Original Article

Comparison of clinical and radiological outcomes of full-endoscopic versus microscopic lumbar decompression laminectomy for the treatment of lumbar spinal stenosis: a systematic review and meta-analysis

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Background: To determine the clinical and radiological outcomes of full-endoscopic (FE) versus microscopic (MI) lumbar decompression laminectomy in the treatment of lumbar spinal stenosis (LSS), we performed a meta-analysis to explore the best choice for patients with LSS requiring surgical relief.

Methods: Literature searches of the PubMed, the Cochrane Library, Embase, Medline, Embase, and Web of Science databases were performed. The searches covered all indexed studies published between 2008 and 2020, using keywords identifying the patient group (lumbar spine stenosis) and the interventions (full-endoscopic lumbar decompression laminectomy and microscopic lumbar decompression laminectomy). A total of 1,727 patients were included in 10 studies. The primary outcomes of the analysis were visual analogue scale (VAS) scores for leg and back pain, and Oswestry Disability Index (ODI) score.

Results: The meta-analysis of the VAS score for low back pain showed that in the first 24 hours postoperatively, participants who underwent FE had better pain control than those who underwent MI [FE: mean difference (MD) =–0.78, 95% confidence interval (CI): –1.11, –0.45; MI: MD =–1.53, 95% CI: –1.94, –1.12]. In all subgroup analyses, the VAS score for back pain was lower in the FE group than in the MI group (MD =–0.71, 95% CI: –0.96, –0.47). Regarding the VAS score for leg pain, the FE group had a significantly lower score than the MI group in the first 24 hours (Total: MD =–1.02, 95% CI: –1.31, –0.73). The meta-analysis demonstrated that the FE group had a significantly lower ODI score than the MI group (MD =–1.03, 9% CI: –1.54, –0.51). At 6 months, the MI group had a significantly lower score than the FE group (MD =1.09, 95% CI: 0.53, 1.64), but at 12 months, the FE group had a significantly lower score than the MI group (MD =–2.40, 95% CI: –3.12, –1.67).

Discussion: Compared to MI decompression, the FE decompression method resulted in better pain control in the early postoperative period, both in the lower back and legs, as well as shorter operative and shorter hospitalization times.

Keywords: Biportal endoscopic spinal surgery; lumbar decompression laminectomy; microscopic surgery; percutaneous full-endoscopic surgery; spinal stenosis

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Introduction

Lumbar spinal stenosis (LSS), a combined syndrome of buttock or leg pain with or without radiating lower back pain, is associated with decreased lumbar spinal space for the neural and vascular elements (1). LSS can be classified as congenital, acquired, or both, and acquired degenerative stenosis, resulting from aging, previous surgery, or spinal infection, is the dominant type (2-4). With the prolongation of life expectancy and the subsequent increase in the elderly population, the prevalence of lumbar degenerative diseases, especially LSS, has increased significantly. After consultation with an orthopedic specialist, more than 200,000 American patients with severe LSS and low back discomfort underwent surgical decompression to improve their mobility and quality of life (5).

The traditional open surgical technique for LSS is a laminectomy with foraminotomy. Given the disadvantages of neural decompression surgery for LSS, minimally invasive surgery (MIS) has been developed to preserve the normal spinal structures, prevent segmental instability, and reduce soft tissue damage. Microscopic (MI) laminectomy was first introduced in the late 1970s, while percutaneous uniportal full-endoscopic (UPEF) and biportal endoscopic spinal surgery (BESS) were respectively introduced in the late 1990s and recently a decade (6-10). Studies have reported satisfying outcomes with UPEF decompressive laminectomy, although specialized equipment is needed (11,12). The BESS technique, which involves the use of 1 portal for the endoscope and the other for working, has also produced positive results for lumbar discectomy, decompressive laminectomy, and foraminotomy (13). The endoscopic procedure is similar to MI laminectomy but has a superior safety profile. However, the results in several studies comparing MI and full-endoscopic (FE) procedures are debatable, and the best choice for patients with LSS is still controversial (13-16).

We conducted a meta-analysis to compare the MI and FE approaches for patients with LSS who require surgical relief, with the aim of providing substantial evidence to inform clinical practice.

We present the following article in accordance with the PRISMA reporting checklist (available at https://dx.doi.org/10.21037/apm-21-198).

Methods

Literature search

Searches of the published literature in 5 electronic databases including PubMed, the Cochrane Library, Embase, Medline, Embase, and Web of Science were performed. The literature searches covered all indexed studies published between 2008 and 2020, and used keywords identifying the patient group ("LSS") and the interventions ("full-endoscopic lumbar decompression laminectomy" and "microscopic lumbar decompression laminectomy"). To ensure our search strategy was as comprehensive as possible, we also manually searched 4 spinal surgery journals: *World Neurosurgery*, *The Spine Journal*, *Journal of Neurosurgery*, and *Spine*. To maintain high sensitivity, we also included relevant Medical Subject Heading terms, common keywords, and comprehensive combinations of the two.

Inclusion criteria

Two examiners (LL and XL) separately screened all of the retrieved studies, including their titles and abstracts, to ensure they met the eligibility criteria. Irrelevant and non-full-text articles were excluded. Before performing the literature searches, we set selection criteria for inclusion and exclusion. The inclusion criteria were: (I) patients with LSS, including single level and multiple levels; (II) comparative studies of randomized controlled trials of FE and MI decompressive laminectomy; and (III) ≥1 outcome of interest reported in the studies. The excluded studies were: (I) non-original articles; and (II) non-English articles. After screening the articles, all studies comparing FE and MI decompressive laminectomy techniques for treating patients with LSS were included. Two reviewers (LL and XL) critiqued the eligible studies based on the designated criteria. The agreement rate between the 2 reviewers needed to be 100%, and if disagreement could not be resolved, a 3rd reviewer (HW) was consulted.

Data extraction

Two reviewers (ST and TNM) independently performed data extraction using standardized data extraction forms. The data included demographic information, surgical technique, clinical outcomes, operation time, Hemovac drains, opioid usage, hospitalization length, radiological outcome, and complications. A general database was built for the meta-analysis of clinical outcomes based on a visual analog scale (VAS), which consists of a hatch mark on a 100-mm line that represents the patient's average pain intensity over the 7 days previously (17). The Oswestry Disability Index (ODI) scores were each normalized to 10 pain-related questions, scored from 0 (no pain) to 5 (most severe pain). Scores were expressed as a percentage of total points, with ≤20% indicating minimal disability, 21–40% indicating moderate disability, 41–60% indicating severe disability, 61–80% indicating crippled, and 81–100% indicating completely bedbound (18). Because the recorded time of the final follow-up differed significantly in each study (P<0.001), the clinical outcomes were measured according to the recorded time. Those without a universal last follow-up were categorized as the final follow-up. Regarding the subgroup analysis, 2 techniques were used for endoscopic decompression, BESS and FE, which we further defined as the biportal or non-biportal endoscopic decompression (NED) groups, respectively. In the NED group, 1 of 2 approaches, translaminar crossover or interlaminar approach, was chosen at the surgeon's discretion.

Quality assessment

Two researchers (ST and TNM) used the Modified Coleman Methodology Score (CMS) to assess the risk of bias in each study as low, high, or unclear. Disagreements were resolved by consensus or through discussion with a 3rd reviewer (HW).

Statistical analysis

All statistical analyses were conducted using RevMan (Review Manager) version 5.4 software (The Nordic Cochrane Centre, Denmark). Meta-regression was applied to explore the cause of heterogeneity by fitting a covariable (e.g., mean age, sex, level, mean follow-up time, preoperative VAS and ODI) in the meta-regression model. Subgroup or sensitivity analysis was then performed according to the results of the meta-regression. Publication bias was assessed using contour funnel plots and Egger's test. The difference between the FE and MI groups was calculated by subtracting the mean value of the MI group from that of the FE group. A negative difference meant that the outcome in the FE group was favorable compared to that in the MI group. The mean difference (MD) was weighted, and a significant value of P<0.05 rejected the null hypothesis (19).

