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Unilateral biportal endoscopic spine surgery for lumbar spinal stenosis: a systematic review and meta-analysis

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Abstract. – OBJECTIVE: Lumbar spinal stenosis is the most common spinal degenerative disease in patients over 60 years, and the unilateral biportal endoscopic (UBE) spine surgery treatment of lumbar spinal stenosis (LSS) has achieved preliminary clinical results. This systematic review and meta-analysis aimed to reveal the clinical efficacy of UBE for LSS and provide evidence for clinical practice.

MATERIALS AND METHODS: PubMed, Embase, Web of Science, and Cochrane databases were searched for literature. The papers selected were those published from inception till October 2021. The selected pieces of literature were graded for evidence using the Oxford Centre for Evidence-Based Medicine: Levels of Evidence (March 2009). Outcomes measures were operation time, blood loss, complication rate, admission period, Visual Analogue Scale (VAS)-back, VAS-leg, and Oswestry Disability Index (ODI) score, and radiological outcomes. The mean comparisons were based on VAS and ODI scores.

RESULTS: A total of 823 patients with a single LSS segment were included from the selected nine studies. There were nine studies comparing UBE clinical outcomes and micro-endoscopic unilateral laminotomy for bilateral decompression (M-ULBD). The meta-analysis revealed that the UBE group had better VAS-leg and -back scores in the first week postoperatively [total: mean difference (MD) = -0.96, 95% confidence interval (CI): -1.19, -0.74, $p < 0.00001$; total: MD = -1.69, 95% CI: -1.93, -1.45, $p < 0.00001$], 1st month postoperatively (total: MD = -0.35, 95% CI: -0.61, -0.08, $p = 0.01$; total: MD = -0.40, 95% CI: -0.68, -0.12, $p = 0.005$), 6th month postoperatively (total: MD = -0.22, 95% CI: -0.35, -0.08, $p = 0.002$; total: MD = -0.24, 95% CI: -0.40, -0.07, $p = 0.005$), and UBE group also performed better in ODI score at 1st month postoperatively (total: MD = -3.36, 95% CI: -4.26, -2.46, $p < 0.00001$). There was no significant difference in VAS-leg and -back scores between both groups at the 3rd and 12th month postoperatively, and ODI scores did not significantly differ between both groups at 3, 6, and 12 months postoperatively (all $p > 0.05$).

CONCLUSIONS: UBE has achieved good preliminary clinical results and may be a minimally invasive alternative surgery for patients with single segmental LSS.

Key Words:

Unilateral biportal endoscopic spine surgery, Lumbar spinal stenosis, Clinical result, Radiological outcomes, Meta-analysis.

Introduction

Lumbar spinal stenosis (LSS) is the progressive stenosis of the spinal canal[1]. LSS is caused by pathological spinal stenosis and nerve root compression[2]. The symptoms include claudication, back and leg pain, and decreased walking ability; nonetheless, the typical manifestation is intermittent claudication[3]. According to different anatomical positions, lumbar spinal stenosis includes the central, lateral recess, and intervertebral foramina types[4]. Katz and Harris[5] reported that lumbar spinal stenosis is a common spinal degenerative disease in patients over 60 years.

Open laminectomy surgery had been the traditional technique for LSS[6]. Open surgery had some disadvantages, such as heavy muscle damage, long operation time, significant intraoperative bleeding, and a high incidence of postoperative complications[7]. Given the disadvantages of open decompression surgery for LSS, minimally invasive surgery (MIS) was developed to preserve the normal spinal structure, prevent segmental instability, and reduce soft tissue damage[8]. De Antoni et al[9] first reported arthroscopy results using two channels in lumbar spine surgery in 1996. In 2015, Soliman[10] used the irrigation endoscopic discectomy (IED) technique in treating patients with LSS; patients were followed up for 28 months, and 87% of the patients were satisfied with the clinical results. Furthermore, Eum et

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al[11] reported a percutaneous biportal endoscopic decompression (PBED) technique for LSS decompression in 2016. Heo et al[12] first proposed the concept of unilateral biportal endoscopy (UBE) and used it in lumbar interbody fusion surgery in 2017. The UBE technique, which involves using one portal for the endoscope and the other for the procedure, also produced positive results for lumbar discectomy, decompressive laminectomy, and foraminotomy[11].

Some studies[18-26] have reported the clinical outcomes and efficacy of UBE for LSS. Therefore, this systematic review and meta-analysis aimed to reveal the clinical efficacy of UBE for LSS and provide evidence for clinical practice.

Materials and Methods

Search Strategy and Inclusion Criteria

This study used the Preferred Reporting Project (PRISMA) guidelines for systematic reviews and meta-analysis[13]. We conducted a comprehensive search on PubMed, Embase, Web of Science, and Cochrane, and the search until October 2021 on UBE research. The keywords were "UBE", "unilateral biportal endoscopy", "BESS", "biportal endoscopic spinal surgery", "two portal endoscopic spinal surgery", "LSS", and "lumbar spinal stenosis". The literature inclusion criteria included: literature related to UBE treatment of LSS, UBE treatment reports, such as VAS-leg, VAS-back, and the Oswestry Disability Index (ODI) score. The exclusion criteria were reviews and case reports, no available technology and research with insufficient statistical reporting, technical notes, non-English reports, and single-arm studies without control groups. The search strategy is illustrated in Figure 1.

Data Extraction

The basic information of the extracted literature included the author's name, publication year, research type, number of patients, patient age, follow-up time, and operated levels (Table I). The results data obtained included VAS-leg, VAS-back, ODI score, operation time, hospital stay, and incidence of complications and radiological outcomes. All the data were qualitatively summarized.

Quality Assessment

A modified NOS (Newcastle-Ottawa Scale) was used to evaluate the selected literature quality[14]. NOS includes three classification criteria; the highest score is 9 points. "Select" gets a maximum of 4 points, "Comparability" gets a maximum of 2 points, and "Result" gets a maximum of 3 points. Research with a score of 7-9 is high quality, 5-6 is medium quality, and 0-4 is poor quality. A summary of the quality assessment procedures is listed in Table I.

Statistical Analysis

All statistical analyses were performed using RevMan (Review Manager) version 5.4 software (The Nordic Cochrane Centre, Copenhagen, Denmark). All the outcome analyses were performed on an intention-to-treat basis. We used risk ratios and their associated 95% confidence intervals to assess outcomes and considered p-values of < 0.05 significant. We conducted heterogeneity using the I^2 test. When $I^2 < 50\%$, we used fixed effects models to pool outcome and random effects while $I^2 \geq 50\%$. Publication bias was assessed using contour funnel plots.

