Comparative Effects and Safety of Full-Endoscopic Versus Microscopic Spinal Decompression for Lumbar Spinal Stenosis: A Meta-Analysis and Statistical Power Analysis of 6 Randomized Controlled Trials

Zechuan Yang, Huan Wang, Wenkai Li, Weihua Hu
Department of Orthopedics, Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, China

Objective: This meta-analysis with statistical power analysis aimed to evaluate the difference between full-endoscopic and microscopic spinal decompression in treating spinal stenosis.

Methods: We searched PubMed, Embase, CENTRAL (Cochrane Central Register of Controlled Trials), and CNKI (China National Knowledge Infrastructure) for relevant randomized controlled trials (RCTs) regarding the comparison of full-endoscopic versus microscopic spinal decompression in treating lumbar spinal stenosis through February 28, 2022. Two independent investigators selected studies, extracted information, and appraised methodological quality. Meta-analysis was conducted using RevMan 5.4 and STATA 14.0, and statistical power analysis was performed using G*Power 3.1.

Results: Six RCTs involving 646 patients met selection criteria. Meta-analysis suggested that, compared with microscopic decompression, full-endoscopic spinal decompression achieved more leg pain improvement (mean difference [MD], -0.20; 95% confidence interval [CI], -0.30 to -0.10; p = 0.001), shortened operative time (MD, -12.71; 95% CI, -18.27 to -7.15; p < 0.001), and decreased the incidence of complications (risk ratio, 0.43; 95% CI, 0.22–0.82; p = 0.01), which was supported by a statistical power of 98.57%, 99.97%, and 81.88%, respectively.

Conclusion: Full-endoscopic spinal decompression is a better treatment for lumbar spinal stenosis, showing more effective leg pain improvement, shorter operative time, and fewer complications than microscopic decompression.

Keywords: Full-endoscopic spinal decompression, Microscopic spinal decompression, Lumbar stenosis, Meta-analysis

INTRODUCTION

Lumbar spinal stenosis is described as pathological spinal canal narrowing, which will result in a series of neurological symptoms due to subsequent compression of nerve roots, including back and leg pain, claudication, and walking difficulty. As one of the most prevalent degenerative conditions, lumbar spinal stenosis was associated with an increased social and economic burden because it leads to pain and disability and reduces patients' quality of life.

For patients diagnosed with lumbar spinal stenosis at the initial phase, conservative treatments are always recommended, including physical therapy, anti-inflammatory agents, and drugs for relieving pain. However, patients will be advised to receive...
surgical intervention if it was more appropriate according to clinical symptoms, physical disability, and magnetic resonance imaging findings. Previous studies have demonstrated that surgical intervention was involved in better clinical outcomes in patients with lumbar spinal stenosis. Unfortunately, traditional open spinal decompression will result in significant trauma, a longer length of hospitalization, and an increased risk of postoperative complications because this surgery requires extensive dissection and stretching of the fatty muscles of the spine. Subsequently, various minimally invasive methods have emerged as an alternative to traditional open spinal decompression preserving the normal vertebral structures, preventing segmental instability, and reducing soft tissue damage.

Among available minimally invasive methods, microscopic spinal decompression has become one of the most common procedures related to less blood loss, lower risk of postoperative pain, and shorter hospital stays. It’s pointed out that microscopic spinal decompression also faced some disadvantages, such as bleeding in the field of view and postoperative adhesions in the spinal canal. However, with advancements in endoscopic spinal surgery, a full-endoscopic spinal system such as uniportal endoscopic system and biportal endoscopic spinal system has been developed and used for the treatment of lumbar spinal stenosis.