Results

The initial literature search produced 197 articles (summarized in *Figure 1*) using the PRISMA template. Of these, 10 compared FE and MI decompression laminectomy, fulfilling the inclusion criteria. There were totally 1,727 patients included in the 10 studies. The primary outcomes of the analysis were VAS scores for leg and back pain, and ODI. Of the 10 studies, 8 (9,13,14,16,20-22) were rated as level III evidence and 1 (15) was a level IV study (*Table 1*).

One study was excluded due to an overlapping sample (10). According to the CMS, the total mean score was 66.1, with a standard deviation of 7.52 (*Table 2*).

Primary clinical outcomes

VAS (back pain)

Four studies reported outcome data for participants in the first 24 hours postoperatively. *Figure 2* presents the key characteristics of the 4 studies, which included 428 participants with a mean score of 3.78 (range, 1.74–6.3). Three studies included participants undergoing BESS, and 2 studies included participants undergoing NED. The participants undergoing FE decompression had better back pain control within the first 24 hours postoperatively than those who underwent MI decompression [BESS: MD =–0.78, 95% confidence interval (CI): –1.11, –0.45; NED: MD =–1.53, 95% CI: –1.94, –1.12; Total: MD =–1.53, 95% CI: –1.33, –0.82, all groups P<0.0001]. In all subgroup analyses, the VAS score for back pain was lower in the FE group than in the MI group (MD =–0.71, 95% CI: –0.96, –0.47). Of the studies, 4, 4, and 2 studies reported outcome data for participants at 6, 12, and 24 months postoperatively, respectively, and 3 of them reported outcomes at the final follow-up; no significant associations were observed among the study characteristics (all P>0.05) (*Figures 2,3*).

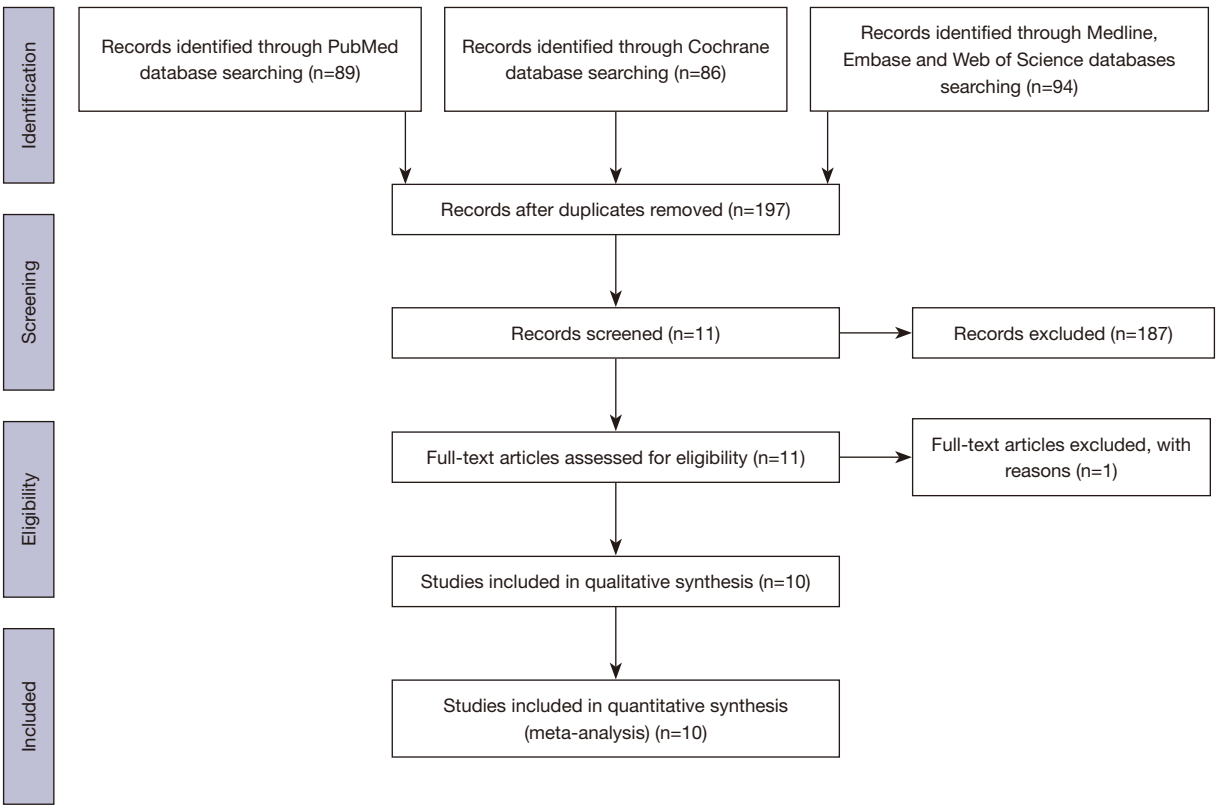


Figure 1 PRISMA flow chart of literature search.

VAS (leg pain)

Two studies reported outcome data for participants in the first 24 hours postoperatively. *Figure 4* presents the key characteristics of the 2 studies, which included 132 participants with a mean score of 4.42 (range, 1.78–3.39). In the first 24 hours, the FE group had a significantly lower VAS score than the MI group (Total: MD =–1.02, 95% CI: –1.31, –0.73, P<0.0001). Of the studies, 4, 3, 2, and 2 studies reported outcome data for participants at 3, 6, 12, and 24 months postoperatively, respectively, and 3 of them reported outcomes at the final follow-up; no significant associations were observed among the study characteristics (all P>0.05) (*Figures 3B*,*4*).

ODI

Four studies reported outcome data for participants within the first 3 months, postoperatively. These 4 studies comprised 494 and 558 participants in the FE and MI groups, respectively. The meta-analysis revealed that the FE group had a significantly lower score than the MI group (MD =–1.03, 95% CI: –1.54, –0.51, P<0.001). Unexpectedly, at 6 months, the MI group had a significantly lower score than the FE group among the 4 pooled studies, and 1,089 participants were extracted (MD =1.09, 95% CI: 0.53, 1.64, P=0.0001). Three studies reported participant outcome data at 12 months, with the FE group having a significantly lower score than the MI group (MD =–2.40, 95% CI: –3.12, –1.67, P<0.00001). The comparison of both groups uncovered no significant difference at 24 months or at the final follow-up (P>0.05) (*Figures 3C*,*5*).

Operative outcomes

Operation time

Eight studies reported data regarding the operative time for 931 patients. The NED subgroup showed comparable outcomes with MI group for operative time. Unilateral FE decompression took less time to complete than MI decompression (MD =–1.88, 95% CI: –3.39, –0.37, P=0.01). However, the BESS group showed no advantage over the MI group (MD =0.11, 95% CI: –1.36, 1.57, P=0.89) (*Figure 6A*).