Results

Study Selection and Characteristics of Study

A preliminary literature search using the PRISMA template yielded 199 articles (see Figure 1 for details). Nine studies met the inclusion criteria. A total of 823 patients with an average age of 65.5 years were enrolled. Table I presents the characteristics of the included studies[18-26]. The main clinical results were evaluated by analyzing VAS-leg and -back pain and ODI scores. Two[18,19] of the included nine studies were first-level evidence, two[20,21] were second-level evidence, and five[22-26] were third-level evidence.

Meta-Analysis Outcomes

Nine studies compared the clinical outcomes of UBE and micro-endoscopic unilateral laminotomy for bilateral decompression (M-ULBD). Therefore, we made a meta-analysis of these nine studies.

Mean Outcomes

Three studies[21,22,26] reported the VAS-leg score in the first postoperative week, which included 218 patients. Figure 2 illustrates the key characteristics of the three studies; in the first week postoperatively, the UBE group had a significantly lower VAS-leg score than the M-ULBD group [total: mean difference (MD) = -0.96, 95% confidence interval (CI): -1.19, -0.74, $p < 0.00001$]. In the first

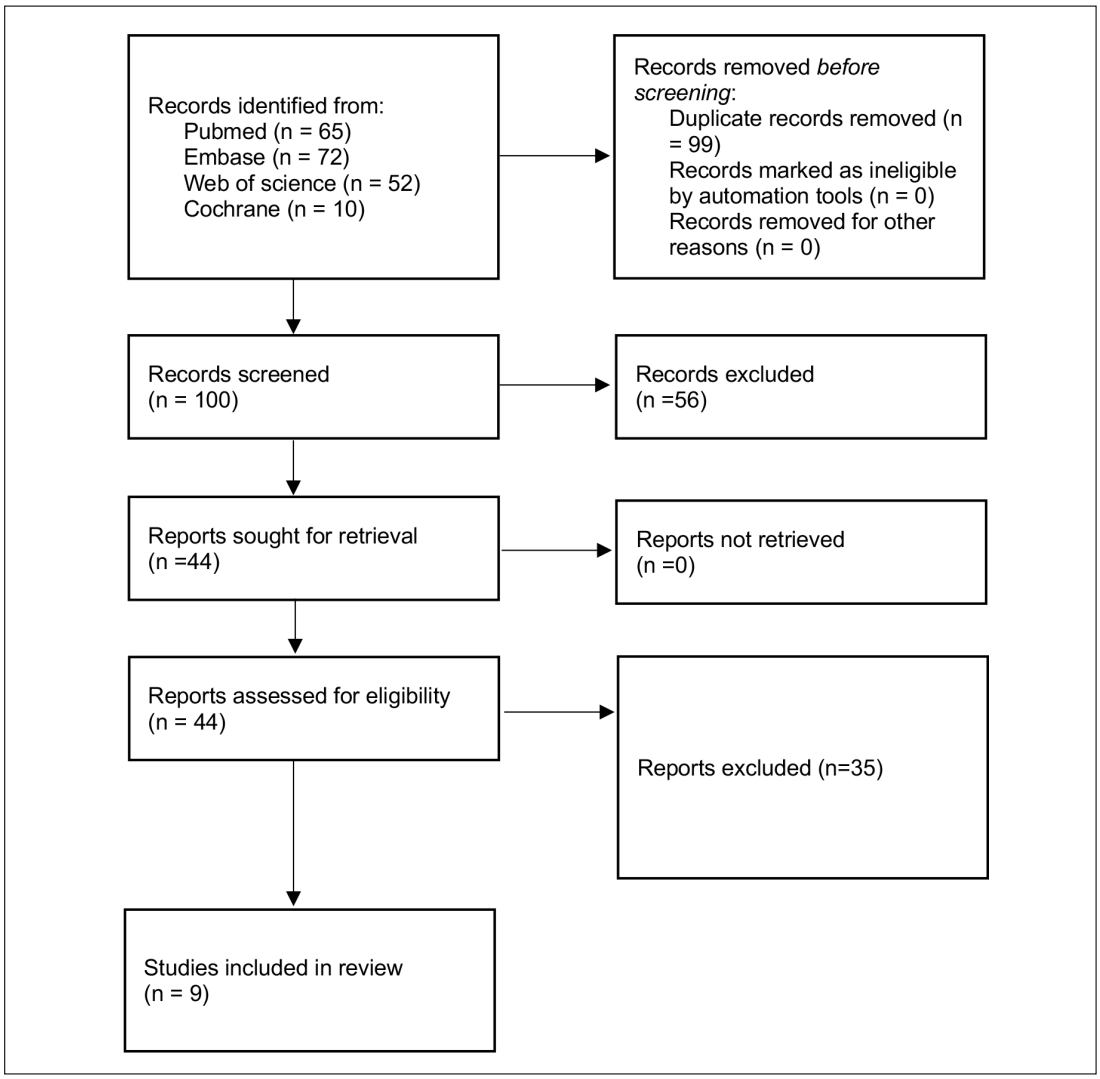

Figure 1. A flowchart of study selection.

postoperative month, two studies[22,25] comprising 125 patients were included in the meta-analysis. Figure 2 illustrates the key characteristics of both studies. In the first postoperative month, the UBE group had a significantly lower VAS-leg score than the M-ULBD group (total: MD = -0.35, 95% CI: -0.61, -0.08, p = 0.01). In three months postoperatively, three studies[18,22,23] comprising 213 cases were included in the meta-analysis, and no significant difference was observed between both groups (total: MD = -0.09, 95% CI: -0.33, 0.16, p = 0.49). In six postoperative months, three studies[18,24,25] comprising 310 cases were included in the meta-analysis, and the UBE group had a significantly lower VAS-leg score than the M-ULBD group (total: MD = -0.22, 95% CI: -0.35, -0.08, p = 0.002). In 12 months postoperatively, four studies[18,21,22,26] comprising 282 cases were included in the meta-analysis, and no significant difference was observed between both groups (total: MD = -0.02, 95% CI: -0.19, 0.14, p= 0.78).

In the first postoperative week, three studies[21,22,26] reported the VAS-back score, which included 218 patients. Figure 3 illustrates the key characteristics of the three studies. In the first postoperative week, the UBE group had a significantly lower VAS-back score than the M-ULBD group (total: MD = -1.69, 95% CI: -1.93, -1.45, p < 0.00001). In the first postoperative month, two studies[22,25], which included 125 patients, reported the VAS-back score. In the first postoperative month, the UBE group had a significantly lower VAS-back score than the M-ULBD group (total: MD = -0.40, 95% CI: -0.68, -0.12, p = 0.005). In

Table I. Characteristics of included studies.