Several meta-analyses have investigated the therapeutic values of the full-endoscopic spinal system in the treatment of lumbar spinal stenosis compared with microscopic spinal decompression. However, the credibility of results from the published meta-analyses was greatly impaired by some limitations, such as incorrect inclusion of studies with overlapping samples and inappropriate combination of data from randomized controlled trials (RCTs) and retrospective studies. Moreover, as one of full-endoscopic surgery, transforaminal endoscopic spine system (TESSYS) was not considered in previous meta-analyses. Therefore, we performed the present meta-analysis to further evaluate the comparative effects and safety of full-endoscopic decompression versus microscopic decompression by only including RCTs.

MATERIALS AND METHODS

1. Study Design

This meta-analysis was designed according to recommendations made by the Cochrane Handbook. Meanwhile, pooled results were reported according to the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analysis) statement. We did not apply for Institutional Review Board’s approval because the data analysis in this meta-analysis was performed based on published studies.

2. Literature Search

Two independent investigators searched PubMed, Embase, Cochrane Central Register of Controlled Trials (CENTRAL), and China National Knowledge Infrastructure (CNKI) for retrieving relevant RCTs from the establishment date of each database through February 28, 2022. The search strategy was developed using the combination of medical subject heading with the free word with the following terms: “spinal stenosis,” “full endoscopic,” “biportal endoscopic spinal surgery,” “unilateral biportal endoscopic technique,” “two portal endoscopic spinal surgery,” “microscopic decompression surgery,” “micro endoscopic spine surgery,” and “random.” The sensitivity of the search strategy was modified according to the requirements of databases. No language and publication status were restricted in the literature search. We summarized detailed search strategies of target databases in Supplementary Table 1. Moreover, we screened reference lists of eligible studies and previous meta-analyses to find additional studies. A third experienced investigator was invited to solve disagreements between 2 investigators about literature retrieval.

3. Selection Criteria

Studies were eligible for our meta-analysis if (1) they enrolled eligible adult patients with diagnosed lumbar spinal stenosis, (2) they are RCTs with full texts, (3) they compared full-endoscopic spinal decompression with microscopic spinal decompression for treating lumbar spinal stenosis, and (4) they reported at least one outcome from visual analogue scale (VAS) score for leg and back pain, operative time, estimated blood loss, the length of hospital stays, and the overall incidence of complications. Certainly, studies were excluded from our meta-analysis if (1) patients suffering from spinal stenosis resulting from a herniated intervertebral disc, (2) studies were designed as ineligible design, such as literature reviews, case reports, experimental studies, (3) repeated studies with relatively poor methodological quality and insufficient information, and (4) essential data for statistical analysis were not available after contacting the leading authors.

4. Data Extraction

Two independent investigators performed the study selection process according to selection criteria from 3 steps: (1) removal
of duplicates, (2) initial eligibility evaluation based on the titles and abstracts, and (3) final eligibility evaluation through checking full texts. Then, essential information was independently extracted by 2 investigators using predesigned standard data extraction sheet from each eligible study: reference information (the first author’s name and publication year), country, sample size randomly assigned into both groups, the proportion of male patients, mean age of patients, types of full-endoscopic spinal decompression, follow-up duration, outcomes of interest, and information for methodological quality. We contacted the leading author to obtain essential information if necessary. A third senior investigator was requested to resolve discrepancies between 2 independent investigators.

5. Outcomes of Interest
We defined the VAS score for leg and back pain at the final follow-up as the primary outcomes in this meta-analysis. Moreover, we regarded operative time, estimated blood loss, the length of hospital stays, and the overall incidence of complications as the secondary outcomes.

6. Risk of Bias Assessment
Two investigators used the Cochrane risk of bias assessment tool to independently assess the methodological quality of the included RCTs. In this assessment tool, the following 6 domains were involved: random sequence generation and allocation concealment (selection bias), blinding of participants and personnel (performance bias), blinding of outcome assessment (detection bias), incomplete outcome data (attrition bias), selective outcome reporting (reporting bias), and other issues. Depending on the actual information reported in the included studies, each domain could be labeled with a “low,” “unclear,” or “high” risk of bias.