Table 1 Characteristics of the included studies

Author	Year	Country	Journal	Types of study	Lesion type	Follow up (months)	Sample size	Full-endoscopic	Microscopic	Age (FE[a] *vs.* MI[b])	Male (FE[a] *vs.* MI[b])	Level distribution (FE[a] *vs.* MI[b])	L2-L3	L3-L4	L4-L5	L5-S1	Preoperative VAS (back pain)	Preoperative VAS (leg pain)	ODI
Choi (20)	2018	South Korea	*Clinics in Orthopedic Surgery*	Retrospective cohort	Lumbar spinal stenosis	24	65	35	30	65.4±11.8 *vs.* 65.2±12.0	14 *vs.* 17		N/A	N/A	N/A	N/A	6.8±1.0 *vs.* 6.8±1.2	6.3±1.1 *vs.* 7.0±1.1	N/A
Heo (9)	2019	South Korea	*Neurosurgical Focus*	Retrospective cohort	L4–5 lumbar stenosis	12.5±3.3	70	37	33	66.7±9.4 *vs.* 63.4±11.1	15 *vs.* 12		N/A	37 *vs.* 33	N/A	N/A	7.02±1.34 *vs.* 6.64 ±1.45	8.05±1.08 *vs.* 7.67±1.08	57.79±5.65 *vs.* 56.36±5.91
Kang (21)	2019	South Korea	*Medicine*	A prospective randomized comparative study	Spinal stenosis	6	62	32	30	65.1±8.6 *vs.* 67.2±9.5	18 *vs.* 14		N/A	4 *vs.* 5	16 *vs.* 15	12 *vs.* 10	N/A	N/A	55 *vs.* 53
Komp (14)	2015	Germany	*Pain Physician*	A prospective, randomized controlled study	Lumbar central stenosis	24	135	71	64	62±10.75	69		5 *vs.* 9	30 *vs.* 25	38 *vs.* 42	7 *vs.* 4	85 *vs.* 83	23 *vs.* 25	84 *vs.* 88
Lee (23)	2019	South Korea	*BioMed Research International*	Retrospective cohort	Lumbar central canal stenosis	6.38	236	164	72	53.22±3.5 *vs.* 59.32±8.28	52 *vs.* 21		N/A	N/A	N/A	N/A	5.97±2.77 *vs.* 5.09±2.84	7.01± 2.31 *vs.* 6.47±2.73	69.8±5.4 *vs.* 56.3±6.1
Min (15)	2020	South Korea	*Journal of Orthopaedic Science*	Multicenter case control	Single-level lumbar spinal central stenosis	28.51±6.3	89	54	35	65.74±10.52 *vs.* 66.74±7.96	27 *vs.* 19		1 *vs.* 1	7 *vs.* 7	43 *vs.* 24	2 *vs.* 3	5.27±0.91 *vs.* 5.34±0.96	7.38±0.65 *vs.* 7.37±0.94	60.4±6.88 *vs.* 61.1±4.89
Park (13)	2019	South Korea	*The Spine Journal*	A randomized controlled trial	Lumbar spinal stenosis	12	64	32	32	66.2±9.75 *vs.* 67.1±8.5	18 *vs.* 13		2 *vs.* 3	5 *vs.* 7	25 *vs.* 17	0 *vs.* 2	6.1±2.6 *vs.* 6.1±2.4	6.5±1.7 *vs.* 7.4±2.1	46.2±20.5 *vs.* 47.0±14.4
Rieger (24)	2019	Germany	*World Neurosurgery*	Retrospective cohort	Lumbar central stenosis	36	740	327	413	76±10 *vs.* 78±13	101 *vs.* 119		N/A	28 *vs.* 37	144 *vs.* 140	97 *vs.* 104	N/A	N/A	53.2±10.3 *vs.* 46.7±23.5
Ruetten (16)	2009	Germany	*J Neurosurg Spine*	A randomized controlled trial	Lumbar central stenosis	24	161	81	80	64±12 in total	104 in total		7 *vs.* 5	20 *vs.* 25	33 *vs.* 31	38 *vs.* 39	19 *vs.* 15	75 *vs.* 71	75 *vs.* 73

[a], Full-endoscopic decompression; [b], Microscopic decompression. FE, full-endoscopic; MI, microscopic; VAS, Visual Analogue Scale; ODI, Oswestry Disability Index.

Table 2 CMS of the included studies

Evaluation Item	Max CMS	Mean score	SD	Range
Part A	60	39.3	7.3	29–50
①Study size	10	10	0	10
②Follow-up	5	2.1	2.18	0–5
③Surgical procedure	10	4.2	3.62	0–7
④Type of study	15	7.5	6.77	0–5
⑤Diagnostic certainty	5	4	2.11	5–10
⑥Description of surgical technique	5	8	2.58	0–5
⑦Description of post-operative rehabilitation	10	3.5	2.42	0–5
Part B	40	26.8	4.92	20–33
①Outcome criteria	10	6.9	1.37	5–8
②Procedure for assessing outcome	15	12.9	3.07	6–15
③Description of subject selection process	15	7	4.22	0–10
Coleman Methodology Score (part A+B)	100	66.1	7.52	53–77

CMS, Coleman Methodology Score; SD, standard deviation.

Hemovac drains

Only 2 studies reported outcome data for Hemovac drains in 125 participants. The results of the FE and MI groups were not comparable (MD =–8.12, 95% CI: –19.59, 3.36, P=0.17) (*Figure 6B*).

Postoperative outcomes

Opioid usage

Outcome data for opioid usage were reported in 2 studies. Patients in the FE group required significantly lower dosages than those in the MI group (MD =–9.17, 95% CI =–11.74, –6.61, P<0.00001). Nevertheless, this result should be interpreted with caution, considering it was based on a small sample size of only 125 participants (*Figure 7A*).

Complications rate

Outcome data for the complications rate were reported in 5 studies involving 2663 participants. Complications included durotomy (MD =0.50, 95% CI: 0.18, 1.38), hematoma (MD =0.33, 95% CI: 0.08, 1.43), transient weakness (MD =0.90, 95% CI: 0.32, 2.50), dysesthesia (MD =0.80, 95% CI: 0.37, 1.70), and infection (MD =0.18, 95% CI: 0.02, 1.59). No significant differences were found between the BESS and NED groups (BESS: MD =1.23, 95% CI: 0.51, 2.93; NED: MD =1.03, 95% CI: 0.58, 1.82; Total: MD =1.04, 95% CI: 0.63, 1.71) (*Figure 7B*,*7C*).

Hospitalization length

Outcome data for hospitalization were reported in 4 studies with 450 participants. The participants in the FE group had a shorter recovery time in hospital than those in the MI group (MD =–2.13, 95% CI: –2.36, –1.91, P<0.00001) (*Figures 3D*,*7D*).