No.	Author	Year	Country	Diagnose	Sample size (n)	Age mean	Design	Follow-up period (month)	Operated levels	Study quality
1	Aygun and Abdulshafi[20]	2021	Saudi Arabia	lumbar canal stenosis	144	64.83	Prospective study	24	NR	7
2	Kang et al[19]	2019	Korea	lumbar central stenosis	62	66.15	RCT	6	62	7
3	Heo et al[21]	2018	Korea	lumbar central stenosis	88	64.7	Prospective case control study	14	88	9
4	Park et al[18]	2020	Korea	lumbar central stenosis	64	66.65	RCT	12	64	9
5	Ito et al[24]	2021	Japan	lumbar canal stenosis	181	65.65	Retrospective study	6	181	8
6	Kim et al[22]	2020	Korea	lumbar central stenosis	60	65.22	Retrospective study	12	60	8
7	Min et al[23]	2020	Korea	lumbar central or canal stenosis	89	66.24	Retrospective study	2	88	7
8	Chio and Kim[25]	2019	Korea	Lumbar stenosis	65	65.3	Retrospective study	6	65	8
9	Heo et al[26]	2019	Korea	Lumbar stenosis	70	65.1	Retrospective study	12	70	8

NR: not reported, RCT: randomized controlled trial, NE: not evaluated.

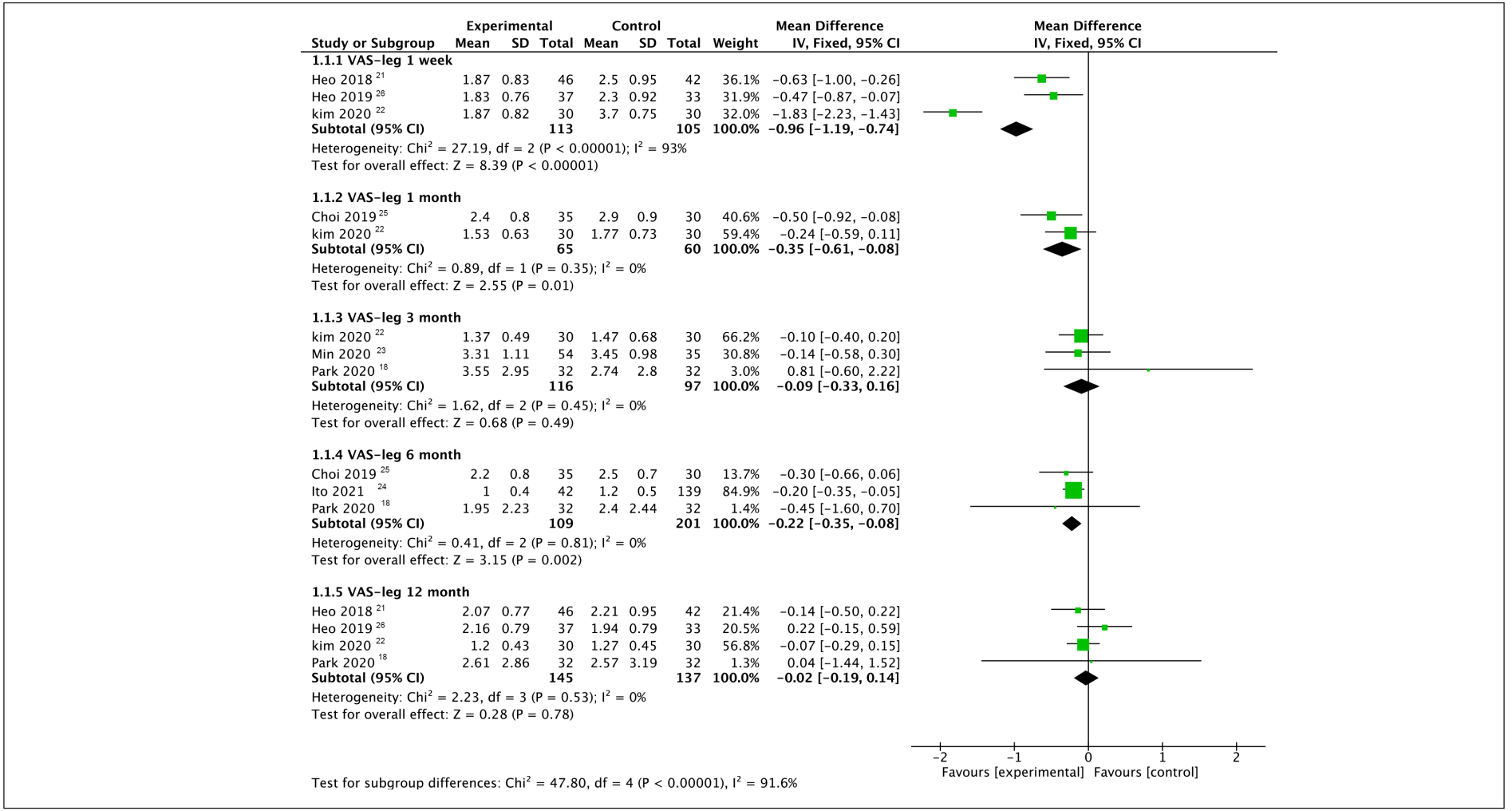

Figure 2. Forest plot of VAS-leg score for the UBE *vs.* M-ULBD.