7. Statistical Analysis
Before performing quantitative synthesis, we used the chi-square test and I2 statistic to evaluate the statistical heterogeneity across eligible studies. A fixed-effects model was selected for data analysis if the absence of statistical heterogeneity (p > 0.1, I2 < 50%); otherwise, data analysis was carried out based on a random-effects model (p ≤ 0.1, I2 ≥ 50%). For dichotomous data, we used the risk ratio (RR) with a corresponding 95% confidence interval (CI) to express the estimates, and the mean difference (MD) with a corresponding 95% CI was sued to express the estimates. We evaluated publication bias for primary outcomes by utilizing Begg rank correlation test and Egger linear regression test. Statistical analysis was carried out using Review Manager (RevMan) 5.4 (Cochrane Collaboration, Oxford, UK), and publication bias examination was performed by using Stata 14.0 (StataCorp LLC, College Station, TX, USA). Moreover, we also calculated the statistical power for each outcome using G*Power software version 3.1 to determine the confidence in drawing a definitive conclusion.

RESULTS

1. Literature Search Results
We identified a total of 29 relevant studies from 4 target electronic databases through performing search strategies, including PubMed (n = 5), Embase (n = 11), CENTRAL (n = 9), and CNKI (n = 4). After screening step by step, 4 eligible RCTs were considered to meet our selection criteria. Moreover, 2 additional RCTs were determined from previous meta-analyses. Finally, 6 RCTs were included in this meta-analysis. The process of study selection is indicated in Fig. 1.

2. The Characteristics of Included Studies
The basic information of included studies is summarized in Table 1. Among the 6 eligible RCTs, the sample size of individual study varied from 62 to 161, with 646 patients. All studies were published between 2009 and 2020. Two studies compared biportal technique with microscopic decompression, 3 studies compared uniportal technique with microscopic decompression, and one study compared the TESSYS with microscopic decompression. The follow-up duration of included studies ranged from 6 months to 24 months. Moreover, four and five studies reported VAS scores for leg and back pain, respectively. All studies reported single-level operative time, 3 studies reported estimated blood loss, 3 studies reported the length of hospital stays, and 5 studies reported the incidence of complications. The outcomes of included studies are summarized in Supplementary Table 2.

3. Quality Assessment
Among 6 included studies, the majority (83.3%) were evaluated as low risk in random sequence generation except for one study, which only stated random but did not describe the details of generating random sequence. Only 2 studies were rated as low risk in allocation concealment, blinding of participants and personnel, and blinding of outcome assessment. All studies were labeled with unclear or low risk in attrition bias domains except for one study, which had a high risk in attri-
tion bias. All studies were regarded as low risk for reporting bias and other bias. Detailed risk of bias assessment is indicated in Supplementary Fig. 1.

4. Meta-Analysis Results

1) Leg and back pain

Four studies reported VAS scores for leg pain at the final follow-up of full-endoscopic spinal decompression in the treatment of lumbar spinal stenosis. We did not detect statistical heterogeneity across studies ($I^2 = 0\%$, $p = 0.99$). Therefore, statistical analysis was carried out based on the fixed-effect model. The pooled result indicated that full-endoscopic spinal decompression was associated with more leg pain relief than microscopic decompression (MD, -0.20; 95% CI, -0.30 to -0.10; $p = 0.0001$) (Fig. 2A).

Five studies reported VAS scores for back pain at the final follow-up of full-endoscopic spinal decompression in the treatment of lumbar spinal stenosis. Substantial statistical heterogeneity was determined between studies ($I^2 = 82\%$, $p < 0.1$). We, therefore, selected the random-effect model to perform statisti-
Full-Endoscopic Spinal Decompression Benefits to Spinal Stenosis

Y. Z, et al.

1000 www.e-neurospine.org

Fig. 2. Meta-analysis of visual analogue scale score for leg (A) and back pain (B) between full-endoscopic and microscopic spinal decompression. SD, standard deviation; IV, inverse variance; CI, confidence interval; df, degrees of freedom.