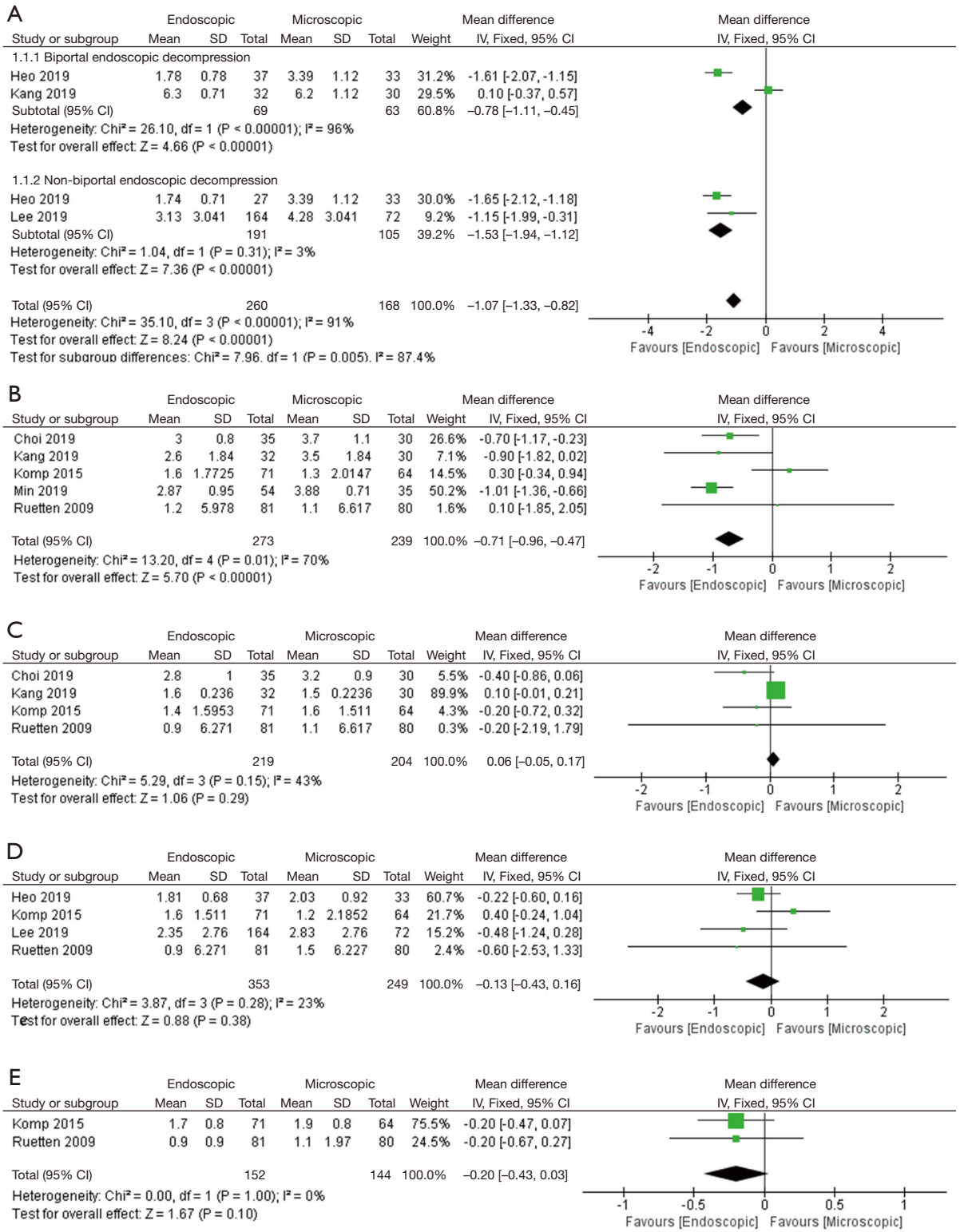
Radiological outcomes

Dura expansion

Outcome data for dura expansion were reported in 3 studies with 394 participants. All studies stated that the results of comparison of pre- and postoperative axial magnetic resonance imaging (MRI) were statistically significant in all groups (11). However, the meta-analysis showed no significant difference among the groups regarding the amount of decompression (MD =–3.22, 95% CI: –7.07, –0.62, P=0.10) (*Figure 8*).

Publication bias

Visual inspection of the Begg's funnel plots for the VAS score (back), VAS score (leg), ODI score, and complications rate revealed symmetry. To ensure that there was no publication bias, Egger's test was also performed (Table S1).



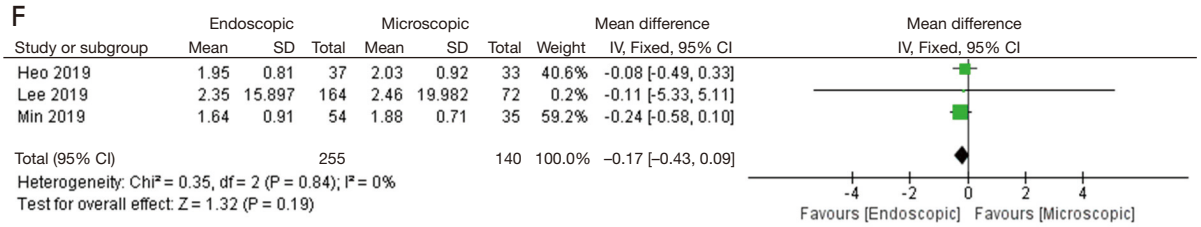


Figure 2 Forrest plots of VAS (back) (A) postoperatively 24 hours; (B) postoperatively 1 to 3 months; (C) postoperatively 6 months; (D) postoperatively 12 months; (E) postoperatively 24 months; (F) final follow-up.

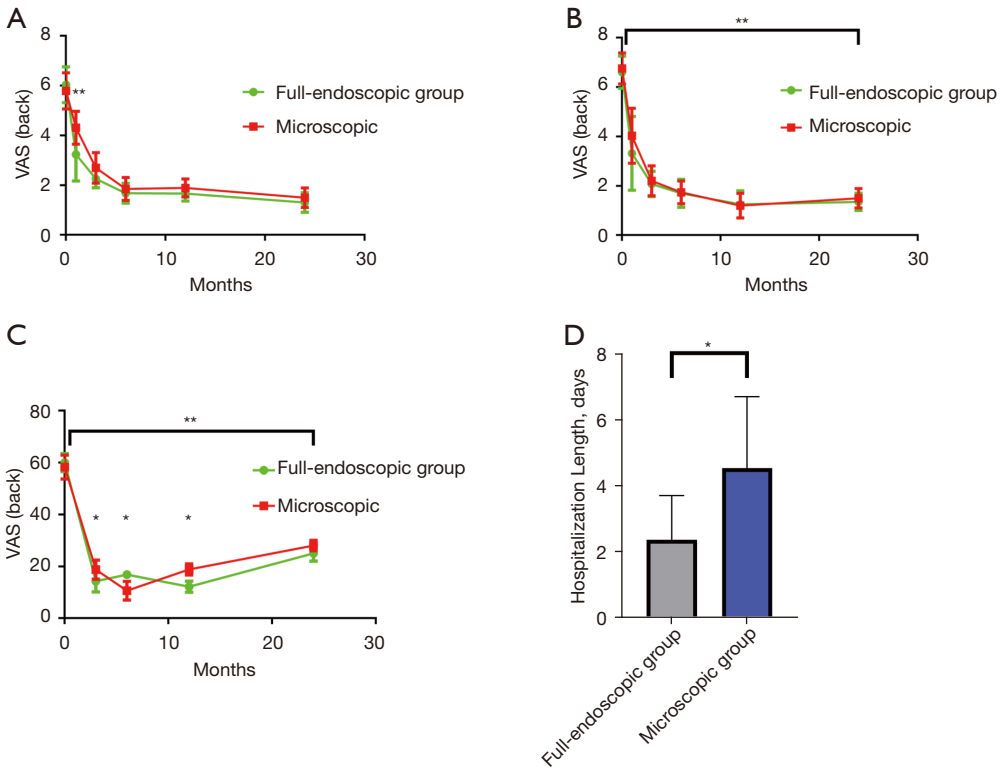


Figure 3 Line charts of clinical outcomes of (A) VAS (back); (B) VAS (leg); (C) ODI; and bar chart of (D) hospitalization length. *, P<0.05; **, P<0.01. VAS, visual analog scale; ODI, Oswestry Disability Index.

No statistically significant publication bias existed for any of the 4 results (95% CI: –3.56, –1.27, P=0.26; 95% CI: –0.77, –1.34, P=0.36; 95% CI: –33.49, –22.47, P=0.24; 95% CI: –4.99, –12.58, P=0.30, respectively) (*Figure 9*, Table S1).

