $P=0.077$ ).

## Publication bias

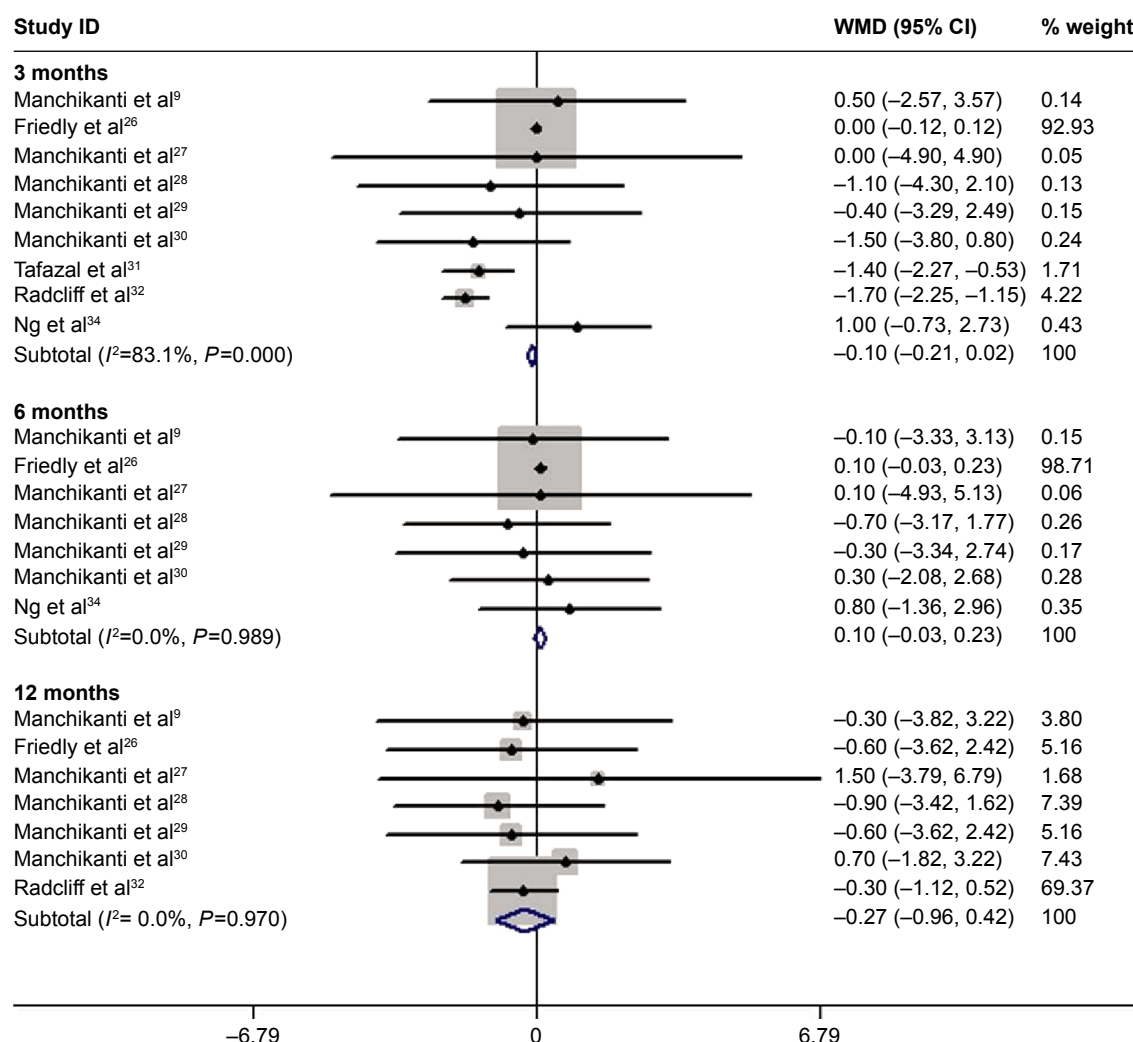
Egger's and Begg's tests were used to assess publication bias among the included studies. We found no potential publication bias according to either Egger's ( $t=0.6$ ,  $P=0.566$ ) or Begg's tests ( $Z=0.4$ ,  $P=0.700$ ).

## Discussion

To the best of our knowledge, this is the first meta-analysis to assess the effectiveness of epidural injections with or without steroids in the treatment of chronic pain related to spinal stenosis. Our analysis of 13 RCTs showed that significant pain relief ( $\geq 50\%$ ) was demonstrated in 53.7% of patients in group 1 and 56.4% of patients in group 2.