Fig. 3. Meta-analysis of operative time (A) and estimated blood (B) loss between full-endoscopic and microscopic spinal decompression. SD, standard deviation; IV, inverse variance; CI, confidence interval; df, degrees of freedom.

2) Operative time

All studies reported single-level operative time between the 2 groups. Substantial statistical heterogeneity was detected between the articles (I^2 = 81%; p < 0.1), and thus the random-effects model was selected for statistical analysis. Meta-analysis indicated that, compared with microscopic spinal decompression, full-endoscopic spinal decompression was associated with shorter operative time (MD, -12.71; 95% CI, -18.27 to -7.15; p < 0.01) (Fig. 3A).

3) Estimated blood loss

Among included studies, 3 studies estimated the volume of blood loss during treatment. As there was statistical heterogeneity between the studies (I^2 = 97%; p = 0.06), we, therefore,
selected the random-effects model to perform statistical analysis. Pooled results suggested no statistical difference between full-endoscopic and microscopic spinal decompression (MD, -22.59; 95% CI, -46.45 to 1.26; p = 0.06) (Fig. 3B).

4) The length of hospital stays
Four studies\textsuperscript{46-48,50} reported the length of hospital stays after treatment. Substantial statistical heterogeneity was detected between studies ($I^2 = 98\%$, p = 0.05). We therefore used the random-effect model to perform statistical analysis. The result indicated no statistical difference between full-endoscopic and microscopic spinal decompression in terms of this outcome (MD, -1.27; 95% CI, -2.55 to 0.02; p = 0.05) (Fig. 4A).

5) Overall incidence of complications
Five studies\textsuperscript{47-51} reported the incidence of complications between full-endoscopic spinal surgery and microscopic decompression. Statistical examination did not detect the presence of substantial statistical heterogeneity between the studies ($I^2 = 0\%$, p = 0.01). We therefore selected the random-effects model for statistical analysis. Meta-analysis indicated a lower overall incidence of complications in patients receiving full-endoscopic spinal decompression than microscopic spinal decompression (RR, 0.43; 95% CI, 0.22–0.82; p = 0.01) (Fig. 4B).

5. Statistical Power
We calculated the statistical power of all outcomes at the significance level of 0.05. Finally, the statistical power of individual outcomes was 98.57% for leg pain, 10.13% for back pain, 99.97% for operative time, 58.35% for the estimated blood loss, 73.70% for the length of hospital stay, and 81.88% for an overall incidence of complications.

6. Publication Bias
Although the number of eligible studies did not meet the criteria of conducting publication bias, we still sought to evaluate publication bias by performing Egger and Begg tests. As indicated in Supplementary Fig. 2, symmetric Egger and Begg plots were created of VAS score for leg ($z = 1.70$, p = 0.089; $t = 1.85$, p = 0.206) and back ($z = 0.24$, p = 0.806; $t = 1.44$, p = 0.245) pain, indicating absence of publication bias.

DISCUSSION

Full-endoscopic spinal decompression has several advantages as an emerging minimally technique, including flexibility, a wide and clear field of view, and less soft tissue damage. However, the therapeutic effects and safety of full-endoscopic spinal decompression continue to be debatable in treating lumbar spinal stenosis in clinical practice compared with microscopic spi-
nal decompression. After including 6 eligible RCTs, the present meta-analysis indicated that full-endoscopic spinal surgery effectively relieved leg pain, with shorter operative time and a lower incidence of complications than microscopic spinal decompression. Unfortunately, we did not perform a separate analysis to compare different full-endoscopic spinal decompression with microscopic spinal decompression due to the limited number of eligible studies, which might introduce bias to impair the reliability of our results. Nevertheless, the statistical power of leg pain, operative time, and the overall incidence of complications exceeded the acceptable level of 80.00%, indicating the robustness and reliability of these outcomes. However, the statistical power of back pain, the estimated blood loss, and the length of hospital stay did not get to the acceptable level. Therefore, the pooled results of these 3 outcomes should be interpreted cautiously. Future RCTs with large sample size and high quality are required to determine the difference between the 2 treatments in terms of these 3 outcomes. In addition, more studies should be performed to explore the difference between different full endoscopic spinal decompression techniques.