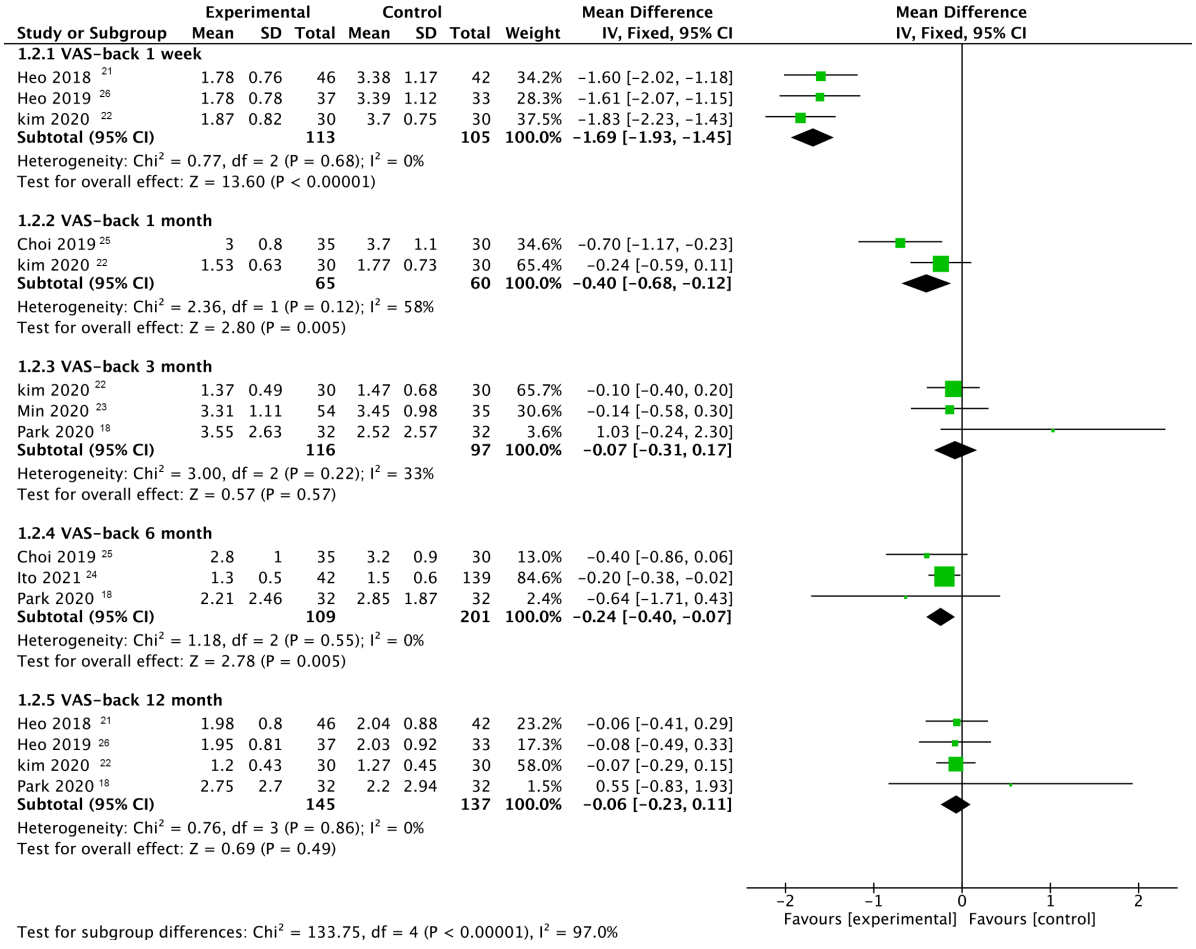

Figure 3. Forest plot of VAS-back score for the UBE *vs.* M-ULBD.

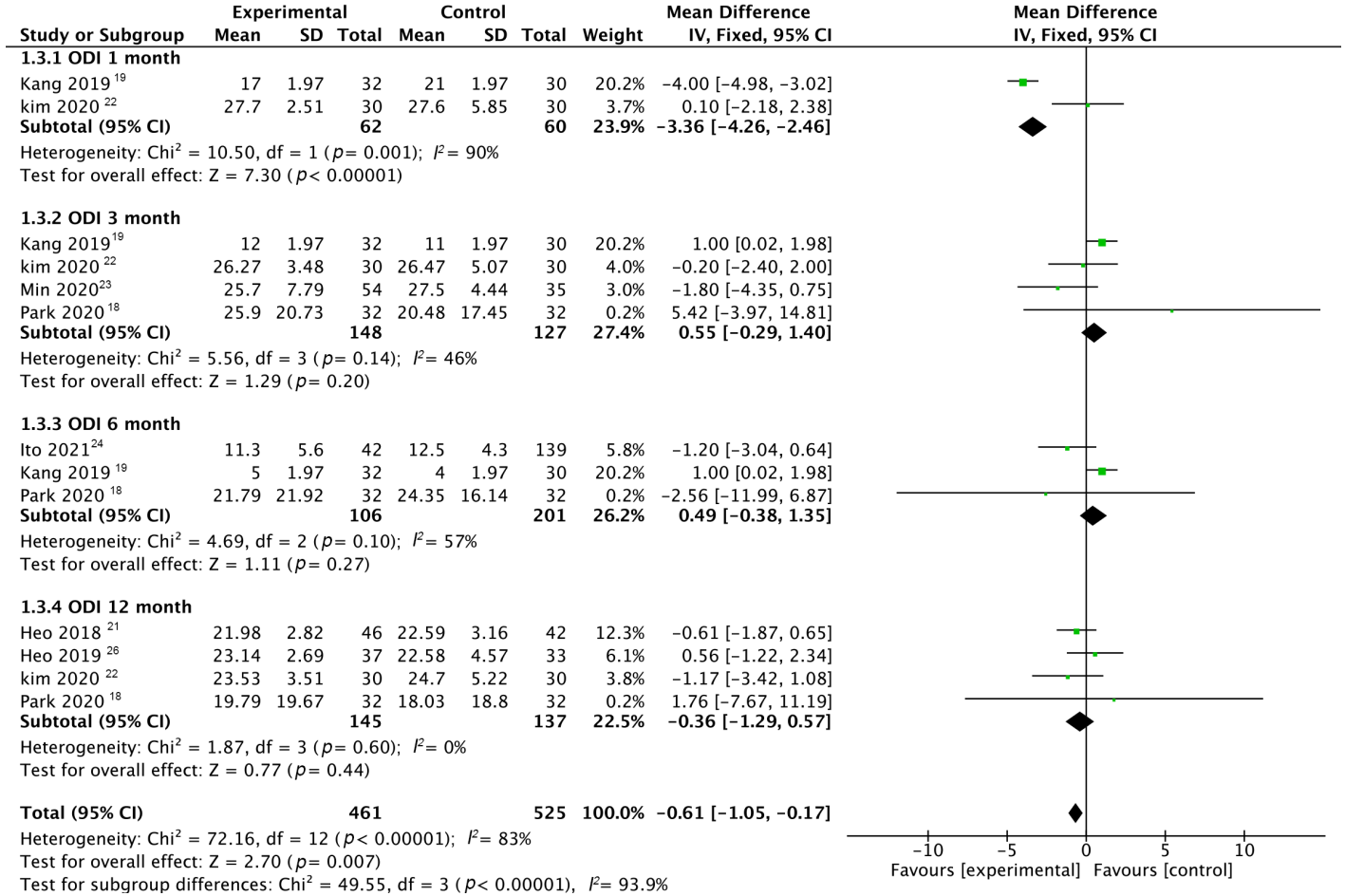

Figure 4. Forest plot of ODI score for the UBE *vs.* M-ULBD.