Discussion

Innovation in the current study

This meta-analysis compared the clinical, operative, postoperative, and radiological outcomes between FE and MI surgery for patients with LSS requiring surgical relief. The results of our meta-analysis may provide substantial evidence to assist clinical practice, but still unable to overcoming the limitations of the learning curve and preliminary evaluation. We found overlapping data that have never been reported before and which affected the accuracy, even leading to publication bias. Heo *et al.* published spinal surgery articles in 2018 (10) and 2019 (9). The data in Heo *et al.*'s 2018 study (10) were extracted from The Leon Wiltse Memorial Hospital between March

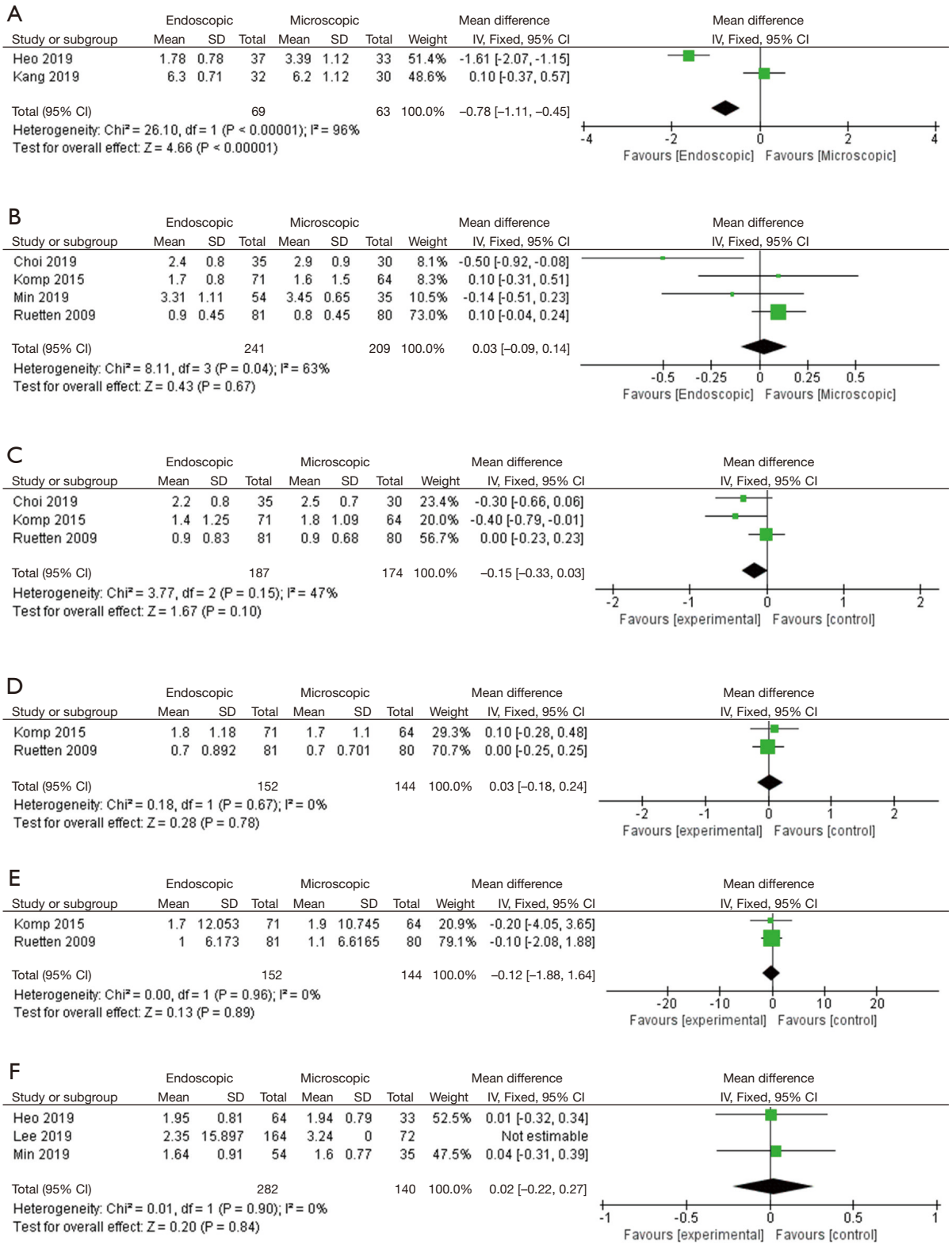


Figure 4 Forrest plots of VAS (leg) (A) postoperatively 24 hours; (B) postoperatively 1 to 3 months; (C) postoperatively 6 months; (D) postoperatively 12 months; (E) postoperatively 24 months; (F) final follow-up. VAS, visual analog scale.

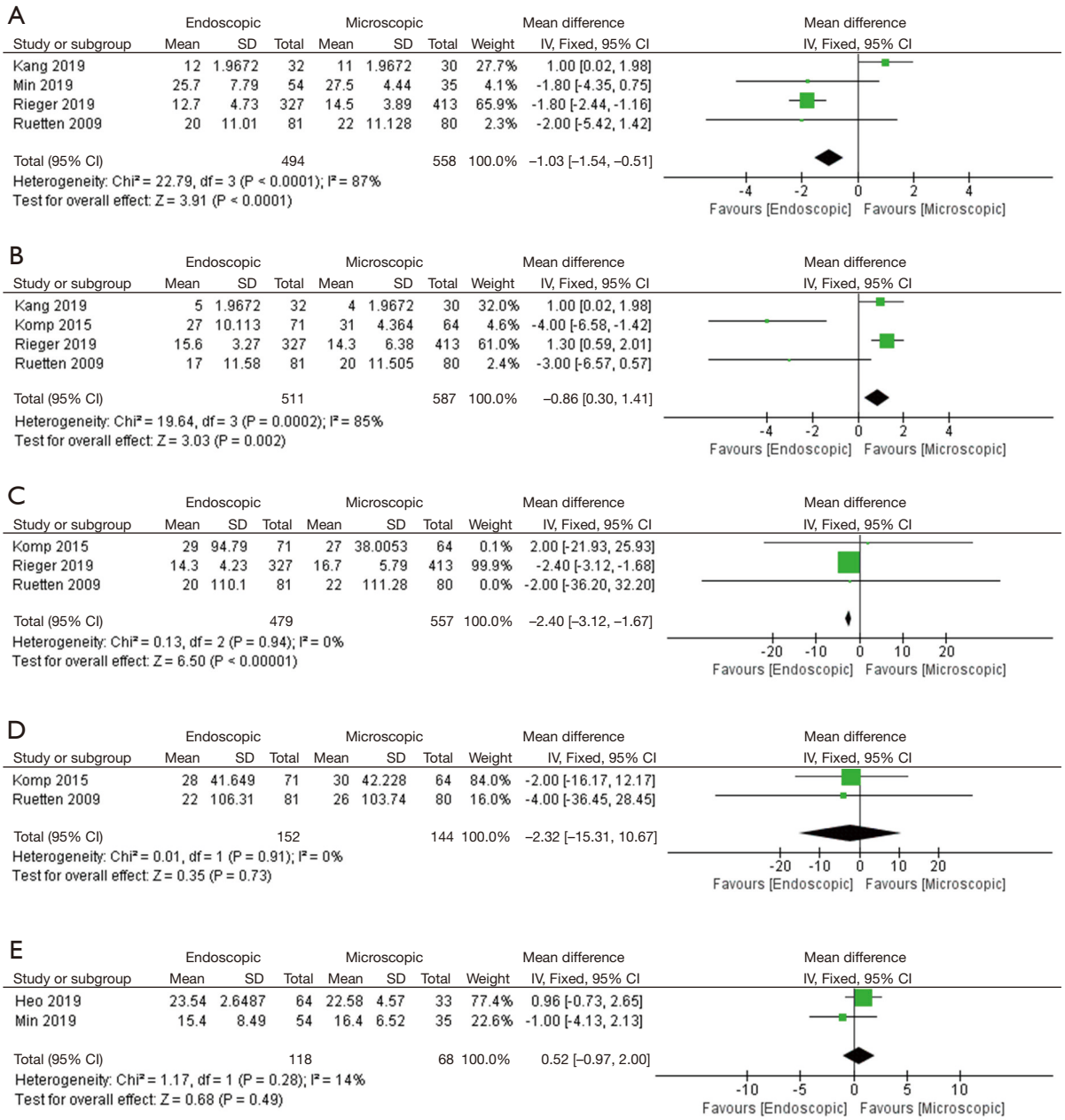


Figure 5 Forrest plots of ODI (A) postoperatively 1 to 3 months; (B) postoperatively 6 months; (C) postoperatively 12 months; (D) postoperatively 24 months; (E) final follow-up. ODI, Oswestry Disability Index.