Several meta-analyses have investigated the comparative effects and safety of full-endoscopic spinal decompression with microscopic spinal decompression to treat lumbar spinal stenosis. Unfortunately, the findings from these meta-analyses must be considered in a cautious manner due to several limitations. For example, all meta-analyses included 2 studies from the same cohort (a prospective case-control study and a retrospective). Therefore, overlapped samples were included to falsely enhance the statistical power. It must be noted that, certainly, all meta-analyses simultaneously included RCTs and retrospective studies to estimate the comparative effects and safety between full-endoscopic spinal decompression and microscopic decompression. However, according to the methodological framework, it is inappropriate to combine results from RCTs and non-RCTs.

Compared with previous meta-analyses, the present meta-analysis generated more robust and reliable findings due to methodological advantages. First, only RCTs were included for the final analysis in this meta-analysis, which significantly enhanced the comparability between studies and the statistical power. Second, all available full-endoscopic spinal decompression systems were considered in the present meta-analysis. However, previous meta-analyses only included biportal or uniportal techniques, which limited the number of eligible studies and did not comprehensively consider the types of full-endoscopic decompression. Third, we either identified relevant studies by searching 4 electronic databases or added additional studies by checking previous meta-analyses, which greatly decreased the risk of missing potentially eligible studies. Finally, we calculated the statistical power of all outcomes to achieve a creditable conclusion, demonstrating the robustness and reliability of positive results in the present meta-analysis.

The present meta-analysis has some limitations, which could not be ignored. First, only 6 eligible RCTs with inadequate sample size were included in the final statistical analysis. Therefore, our findings may be fluctuated due to inadequate statistical power. Second, follow-up duration was different from one to another eligible study. However, we only extracted data at the final follow-up to evaluate the comparative effects and safety, which may introduce bias to impair the robustness of our findings. Third, this meta-analysis identified 3 available full-endoscopic spinal surgeries for lumbar spinal stenosis, including uniportal technique, biportal technique, and TESSYS. However, subgroup analysis was not performed according to the types of full-endoscopic spinal decompression due to inadequate number of eligible studies, which could cause heterogeneous results. Fourth, although on restriction on language and publication status was imposed in this meta-analysis, potential risk of missing relevant studies could not be avoided because only 4 electronic databases were considered. Fifth, we developed the methodological framework for this meta-analysis in strict accordance with the recommendations made by the Cochrane handbook; however, we did not register the formal protocol in any public platform.

CONCLUSION

This meta-analysis evaluated the comparative effect and safety of full-endoscopic spinal decompression with microscopic spinal decompression in treating lumbar spinal stenosis by including 6 RCTs. Our results suggested that full-endoscopic spinal decompression is more effective than microscopic decompression, with more significant leg pain relief, shorter operative time, and lower complications. Due to the extremely insufficient statistical power of back pain, the estimated blood loss, and the length of hospital stay, future studies with a large-scale and high quality are warranted to determine the difference between full-endoscopic spinal decompression and microscopic decompression in treating lumbar spinal stenosis. Moreover, studies are also required to investigate the comparative effects and safety of different full-endoscopic spinal decompression systems.
NOTES

Supplementary Materials: Supplementary Tables 1-2 and Figs. 1-2 can be found via https://doi.org/10.14245/ns.2244600.300.

Supplementary Table 1. Search strategy of target databases

Supplementary Table 2. Outcomes of included studies (n = 6)

Supplementary Fig. 1. Risk of bias assessment.

Supplementary Fig. 2. Egger and Begg plots of visual analogue scale score for leg and back pain between full-endoscopic (a) and microscopic spinal decompression (b). SE, standard error.