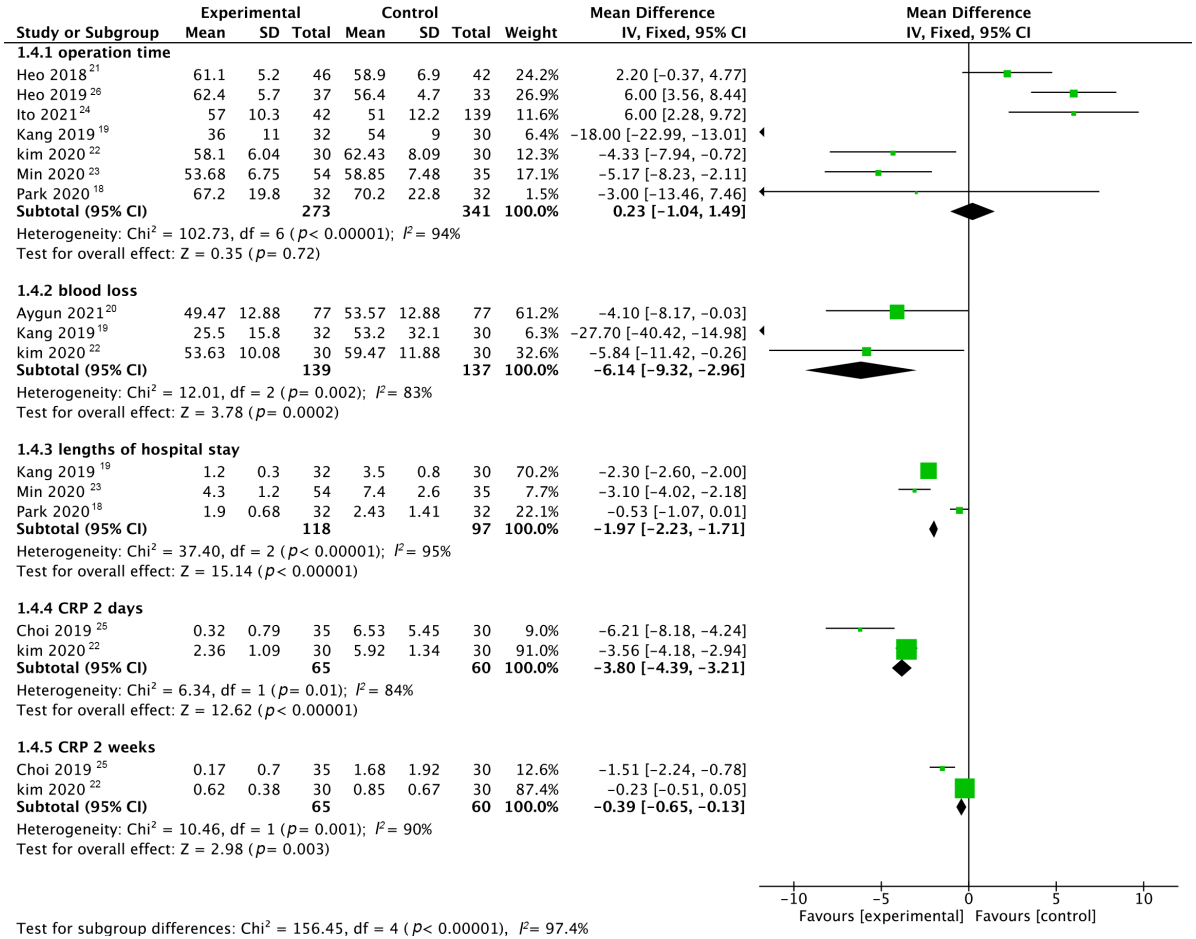

Figure 5. Forest plot of operation time, blood loss, lengths of hospital stay and CRP for the UBE *vs.* M-ULBD.

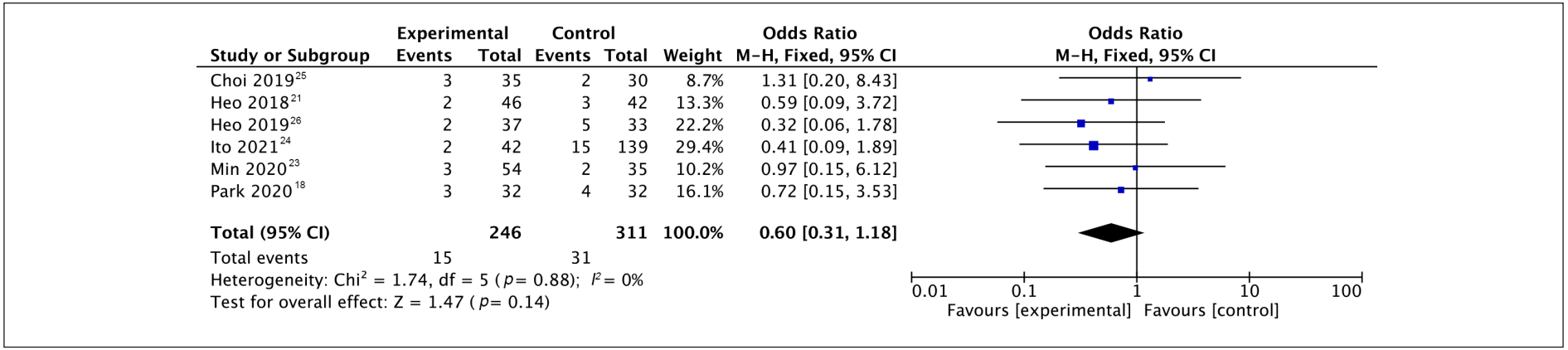

Figure 6. Forest plot of complications rate for the UBE *vs.* M-ULBD.

Table II. Radiological outcomes.

Author	Years	Surgery	IVA (°)	Dynamic IVA (°)	Slip (%)	Dynamic slip (%)	IVD (mm)
Kim and Cho[i27]	2018	UBE	Preop: 6.26 ± 3.54 Final follow: 5.58 ± 3.23 (p = 0.027)	Preop: 6.54 ± 3.71 Final follow: 6.76 ± 3.59 (p = 0.562)	Preop: 3.76 ± 5.01 Final follow: 3.81 ± 5.28 (p = 0.531)	Preop: 2.65 ± 3.37 Final follow: 2.76 ± 3.71 (p = 0.985)	Preop: 10.43 ± 2.23 Final follow: 10.0 ± 2.24 (p = 0.000)
Min et al[23]	2020	UBE *vs.* M-ULBD	NR	Preop: 6.68 ± 3.38 *vs.* 6.54 ± 2.28 Postop: 6.79 ± 4.00 *vs.* 6.72 ± 2.46	Preop: 3.24 ± 4.81 *vs.* 3.09 ± 3.46 Postop: 3.36 ± 5.02 *vs.* 3.27 ± 3.44	Preop: 2.12 ± 3.04 *vs.* 2.58 ± 2.44 Postop: 2.43 ± 3.51 *vs.* 2.95 ± 2.48	NR

IVA: intervertebral angle, IVD: intervertebral distance, NR: not reported.