Patients showed a reduction in NRS pain score of 3.7 and 3.6 in the two groups, respectively. Significant functional improvement was achieved in 65.2% and 63.1% of patients in groups 1 and 2, with an ODI reduction of 13.8 points and 14.5 points, respectively. The overall number of injections per year was  $3.2 \pm 1.3$  and  $3.4 \pm 1.2$  with average total relief per year of  $29.3 \pm 19.7$  and  $33.8 \pm 19.3$  weeks in groups 1 and 2, respectively, and the opioid intakes decreased from baseline by 12.4 and 7.8 mg, respectively. However, there were no significant differences between the two groups in terms of the outcomes mentioned earlier except in the total relief time.

It is challenging to treat the disabling pain associated with spinal stenosis, with or without surgery. A previous report,<sup>3</sup> showed surgery to be more effective than conservative management. However, no studies with the criteria of contemporary interventional pain management have been conducted to assess the conservative management approach used in the past. Consequently, the most effective management strategy for spinal stenosis has not been still



**Figure 5** Comparison of ODI between epidural injections with or without steroids for patients with lumbar spinal stenosis.

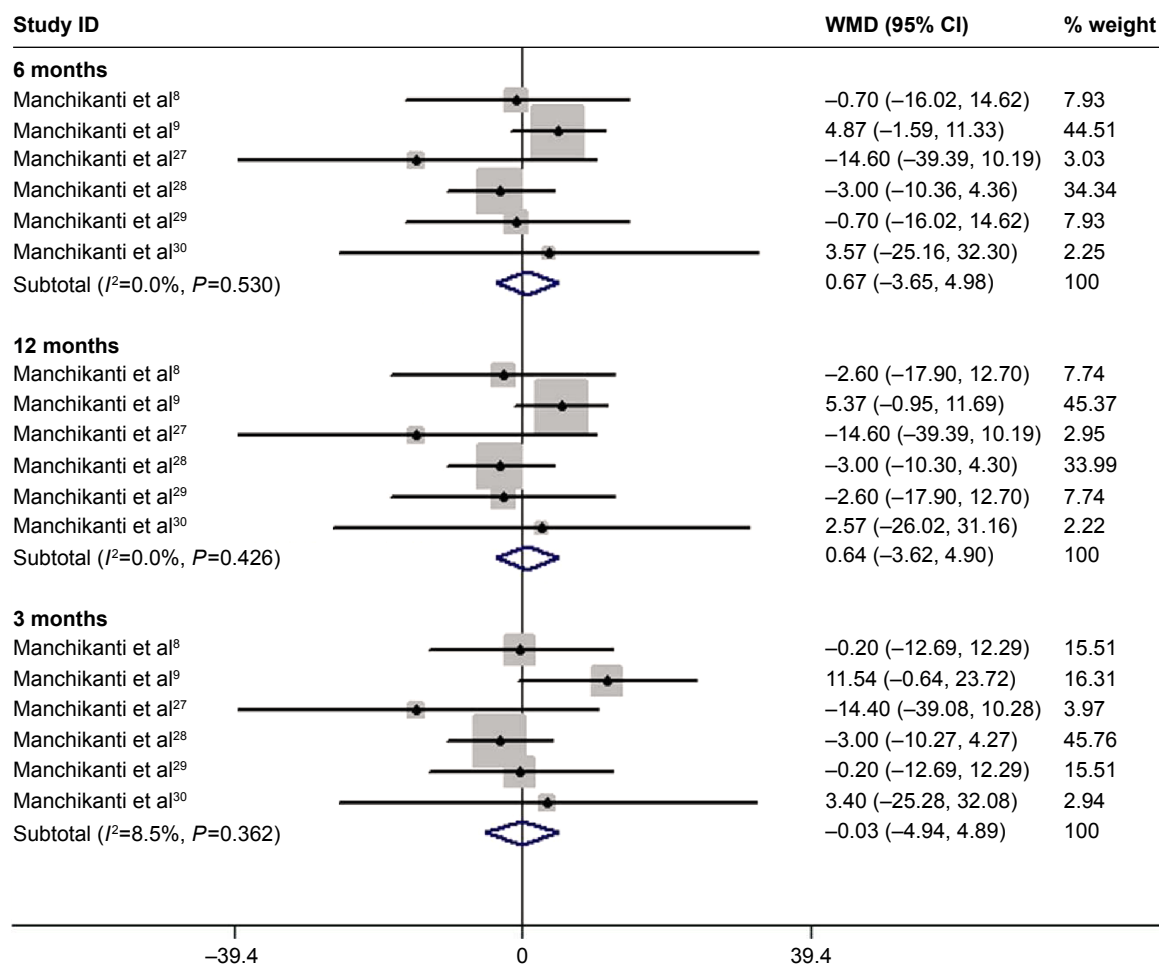
**Abbreviations:** ODI, Oswestry Disability Index; WMD, weight mean difference; CI, confidence interval.