Conflict of Interest: The authors have nothing to disclose.

Funding/Support: This study received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Author Contribution: Conceptualization: ZY, WL, WH; Formal analysis: HW, WH; Methodology: ZY, HW, WL, WH; Writing - original draft: ZY, HW, WL; Writing - review & editing: ZY, HW, WL.

ORCID
Zechuan Yang: 0000-0002-3842-2511
Huan Wang: 0000-0001-5426-3971
Wenkai Li: 0000-0001-6572-0269
Weihua Hu: 0000-0003-4813-0069

REFERENCES


20. Guha D, Heary RF, Shamji MF. Iatrogenic spondylolisthesis

https://doi.org/10.14245/ns.2244600.300
www.e-neurospine.org


44. Faul F, Erdfelder E, Lang AG, et al. G*Power 3: a flexible sta-

https://doi.org/10.14245/ns.2244600.300
### Supplementary Table 1. Search strategy of target databases

#### Search strategy for PubMed

<table>
<thead>
<tr>
<th>Acronym</th>
<th>No.</th>
<th>Query</th>
<th>Filters</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>P+I+C+S</td>
<td>10</td>
<td>(((&quot;Spinal Stenosis&quot;[Mesh]) OR (((Spinal Stenosis[Title/Abstract]) OR (Spinal Stenoses[Title/Abstract])) OR (lumbar stenosis[Title/Abstract])) OR (lumbar stenoses[Title/Abstract]))) AND (((((biportal endoscopic spinal surgery[Title/Abstract]) OR (unilateral biportal endoscopic technique[Title/Abstract]) OR (biportal endoscopic[Title/Abstract]) OR (unilateral biportal endoscopy[Title/Abstract]) OR (two portal endoscopic spinal surgery[Title/Abstract]) OR (full-endoscopic[Title/Abstract]) OR (percutaneous transforaminal endoscopic decompression[Title/Abstract]) OR (TESSYS[Title/Abstract])) AND (((microscopic decompression surgery[Title/Abstract]) OR (micro endoscopic spine surgery[Title/Abstract])) OR (microscopic endoscopic[Title/Abstract])) OR (microscopic[Title/Abstract])) OR (TESSYS[Title/Abstract])) AND (((&quot;Randomized Controlled Trial&quot; [Publication Type]) OR &quot;Randomized Controlled Trials as Topic&quot; [Mesh]) OR &quot;Random Allocation&quot; [Mesh] OR &quot;Placebos&quot; [Mesh]) OR ((random*) OR (placebo*)) AND (humans[Filter]))</td>
<td>Humans</td>
<td>5</td>
</tr>
<tr>
<td>P+I+C+S</td>
<td>9</td>
<td>#3 AND #4 AND #5 AND #8</td>
<td>Humans</td>
<td>1,191,528</td>
</tr>
<tr>
<td>P+I+C+S</td>
<td>8</td>
<td>#6 OR #7</td>
<td></td>
<td>1,885,528</td>
</tr>
<tr>
<td>P+I+C+S</td>
<td>7</td>
<td>(random*) OR (placebo*)</td>
<td></td>
<td>1,612,252</td>
</tr>
<tr>
<td>P+I+C+S</td>
<td>6</td>
<td>#3 OR #4 OR &quot;Randomized Controlled Trials as Topic&quot; [Mesh] OR &quot;Random Allocation&quot; [Mesh] OR &quot;Placebos&quot; [Mesh] OR ((random*) OR (placebo*))</td>
<td></td>
<td>820,044</td>
</tr>
<tr>
<td>C</td>
<td>5</td>
<td>((microscopic decompression surgery[Title/Abstract]) OR (micro endoscopic spine surgery[Title/Abstract])) OR (microscopic endoscopic[Title/Abstract]) OR (microscopic[Title/Abstract])</td>
<td></td>
<td>180,620</td>
</tr>
<tr>
<td>C</td>
<td>4</td>
<td>(((((biportal endoscopic spinal surgery[Title/Abstract]) OR (unilateral biportal endoscopic technique[Title/Abstract]) OR (biportal endoscopic[Title/Abstract]) OR (unilateral biportal endoscopy[Title/Abstract]) OR (two portal endoscopic spinal surgery[Title/Abstract]) OR (full-endoscopic[Title/Abstract]) OR (percutaneous transforaminal endoscopic decompression[Title/Abstract]) OR (TESSYS[Title/Abstract]))</td>
<td></td>
<td>609</td>
</tr>
<tr>
<td>C</td>
<td>3</td>
<td>(&quot;Spinal Stenosis&quot; [Mesh]) OR (((Spinal Stenosis[Title/Abstract]) OR (Spinal Stenoses[Title/Abstract])) OR (lumbar stenosis[Title/Abstract]) OR (lumbar stenoses[Title/Abstract]))</td>
<td></td>
<td>9,552</td>
</tr>
<tr>
<td>C</td>
<td>2</td>
<td>(((Spinal Stenosis[Title/Abstract]) OR (Spinal Stenoses[Title/Abstract])) OR (lumbar stenosis[Title/Abstract]) OR (lumbar stenoses[Title/Abstract]))</td>
<td></td>
<td>6,516</td>
</tr>
<tr>
<td>C</td>
<td>1</td>
<td>&quot;Spinal Stenosis&quot; [Mesh]</td>
<td></td>
<td>6,787</td>
</tr>
</tbody>
</table>