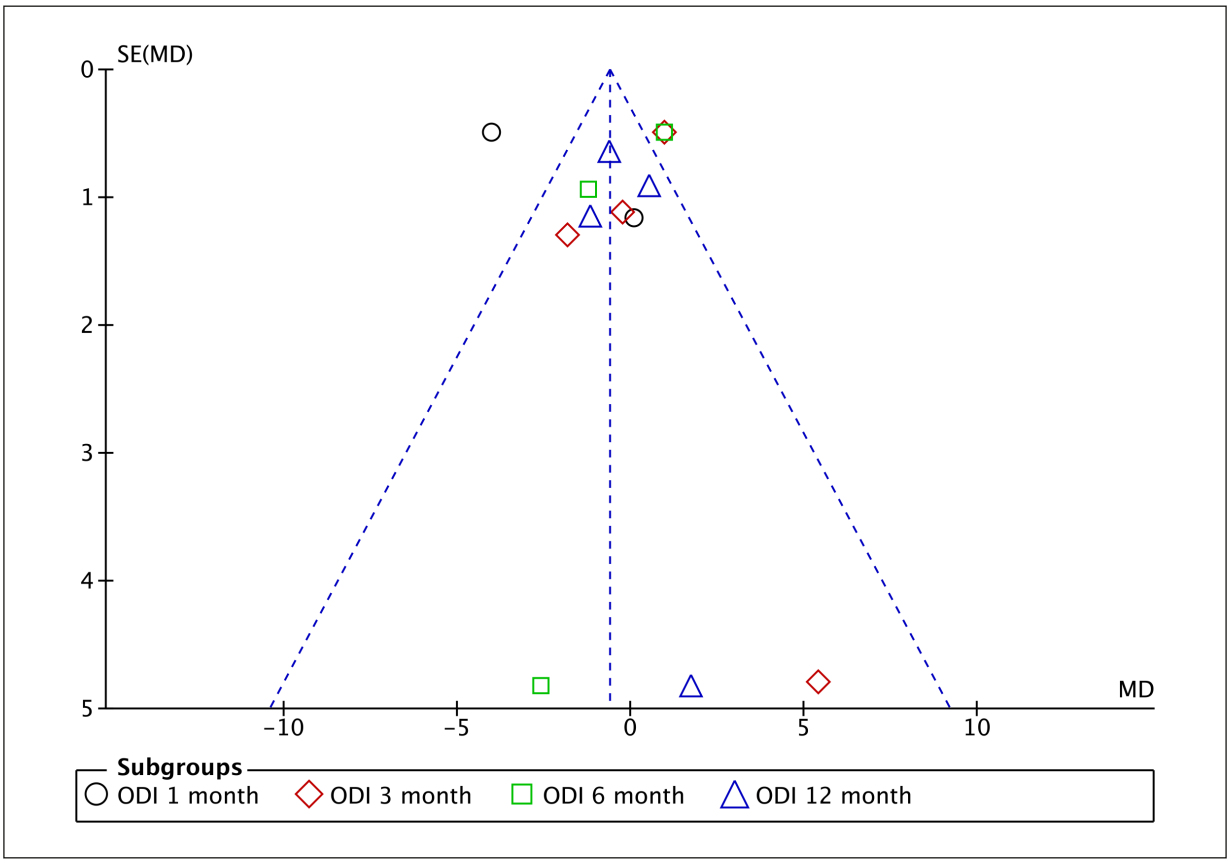

Figure 7. Funnel plots of ODI score.

three months postoperatively, three studies[18,22,23] comprising 213 cases were included in the meta-analysis, and no significant difference was observed between both groups (total: MD = -0.07, 95% CI: -0.31, 0.17, p = 0.57). In the six postoperative weeks, three studies[18,24,25] comprising 310 cases were included in the meta-analysis, and the UBE group had a significantly lower VAS-back score than the M-ULBD group (total: MD = -0.24, 95% CI: -0.40, -0.07, p = 0.005). In 12 months postoperatively, four studies[18,21,22,26] comprising 282 cases were included in the meta-analysis, and no significant difference between both groups (total: MD = -0.06, 95% CI: -0.23, 0.11, p = 0.49).

Furthermore, two studies[19,22] reported ODI scores in the first postoperative month. Figure 4 illustrates the key characteristics of both studies. In the first postoperative month, the UBE group had a significantly lower ODI score than the MI group (total: MD = -3.36, 95% CI: -4.26, -2.46, p < 0.00001). Of the nine included studies, four[18,19,22,23], three[18,19,24], and four[18,21,22,26] reported outcome data for participants at 3, 6, and 12 months postoperatively, respectively. No significant associations were observed among the study characteristics (all p > 0.05).

Secondary Outcomes

Seven studies[18,19,21-24,26] reported operation time with the comparison of UBE and M-ULBD. Figure 5 presents the key characteristics of the seven studies, and no significant difference was observed between both groups (total: MD = 0.23, 95% CI: -1.04, 1.49, p = 0.72).

Additionally, three studies[18-20] reported blood loss comparing UBE and M-ULBD. Figure 5 presents the key characteristics of the three studies, and less blood loss was observed in the UBE group (total: MD = -6.14 95% CI: -9.32, -2.96, p= 0.0002).

Three studies[18,19,23] reported lengths of hospital stay with the comparison of UBE and M-ULBD. Figure 5 presents the key characteristics of three studies, and shorter hospital stay was observed in the UBE group (total: MD = -1.97, 95% CI: -2.23, -1.71, p < 0.00001).

In two days postoperatively, two studies[22,25] reported C-reactive protein (CRP). Figure 5 il-

lustrates the key characteristics of both studies. In two days postoperatively, the UBE group had a significantly lower CRP than the M-ULBD group (total: MD = -3.80, 95% CI: -4.39, -3.21, $p < 0.00001$). In two weeks postoperatively, two studies[22,25] reported CRP. Figure 6 presents the key characteristics of both studies and in 2 weeks postoperatively, the UBE group had a significantly lower CRP than the M-ULBD group (total: MD = -0.39, 95% CI: -0.65, -0.13, $p = 0.003$).

Six studies[18,21,23-26] reported complications with the comparison of UBE and M-ULBD. Figure 6 presents the key characteristics of the six studies, and no significant associations were observed among the study characteristics (total: MD = 0.60, 95% CI: 0.31, 1.18, $p = 0.14$).

Only two studies[23,27] reported the radiological UBE outcomes; one reported no significant differences in pre- and post-operative dynamic intervertebral angle (IVA), percentage of slip, and dynamic percentage of slip. However, the intervertebral angle and intervertebral distance reduced significantly at the last follow-up. The other compared the radiological outcomes between UBE and M-ULBD, and they observed no significant differences in dynamic IVA, slip, and dynamic slip in both groups (Table II).

Publication Bias

The funnel plots in Figure 7 illustrate the publication bias test for the ODI scores. The funnel plots are generally symmetrical; nevertheless, since most of the literature was published by Korean scholars, there may be a publication bias.

Discussion

LSS is the most common reason for spinal surgery admission in the elderly (over 65 years)[15]. UBE is an emerging minimally invasive spinal procedure used to treat LSS[13]. Furthermore, all the reports in this meta-analysis reported that UBE produces good clinical LSS results. Nine studies reported the VAS-leg, VAS-back, and ODI scores of the UBE and M-ULBD groups, and these scores decreased than the preoperative scores at the final follow-up. The meta-analysis revealed that the UBE group had better pain control in the early postoperative period. However, no significant difference was observed at the final follow-up.