2016 and October 2017. In their 2019 study (9), Heo *et al.* prospectively collected data on patients with LSS treated at the same hospital between March 2016 and December 2017. We extracted the data from both studies and compared them, finding that overlap was extremely likely. Consequently, we included Heo *et al.*'s more recent study (9), with the larger sample size and updated results, and excluded the other study. To minimize error, we separated the final follow-up times for patients with recorded data, and we broke down the complications rate to demonstrate detailed results by line and bar charts in order to show the comparison between groups and the efficacy of each surgical technique. Additionally, we compared the participants' radiological outcomes, which was a new approach among

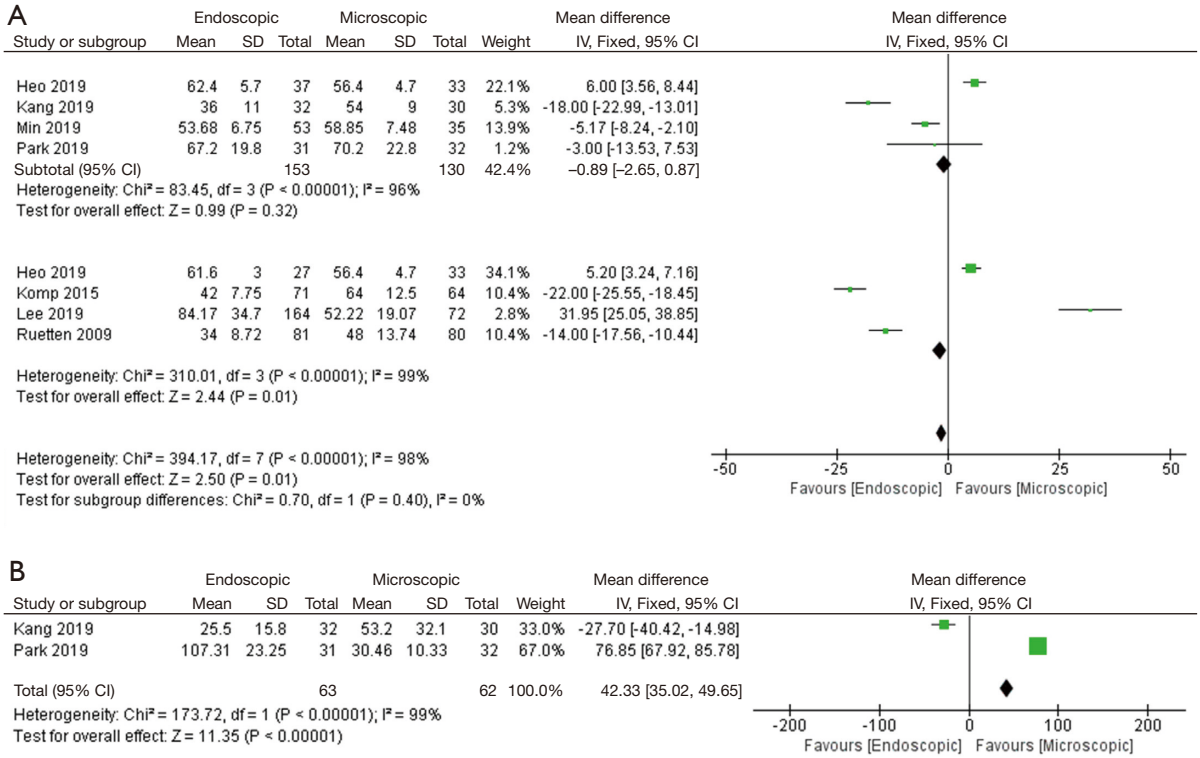


Figure 6 Forrest plots of operative outcomes (A) operation time; (B) hemovac drains.

similar meta-analyses.

Association between surgical technique and clinical outcomes

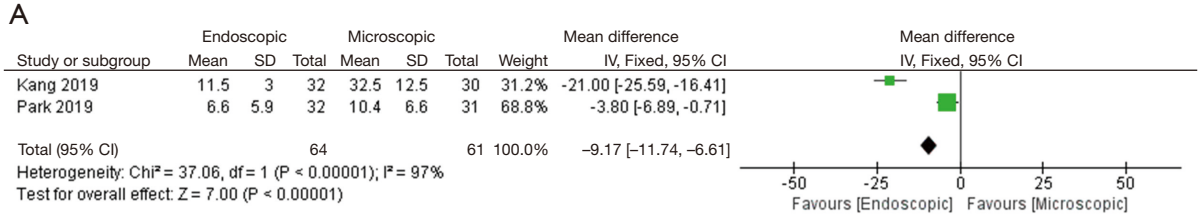
This meta-analysis indicated that patients who underwent the FE surgical technique had better pain control in the early stage of the recovery process according to all VAS and ODI scores. The primary outcomes matched the opioid usage result, even though the sample size in the comparison was insufficient. Because of the rapid advancements in imaging modalities, it is most likely that the pain region and the pathological degenerated disc were diagnosed accurately (25); thus, there was significantly increased pain control in all groups. To minimize postoperative pain, the tubular-retractor system and endoscope are used for better visualization, maximal muscle sparing, and minimization of soft tissue damage (26). The surgeon has good vision of the contralateral, sublaminar, and foraminal areas with high magnification (27). Not only do MIS techniques minimize operative skin scars, but they also result in a shorter hospital stay with a faster recovery time, and an earlier return to normal life (28,29). On the other hand, shortcomings of the MI surgical technique may affect the early postoperative stage. First, contralateral access is challenging due to instrument entry through a small incision, and can be particularly difficult in obese or overweight patients (30). Second, excessive tilting of the microscope can be necessary in some cases.

However, our results indicated that the long-term outcomes of the 2 approaches were similar. The MI surgical technique enables satisfactory decompression protecting the contralateral facet joint, muscle, and posterior ligamentous complex while minimizing ipsilateral facet joint disruption (15,31). Although successful results of spinal endoscopy were available initially, Rieger *et al.* (24) suggested that the combination of navigation and endoscopy might have resulted in a steeper learning curve, but that long-term results are comparable.