determined, even though the condition was first reported in 1954, when it was characterized by the narrowing of spinal canal, neurogenic spinal claudication, and radicular pain.<sup>37</sup> Reports indicate that only a subgroup of patients has a good response to surgical intervention for spinal stenosis, whereas other subgroups of patients respond well to epidural injections.<sup>7,8</sup> However, until now no studies could explicitly delineate the characteristics of these subgroups. Future studies should focus on these issues.

The mechanisms by which epidural injections with steroids produce beneficial effects in pain relief and functional status improvement are not entirely known. It is hypothesized that the anti-inflammatory properties of steroids are responsible for the neural blockade.<sup>38–41</sup> Emerging evidence demonstrates that local anesthetics may be as effective as steroids in the management of low back pain, without disc herniation originating at the facet joint, and in some other

types of nerve block.<sup>42–45</sup> This was also verified in a recently published systematic review and meta-analysis.<sup>46</sup> In that study, the authors summarized ten RCTs to compare the effectiveness of epidural steroid injection to that of local anesthetic in patients with lumbar spinal stenosis. The pooled results showed minimal or no significant difference between the epidural steroid injection group and the local anesthetic injection group for short-term benefit, specifically, changes in leg pain VAS score (WMD = -7.00, 95% CI: -12.73, -1.27;  $P=0.02$ ), changes in back pain VAS score (WMD = 0.60, 95% CI: 0.07, 1.13;  $P=0.03$ ), and Swiss Spinal Stenosis Questionnaire (SSSQ) subscales for symptoms (WMD = -0.2, 95% CI: -0.34, -0.06;  $P=0.05$ ).<sup>46</sup> Therefore, the authors concluded that compared with local anesthetic, epidural steroid injection therapy provided no statistically significant improvement in pain symptoms or walking ability in lumbar spinal stenosis patients.<sup>46</sup> On the





**Figure 6** Comparison of opioid intake between epidural injections with or without steroids for patients with lumbar spinal stenosis.

**Abbreviations:** WMD, weight mean difference; CI, confidence interval.

basis of their report, patients with spinal stenosis would be expected to improve symptomatically with epidural injection of local anesthetic or with steroids.

Additionally, emphasis should be placed on the targeted delivery of the injectate to the site of pathology. It is reported that the use of blind approach to epidural procedures is the main reason for failed responses. According to the previous publications, inappropriate placement of drug because of inaccurate injection had occurred in 20%–38% of the patients.<sup>47–49</sup> The use of fluoroscopy to guide epidural injections is therefore essential to ensure accurate and consistent drug placement at the target site.

There are some limitations in this meta-analysis, which should be taken into account when interpreting our results. First, we acknowledge that the studies we included lack homogeneity in their approaches to epidural injection, as well as in dosing, injection frequency, and length of follow-up. These differences potentially influence the treatment effects reported. Second, our meta-analysis included several studies

with relatively small numbers of patients ( $n < 50$  in three studies), and in some the relevant data was incomplete. Third, injection routes are important factors that influence the treatment effect of epidural injections with steroids, and there are debates about the effects of three epidural injection routes (transforaminal epidural injection, caudal epidural injection, and interlaminar approach). Because of limited reporting across the trials, we did not compare the effects or long-term effectiveness of epidural injection with steroids between the different injection routes.

## Conclusion

This study shows that epidural injections, with or without steroids, are effective in managing chronic low back pain secondary to spinal stenosis. However, the inclusion of steroids does not provide any additional benefit compared with injection of local anesthetic alone. Therefore, on the basis of the current findings, there is a lack of evidence to support that the addition of steroids to epidural injections provides

benefit in patients with spinal stenosis. Further, large-scale, well-conducted RCTs are required to clearly determine the effectiveness of epidural injections with steroids in the treatment of spinal stenosis.

## Disclosure

The authors report no conflicts of interest in this work.

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