#### Search strategy for Embase

<table>
<thead>
<tr>
<th>Acronym</th>
<th>No.</th>
<th>Query</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>P+I+C+S</td>
<td>9</td>
<td>#3 AND #4 AND #5 AND #8</td>
<td>11</td>
</tr>
<tr>
<td>S</td>
<td>8</td>
<td>#6 OR #7</td>
<td>2,219,989</td>
</tr>
<tr>
<td>P</td>
<td>3</td>
<td>#1 OR #2</td>
<td>16,244</td>
</tr>
</tbody>
</table>

(Continued)
**Supplementary Table 1.** Search strategy of target databases (Continued)

Search strategy for CENTRAL (Cochrane Central Register of Controlled Trials)

<table>
<thead>
<tr>
<th>Acronym</th>
<th>ID</th>
<th>Search</th>
<th>Hits</th>
</tr>
</thead>
<tbody>
<tr>
<td>P</td>
<td>1</td>
<td>(Spinal Stenosis):ti,ab,kw OR (Spinal Stenoses):ti,ab,kw OR (lumbar stenosis):ti,ab,kw</td>
<td>1,532</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>MeSH descriptor: [Spinal Stenosis] explode all trees</td>
<td>450</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>#1 or #2</td>
<td>1,532</td>
</tr>
<tr>
<td>I</td>
<td>4</td>
<td>(biportal endoscopic spinal surgery):ti,ab,kw OR (unilateral biportal endoscopic technique):ti,ab,kw</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>(full-endoscopic):ti,ab,kw OR (spine endoscopic):ti,ab,kw OR (percutaneous transforaminal endoscopic decompression):ti,ab,kw</td>
<td>131</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>#4 or #5</td>
<td>133</td>
</tr>
<tr>
<td>C</td>
<td>7</td>
<td>(microscopic decompression surgery):ti,ab,kw OR (micro endoscopic spine surgery):ti,ab,kw OR (microscopic endoscopic):ti,ab,kw</td>
<td>2,538</td>
</tr>
<tr>
<td>S</td>
<td>8</td>
<td>(random*):ti,ab,kw OR (placebo*):ti,ab,kw</td>
<td>1,238,699</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>MeSH descriptor: [Randomized Controlled Trial] explode all trees</td>
<td>119</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>MeSH descriptor: [Random Allocation] explode all trees</td>
<td>20,664</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>MeSH descriptor: [Placebos] explode all trees</td>
<td>24,587</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>#8 or #9 or #10 or #11</td>
<td>1,238,699</td>
</tr>
<tr>
<td>P+I+C+S</td>
<td>13</td>
<td>#3 and #6 and #7 and #12</td>
<td>9</td>
</tr>
</tbody>
</table>
### Supplementary Table 2. Outcomes of included studies (n = 6)