The UBE performed better in VAS-back and -leg during the first week, first month and sixth month postoperatively, and 12 months postoperatively, and no significant associations were observed between both groups. The UBE group had better ODI scores in the first month postoperatively and 12 months postoperatively, and no significant associations were observed between both groups. The UBE group had shorter lengths of hospital duration and lesser blood loss volumes. Additionally, no significant difference was observed in the complications rate of both groups. The UBE group had lower CRP in two days and two weeks postoperatively.

Chronic intermittent claudication is the main symptom of lumbar spinal stenosis. However, of the nine included studies, three[19,21,26] mentioned intermittent claudication in their inclusion criteria, and one[16] reported the comparison of pre- and post-operative walking distances. This means that studies are needed to report improvements in walking distance.

The UBE technique is under continuous saline irrigation, providing a clear visual field and controlling epidural and bone bleeding and infection[16]. However, excessive pressure may lead to epidural fat and blood vessel damage. Choi et al[17] reported that 30 mmHg maintains a clear surgical view and prevents damage. Due to continuous saline irrigation, hidden intraoperative blood loss is usually overlooked, and research is needed concerning this issue.

Two[18,19] of the nine studies were first-level evidence, another two[20,21] were second-level evidence, and five[22-26] were third-level evidence. We discussed according to evidence-based medical grading.

There were only two first-level evidence studies[18,19], both RCT. Park et al[18] reported that 64 patients were diagnosed with first-level LSS and required decompressive laminectomy. They compared the clinical outcomes of UBE and M-ULBD. The operation time was 67.2 ± 19.8 min in the UBE group and 70.2 ± 22.8 min in the M-ULBD group, and the length of hospital stay was 45.6 ± 16.2 h in the UBE group and 58.4 ± 33.9 h in the M-ULBD group. Additionally, seven complications were reported, and three cases were caused by UBE, which included two incidental durotomies and a symptomatic hematoma with revision surgery. Four complication cases were caused by M-ULBD, which included two incidental durotomies, two symptomatic hematomas with revision surgery, and a revision surgery due to recurrent pain. After 12 months of follow-up. Furthermore, no significant difference was observed between groups in ODI, VAS, EQ-5D , and ainDETECT for neuropathic pain scores at the 3-, 6-, or

12-month follow-up. This meant that biportal endoscopic decompressive laminectomy was an alternative to and offered similar clinical outcomes as M-ULBD in patients with symptomatic LSS. Kang et al[19] designed a prospective randomized comparative study that involved 70 patients diagnosed with central spinal stenosis who were randomized into two groups (the biportal technique/endoscopic and microscopic surgery groups). Clinical outcomes were measured using ODI and VAS-back scores. After six months of follow-up, no significant difference was observed in ODI and VAS-back scores. However, the operation time was 36 ± 11 min in the UBE group and 54 ± 9 min in the M-ULBD group per level, the blood loss was 25.5 ± 15.8 mL in the UBE group and 53.2 ± 32.1 mL in the M-ULBD group, the opioid usage was 2.3 ± 0.6 T in the UBE group and 6.5 ± 2.5 T in the M-ULBD group, and length of hospital stay was 1.2 ± 0.3 days in the UBE group and 3.5 ± 0.8 days in the M-ULBD group. Both groups had no failures or postoperative infection cases, and each had a revision operation case due to postoperative hematoma. This meant that the UBE group experienced less pain and had a shorter hospital stay than the M-ULBD group; therefore, UBE could be an alternative treatment for LSS. Based on the above studies, UBE achieved initial clinical results and could become an alternative for LSS. However, more RCTs with larger sample sizes and prolonged follow-up are required to further prove its effectiveness in LSS.

Two studies[20,21] were second-level evidence. Aygun and Abdulshafi[20] enrolled 144 patients and randomized them into UBE and M-ULBD surgery groups. The ODI, Zurich Claudication Questionnaire (ZCQ), Modified Macnab Criteria (MMC), length of hospital stay, operation time, and estimated blood loss of both groups were compared and followed up for at least 24 months. The ODI (84% *vs.* 79%) and ZCQ (79% *vs.* 73%) were significantly superior in UBE cases at al[1] periods, and UBE and TME had 63% and 29% excellent results, respectively, in MMC. UBE also had a shorter admission period (days: 1.11 *vs.* 1.28), shorter operation time (minutes: 57.74 *vs.* 65.31), and lesser blood loss (mL: 49.47 *vs.* 53.57). This meant that UBE could be an effective alternative for LSS with a higher clinical success rate. This study revealed that UBE had better clinical results because it could provide clearer surgical visualization. Heo et al[21] compared a 12-month clinical outcome of UBE to that of M-ULBD in managing the single-level lumbar central stenosis, and 42 patients were assigned to the M-ULBD group and 46 patients to the UBE group. The VAS-back score was significantly greater in the UBE group on postoperative day one. However, no significant differences were observed in the VAS-back and -leg and ODI scores at the final follow-up between both groups. The operation times were 61.1 ± 5.2 min in the UBE group and 58.9 ± 6.9 min in the M-ULBD group. The complication rate of UBE was 4.3% (2/46), with one case of durotomy and the other of postoperative hematoma. On the other hand, it was 7.1% (3/42) in the M-ULBD group, with one case of durotomy and two cases of postoperative hematoma. This study concluded that UBE could achieve clinical outcomes like M-ULBD; hence, this technique may be safe and effective for lumbar degenerative spinal stenosis treatment.

Five research[22-26] were third-level evidence. Kim et al[22] designed a retrospective study that included 60 patients diagnosed with lumbar central canal stenosis. The follow-up was a year, the operation time was 58.10 ± 6.04 min in the UBE group and 62.43 ± 8.09 min in the M-ULBD group, the mean blood loss was 53.63 ± 10.08 mL in the UBE and 59.47 ± 11.88 mL in the M-ULBD group, serum creatine kinase, and CRP were lower in the UBE group than in the M-ULBD group on the first postoperative day (CK: 130.87 ± 51.49 *vs.* 331.40 ± 118.09; CRP: 2.36 ± 1.09 *vs.* 5.92 ± 1.34); however, serum CRP did not significantly differ between both groups at the sixth postoperative day (0.62 ± 0.38 *vs.* 0.85 ± 0.67). The UBE group performed better in the mean VAS, ODI, and modified MacNab scores and horizontal displacement degree. Four complication cases were reported in this study; two were cerebrospinal fluid leaks, one was a surgical site infection in the M-ULBD group, and one was a cerebrospinal fluid leak in the UBE group. Min et al[23] compared the clinical and radiologic outcomes of UBE and M-ULBD. The study included 89 patients, and follow-up was ≥ 24 months. The UBE group had shorter operation time (53.6 ± 6.7 min *vs.* 58.9 ± 7.4 min) and shorter hospital stay (4.3 ± 1.2 days *vs.* 7.4 ± 2.6 days) than the M-ULBD group. The VAS and ODI scores of both groups improved significantly in the final follow-up, and there was no significant difference in the VAS and ODI scores of both groups except VAS-back in the second postoperative month, in which the UBE group was better than the M-UBLD group. Moreover, there was no significant difference in the frequency of complications between both groups. Three