Association between surgical technique and operative outcomes

Regarding the operative time, the results showed

A



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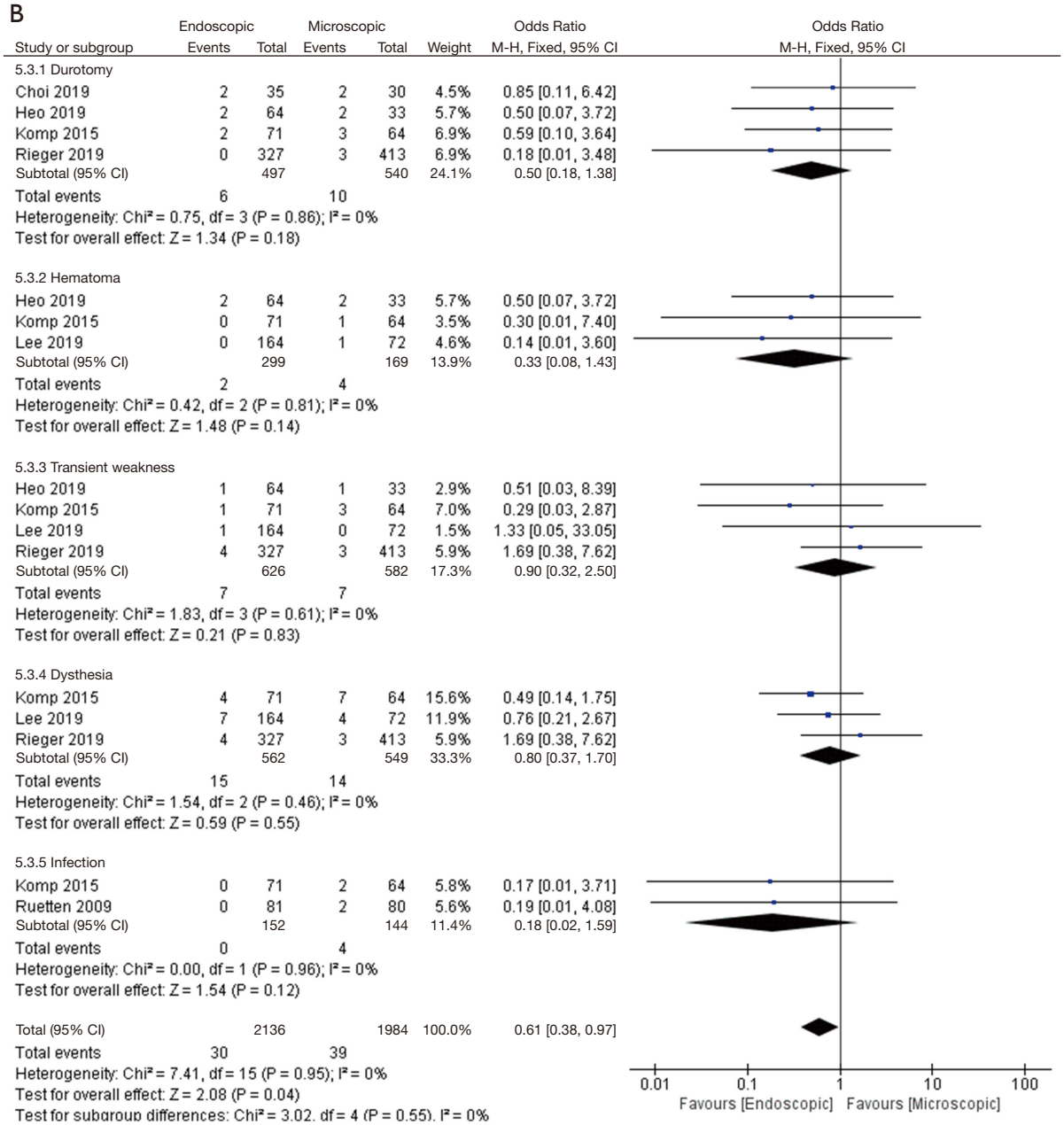

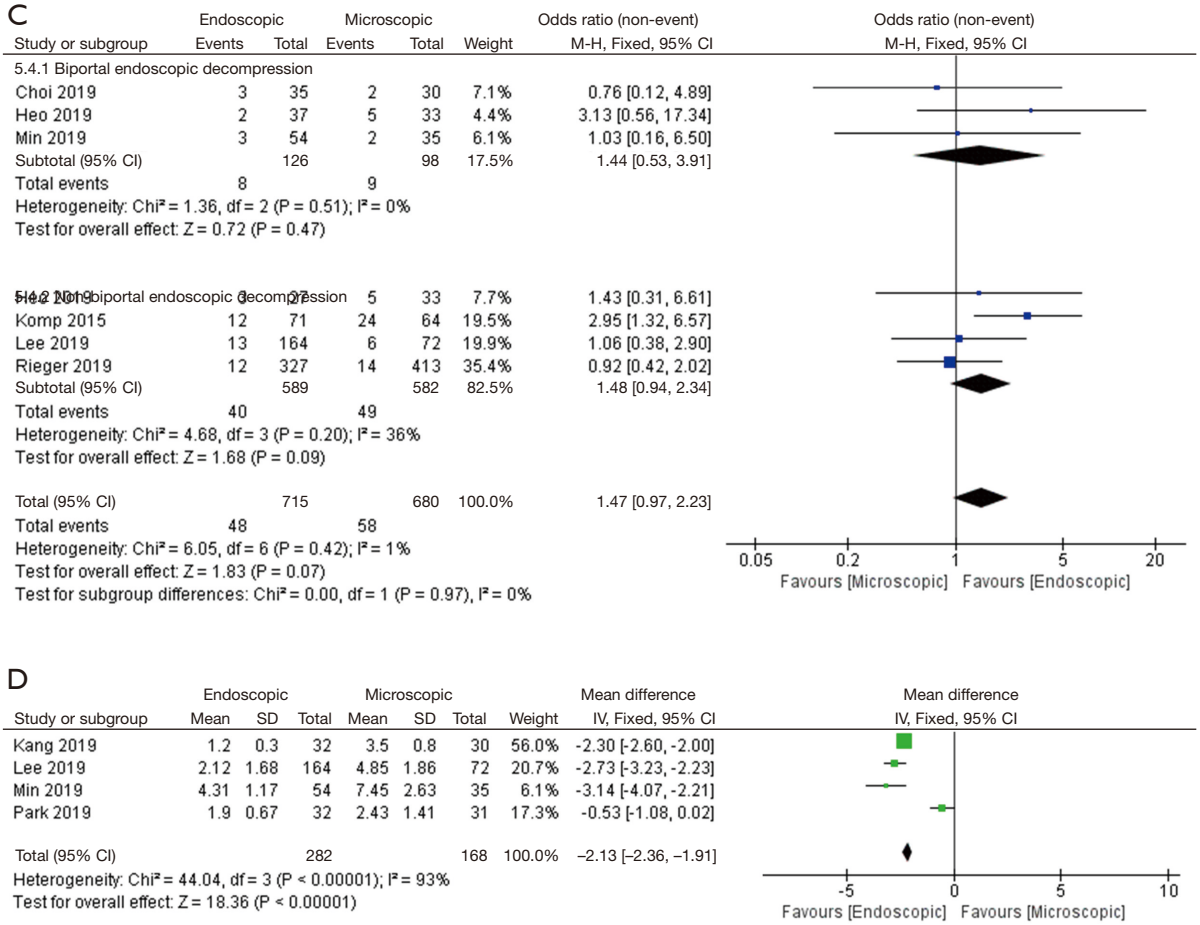

Figure 7 Forrest plots of postoperative outcomes (A) opioid usage; (B) complications; (C) overall complication rate; (D) hospitalization length.

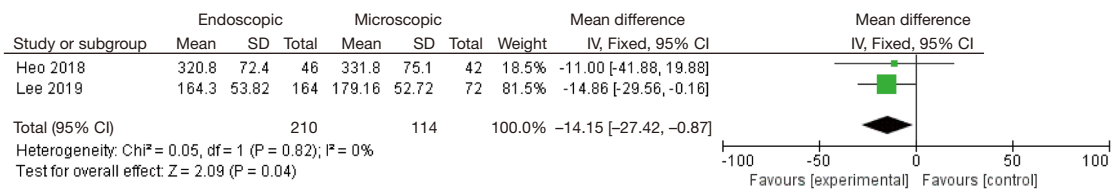

Figure 8 Forrest plots of dural expansion.

that patients undergoing FE decompression had a shorter operative time than those who underwent MI decompression. During the FE procedure, no blood loss occurs, and no drainage is required. The stabilizing structures resection rate was decreased and reduced trauma of the ligamentum flavum appears to have certain advantages (32,33). The results for the comparisons of operative time, trauma, and operation-related sequelae in the FE group were similar to those reported in the literature on discectomies (34,35). In a review of the chronological change in operative time for FE decompression, Lee *et al.* concluded that the FE decompression technique has a lesser operative time compared with other traditional techniques and can be learned in less time (11).