<table>
<thead>
<tr>
<th>Study</th>
<th>Single-level operative time (min)</th>
<th>Blood loss (mL)</th>
<th>Hospital stay (day)</th>
<th>Preoperative VAS score for back pain</th>
<th>VAS score for leg pain</th>
<th>Final follow-up VAS score for back pain</th>
<th>VAS score for leg pain</th>
<th>Complications (n)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kang et al.2019</td>
<td>36 ± 11 vs. 54 ± 9</td>
<td>25.5 ± 15.8 vs. 53.2 ± 32.1</td>
<td>1.2 ± 0.3 vs. 3.5 ± 0.8</td>
<td>NR</td>
<td>NR</td>
<td>1.6 ± 0.26 vs. 1.5 ± 0.26</td>
<td>NR</td>
<td>1 vs. 1</td>
</tr>
<tr>
<td>Park et al.2020</td>
<td>47.2 ± 19.8 vs. 70.2 ± 22.8</td>
<td>NR</td>
<td>1.9 ± 0.68 vs. 2.4 ± 1.3</td>
<td>NR</td>
<td>NR</td>
<td>2.75 ± 2.70 vs. 2.2 ± 2.9</td>
<td>2.61 ± 2.86 vs. 2.57 ± 3.19</td>
<td>3 vs. 4</td>
</tr>
<tr>
<td>Kompp et al.2015</td>
<td>42 ± 9.14 vs. 64 ± 14.5</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>1.7 ± 0.8 vs. 1.5 ± 0.8</td>
<td>1.7 ± 0.8 vs. 1.9 ± 0.8</td>
<td>3 vs. 8</td>
</tr>
<tr>
<td>Hatati et al. 2021</td>
<td>57.7 ± 23.8 vs. 65.3 ± 23.8</td>
<td>49.47 ± 12.8 vs. 53.57 ± 12.8</td>
<td>1.11 ± 0.53 vs. 1.28 ± 0.53</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Ruettner et al.2009</td>
<td>34 ± 8.72 vs. 48 ± 13.74</td>
<td>NR</td>
<td>NR</td>
<td>1.6 ± 0.9 vs. 1.3 ± 0.9</td>
<td>7.3 ± 1.9 vs. 7.9 ± 1.9</td>
<td>1 ± 0.9 vs. 1.2 ± 0.9</td>
<td>0.9 ± 0.9 vs. 1.1 ± 0.9</td>
<td>5 vs. 14</td>
</tr>
<tr>
<td>Chen et al.2018</td>
<td>75.2 ± 24.6 vs. 77.2 ± 26.3</td>
<td>48.3 ± 11.8 vs. 85.0 ± 18.6</td>
<td>2.81 ± 2.1 vs. 5.02 ± 2.2</td>
<td>7.8 ± 1.6 vs. 7.6 ± 1.4</td>
<td>8.3 ± 2.1 vs. 8.1 ± 1.9</td>
<td>1.7 ± 0.6 vs. 1.4 ± 0.3</td>
<td>0.9 ± 0.3 vs. 1.1 ± 0.2</td>
<td>0 vs. 0</td>
</tr>
</tbody>
</table>

VAS, visual analogue scale; NR, not reported.
Supplementary Fig. 1. Risk of bias assessment.
Supplementary Fig. 2. Egger and Begg plots of visual analogue scale score for leg and back pain between full-endoscopic (a) and microscopic spinal decompression (b). SE, standard error.