complication cases were reported in the UBE group and two in the M-ULBD group. There was no significant difference in the complication rate between both groups. In the UBE group, two cases of dural tear and one case of postoperative epidural hematoma requiring surgery occurred. A case of dural tear and a postoperative epidural hematoma occurred in the M-ULBD group. The radiological results were reported in this study, and no significant difference was observed in the radiological findings (dynamic intervertebral angle, slip percentage, and dynamic slip percentage) of both groups. Therefore, UBE was considered an alternative to M-ULBD in degenerative lumbar spinal stenosis. Ito et al[24] reported the clinical comparison between UBE and M-UBLD. The study enrolled 181 patients diagnosed with lumber canal stenosis and followed up for six months. The bone resection area and facet preservation rate were reported in this study, and the bone resection area was 1.0 ± 0.2 cm^2 in the UBE group and 1.5 ± 0.3 cm^2 in the M-UBLD group. The facet preservation rate was 78% ± 6% on the advancing side and 85% ± 4% on the opposite side in the UBE group and 86% ± 6% (advancing side) and 94% ± 3% (opposite side) in the M-ULBD group. No significant difference was observed in the lumbago VAS score, VAS-leg pain, and ODI scores between both groups. Additionally, no significant difference was observed in the complications between both groups. UBE had no hematoma paralysis case and two cases of dura injury. In contrast, five cases of hematoma paralysis, eight cases of dura injury, and two cases of reoperation were observed using M-ULBD. Choi and Kim[25] reported the clinical benefits of UBE for spinal stenosis in comparison to M-ULBD. After six months of follow-up, the VAS-back score improved from 6.8 to 2.8 and 6.8 to 3.2 for the UBE and M-ULBD groups, respectively; the VAS-leg pain improved from 6.3 to 2.2 and 7.0 to 2.5 for the UBE and M-ULBD groups, respectively. CRP changed from 0.19 to 0.32 and 0.26 to 6.53 in the UBE and M-ULBD groups, respectively, in two days postoperatively; one week postoperatively, it came to 0.17 and 1.68 for the UBE and M-ULBD groups, respectively; and two weeks postoperatively, it became 0.41 and 0.82 for the UBE and M-ULBD groups, respectively. Regarding complications, UBE resulted in three cases, including two dural tears and one root injury, whereas in the M-ULBD group, it caused two cases of dural tears. Heo et al[26] reported the clinical outcomes of the UBE and M-ULBD groups. The VAS-back pain score improved from 7.02 to 1.78 and 6.64 to 3.39 on the first postoperative day in the UBE and M-ULBD groups, respectively; it became 1.95 and 2.03 at the final follow-up; the VAS-leg pain score improved from 8.05 to 1.83 and 7.67 to 2.30 on the first postoperative day in the UBE and M-ULBD groups, respectively; it became 2.16 and 2.16 in the UBE and M-ULBD groups, respectively, at final the follow-up; and the ODI score changed from 58.68 to 23.14 and 56.36 to 22.58 in the UBE and M-ULBD groups, respectively at the final follow-up.

There were four studies[16,27-29] without control groups that only reported the clinical outcomes of the UBE group. Nonetheless, the same outcomes were reported in these studies. Torudom and Dilokhuttakarn[16] reported LSS treated *via* UBE in 2016. The study included 30 patients, and follow-up lasted at least two years. The mean VAS-back pain, VAS-leg pain, and ODI scores dropped significantly at every time point compared to the preoperative scores. Additionally, the postoperative walking distance was significantly prolonged than the preoperative. Preoperatively, 90% (n = 27) could walk painlessly for < 400 m and 10% (n = 3) for > 400 m but < 1,200 m. Nonetheless, at the final review, one patient (3.3%) could walk < 400 m, five (16.7%) could walk > 400 m, but less than 1,200 m, and 23 (76.7%) could walk > 1,200 m. However, the walking distance was related to complications (6.6%) in two patients. The conclusion was that the UBE had initial benefits; nonetheless, long-term studies are required to prove its safety and effectiveness. Kim et al[27] reported the clinical and radiological outcomes of UBE decompression. The study enrolled 55 patients and the mean follow-up period was 29 months. The VAS-leg pain improved from 7.7 ± 1.5 preoperatively to 1.7 ± 1.5 ($p < 0.01$) at the 2-year follow-up, and the ODI score improved from 67.4 ± 11.5 to 19.3 ± 12.1 ($p < 0.01$) at the 2-year follow-up. Regarding the radiological results in this study, the IVA increased from 6.24° ± 4.27° to 6.96° ± 3.58° in one year postoperatively, while the dynamic IVA decreased from 6.27° ± 3.12° to 6.04° ± 2.41°; the preoperative slip percentage was 3.41% ± 5.24% and increased to 6.01% ± 1.43% at the 1-year follow-up; the preoperative dynamic slip percentage was 2.90% ± 3.37% and increased to 3.13% ± 4.11% in one year postoperatively. Czigleczki et al[28] reported initial clinical results using UBE for LSS, and the study included 21 patients. All the patients achieved satisfactory results after surgery. In the early postoperative period, 17 patients (81%) presented with discomfort, 3 (14%)

reported mild pain relieved using analgesics, and 1 (5%) had postoperative discomfort. However, all the patients presented mild symptoms at the last follow-up. Song et al[29] reported two cases of lumbar stenosis treated using biportal endoscopic spinal surgery and observed that UBE is a lumbar stenosis treatment option.

Limitations

There were several limitations in our review. First, most studies were low-quality retrospective studies and lacked high-quality randomized controlled trials for reference, adding bias to the study results. Second, the search was limited to English reports, which may have resulted in relevant literature not being included. Third, the study's sample size was small and lacked multicenter studies with large sample sizes. Fourth, the studies included had different final follow-up periods, which may have impacted the results.

Conclusions

The present study indicates that UBE results in a shorter hospital stay and lesser blood loss; however, operation time, complication rate, and clinical outcome followed up for 12 months, and no significant difference was observed in both groups. Therefore, UBE may be an alternative treatment for patients with LSS.

Conflict of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Authors' Contributions

Each author made substantial contributions to this work. HXZ and QF contributed to the acquisition of study data. HXZ contributed to the analysis and interpretation of data. QF contributed to the conception and design of the work. All authors have drafted the work or substantively revised it. All authors contributed to the article and approved the submitted version

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Availability of Data and Materials

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