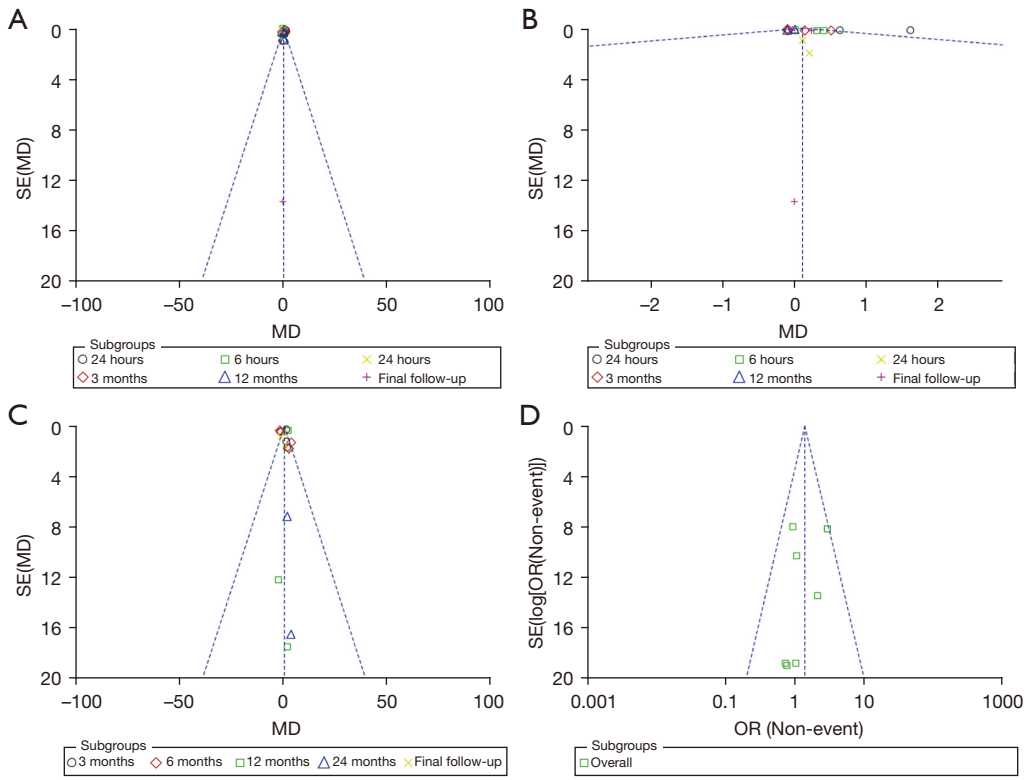

Figure 9 Funnel plots of (A) VAS (back); (B) VAS (leg); (C) ODI; (D) overall complication rate. VAS, visual analog scale; ODI, Oswestry Disability Index.

However, the postoperative drainage volume was significantly larger in the FE group, possibly because saline irrigation infiltrates the soft issue and then leaks out postoperatively. Another plausible reason is that bleeding may be masked by the water pressure and then leak out postoperatively. Thus, compression of the bleeding site by the water pressure can lead to uncontrolled bleeding flowing into the Hemovac drains (13). Nevertheless, we must interpret the drainage results with caution owing to the small number of included samples.

Association between surgical technique and complications

The major postoperative complications are durotomy, hematoma, transient weakness, dysthesia, and infection. Compared with traditional open surgery, FE and MI spinal surgery decreases the complications rate. The purpose of FE decompressive surgery for LLS is to perform wide decompression of the neural canal and to minimize injury to the posterior muscular-ligamentous structures. The equipment required consists of conventional open spinal surgical instruments and ordinary arthroscopic instruments, so the surgeon has free movement and handling, as well as angulation, of the instruments (36). Thus the surgery-related posterior muscular-ligamentous injury rate may be lower with the biportal or uniportal FE technique than with the MI procedure. When a dural tear occurs during FE decompression, it can be repaired with a gelfoam and TachoSil sealant patch (Baxter Healthcare Corporation, Deerfield, IL, USA) (37-39). Differentiation and manipulation of the related structures in the narrow operative field can be readily made with constant saline irrigation through the working channel providing a wider epidural space between the neural structures and the surrounding soft tissue during the surgery. The irrigation pressure during FE decompression provides a better intraoperative visual field, which helps to reduce the complications rate (11). In view of the FE decompression was in the learning curve, this meta-analysis demonstrated that MIS surgery is a relatively safe and reliable method for decompression of the stenotic spinal canal and lateral recess.

Association between surgical technique and radiological outcomes

This meta-analysis is the first to assess dural expansion, which was examined by MRI. There was no significant difference in the degree of dural expansion between the groups. According to Heo *et al.* (9), although their result was inconclusive, FE decompression may have the advantage of facet preservation (facet undercutting) while minimizing muscle injury. Several studies report that 1 of the drawbacks of MIS spinal bilateral decompression via a unilateral approach is incomplete decompression due to the very limited surgical view and working space to manipulate instruments (40,41). The contradictory outcomes could result from unfamiliarity with the use of FE instruments during the early stage of the learning curve. High-speed drills and punches are the primary FE instruments that can help the surgeon to perform bilateral decompression. Bleeding control can be done by bipolar RF and proper adjustment of the hydrostatic pressure by an irrigation pump system. Tilting and rotating the endoscope helps the surgeon completely explore the surgical site (11). The results elucidated that patients who undergo FE surgery can have outcomes as optimistic as those for patients who undergo MI spinal surgery.

Limitation

Overall, the numbers of participants were sufficient (1,727 participants), but the set point of each study was different. Consequently, comparing the 2 interventions was challenging. We included all available publications, reflecting the latest surgical results, and focused on the results of FE and MI lumbar decompression laminectomy for LSS. There are several limitations to this study that should be taken into consideration. First, there was inconsistent reporting of outcome measures across the FE and MI groups. Some of the final follow-ups did not have accurate reporting times for both interventions. There was a wide range (6–24 months), so we tried to separate the comparison by reporting times. Second, even though the sample size was sufficient, the comparative standards varied among studies. Lots of interesting outcome data could not be imported or became inconclusive due to missing records in other extracted studies. Third, data for the comparison of techniques of FE spinal surgery between BESS and percutaneous UPFE were insufficient. Collectively, some outcomes using different techniques are still questionable.

We determined if there were any differences between FE and MI decompression in clinical and radiological outcomes, which are also essential determinants in establishing the efficacy of a surgical approach. Despite the challenge of extracting and interpreting data from the primary studies, the evidence showed similar final clinical outcomes for FE and MI decompression. However, compared with MI decompression, FE decompression was associated with better pain control in the early period, in both the lower back and legs, and had shorter operative and hospitalization times. In the future, more benefit claims should be proved by data from well-designed trials. Researchers investigating any related treatment for LSS should provide a common set of outcomes, and the outcome trials should be standardized.

Conclusions

In our analysis, FE and MI decompression had equivalent ultimate clinical outcomes, and complications rates. However, compared with MI decompression, FE decompression attained better pain control in the early postoperative period, in both the back and legs, and had shorter operative and shorter hospitalization times for patients with LSS.

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Footnote

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://dx.doi.org/10.21037/apm-21-198). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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Supplementary

Table S1 Egger test for publication bias

Std_Eff	Coef.	Std.Err.	t	P> |t|	[95% Conf.	Interval]
Published bias for VAS (back)						
slop	−1.725543	0.1508133	−11.44	0	−2.144268	−1.306818
bias	−1.145887	0.8711523	−1.32	0.259	−3.564594	1.272819
Published bias for VAS (leg)						
slop	−1.429195	0.065349	−21.87	0.002	−1.71037	−1.14802
bias	0.2878332	0.245599	1.17	0.362	−0.76889	1.344559
Published bias for ODI						
slop	−1.983007	0.441715	−4.49	0.14	−7.59553	3.629511
bias	−5.509741	2.201989	−2.5	0.242	−33.4887	22.46918
Published bias for overall complication rate						
slop	−0.003956	0.089754	−0.04	0.967	−0.25315	0.24524
bias	3.796791	3.165656	1.2	0.297	−4.99248	12.58606

VAS, Visual Analogue Scale; ODI, Oswestry Disability Index.

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