Systematic Review and Meta-Analysis

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Efficacy and safety of unilateral biportal endoscopy compared with microscopic decompression in the treatment of lumbar spinal stenosis

A protocol for systematic review and meta-analysis

Chuntao Li[a], Fei Ju[a], Wenyi Li[b,*], Shangju Gao[b], Can Cao[b], Changren Li[a], Liang He[a], Xu Ma[a], Meng Li[c]

Abstract

Objective: Systematic evaluation of the efficacy and safety of unilateral biportal endoscopic decompression in the treatment of lumbar spinal stenosis.

Methods: We conducted a systematic literature search and compared the randomized controlled trials (RCTs) and retrospective studies of unilateral biportal endoscopy (UBE) and microscopic decompression (MD) in the treatment of lumbar spinal stenosis from several databases.

Results: Seven studies were included. The results of meta-analysis showed that the operation time of UBE was shorter than that of MD. [SMD = −0.443, 95% CI (−0.717, −0.169), *P* = .002]. Compared with MD, the patients' back pain was slighter on the 1st day, 1–2 months and 6 months after UBE. During the long-term follow-up, there was no significant difference in back pain between MD and UBE [SMD = −0.519, 95% CI (−0.934, −0.104), *P* = .014]. There was no significant difference in lower limb visual analogue score (VAS) score between UBE decompression and MD [SMD = −0.105, 95% CI (−0.356, 0.146), *P* = .412]. The results of meta-analysis showed that the C-reactive protein (CRP) level of UBE was lower than that of MD [weighted mean difference = −1.437, 95% CI (−2.347, −0.527), *P* = .002]. There was no significant difference in other clinical effects between the 2 groups.

Conclusion: The operation time of UBE was shorter than that of MD, and it was superior to micro decompression in early back VAS score, lower limb VAS score and early postoperative CRP level. There was no statistical difference between UBE and MD in other outcomes.

Abbreviations: BESS = biportal endoscopic spinal surgery, CRP = C-reactive protein, MD = microscopic decompression, RCT = randomized controlled trial, UBE = unilateral biportal endoscopy, VAS = visual analogue score.

Keywords: biportal endoscopic spinal surgery, meta-analysis, microscopic decompression, unilateral biportal endoscopy

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All data generated or analyzed during this study are included in this published article [and its supplementary information files].

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1. Strengths and limitations

Our research has many advantages. First of all, compared with other authors' studies, the number of documents we have included is currently the most comprehensive. Secondly, in the course of our research, we conducted more comparisons of results, including the long-term efficacy of this new technology, which was not achieved in previous studies by other people. Of course, we also have some shortcomings. After a comprehensive search and screening, the number of randomized controlled trials (RCTs) is relatively small. Although we include all of them, this will cause a certain bias in this analysis. We hope to include higher quality RCT articles in the future to eliminate bias. Secondly, this technology is currently the most widely used in South Korea, and most of the published literature is Korean, so it may cause a certain regional bias.

2. Introduction

Lumbar spinal canal stenosis (LSS) is a common spinal degenerative disease in the middle-aged and elderly. The main manifestation is that the waist and legs are sore and painful when walking or standing for a period of time, and they need to rest before they can continue to move. With the progress of the disease, the walking distance is gradually shortened, while the rest time is gradually prolonged. At present, the traditional treatment of lumbar spinal stenosis, such as total laminectomy decompression, semi-laminectomy decompression, all cause some damage to the lamina, and affect the stability of the spine. In addition, intraoperative muscle separation and traction often lead to postoperative low back pain and other complications. In order to reduce the damage to the normal structure of the spine, the attention of spinal surgeons has gradually shifted to minimally invasive surgery. With the continuous innovation of technology, there are microscopic decompression (MD) of spinal canal, percutaneous endoscopic technique, interbody fusion, and other treatment of LSS, all of which have achieved satisfactory results in clinical practice. In the treatment of lumbar spinal stenosis, the traditional laminectomy and decompression surgery will extensively peel off the muscles and destroy the stability of the spine. Patients may have chronic low back pain and secondary instability of the spine after the operation.[1,2] In 2002, Guiot et al[3] proposed a bilateral decompression technique assisted by micro endoscope, which reduces the damage to paraspinal muscles and spinal structure by expanding the paraspinal muscles of the cannula step by step. However, some scholars have pointed out that when the microscope is decompressed on the opposite side, it is necessary to tilt the microscope.[4,5] It may cause spinous process fracture and so on. In addition, the learning curve of decompression under microscope is steep.[6] Another widely used technique is percutaneous endoscopic transforaminal discectomy. Compared with MD, the instrument operation of this technique is difficult, the learning curve is steep, and it is difficult to deal with the upward or downward separation of intervertebral disc tissue, and the postoperative recurrence rate is higher than that of MD.[7–9] The development of the new technique of unilateral biportal endoscopy (UBE) has solved the problems of narrow channel and limited instruments during single-hole endoscopy and microsurgical decompression. UBE uses water as a medium like a single-channel endoscope, and continuous water irrigation can ensure the clarity of the surgical field. In addition, its visibility is similar to that of a microscope, which can reduce the damage to muscles and other tissues.[10]

The purpose of this study is to systematically evaluate the outcomes of UBE decompression under contrast microscope in the treatment of LSS, in order to provide reference for clinical work.

3. Materials and methods

3.1. Data sources and searches

Randomized controlled trials and cohort studies were systematically retrieved from the CNKI, WANFANG, PubMed, EMBASE, Cochrane Library database. The retrieval languages were limited to English and Chinese, and the retrieval time range was from the establishment of the database to October 2020. The keywords searched include: "unilateral biportal endoscopy;" "UBE;" "two portal endoscopic spinal surgery"; "biportal endoscopic;" "Irrigation endoscopic discectomy". The retrieval strategy of literature is as follows: ("UBE"[All Fields] OR ("biportal"[All Fields] AND ("endoscope s"[All Fields] OR "endoscoped"[All Fields] OR "endoscopes"[MeSH Terms] OR "endoscopes"[All Fields] OR "endoscope"[All Fields] OR "endoscopical"[All Fields] OR "endoscopically"[All Fields] OR "endoscopy"[MeSH Terms] OR "endoscopy"[All Fields] OR "endoscopic"[All Fields]))) AND ("monde dent"[Journal] OR "md"[Journal] OR "md chic"[Journal] OR "md"[All Fields] OR (("microscop"[All Fields] OR "microscopal"[All Fields] OR "microscope"[All Fields] OR "microscope s"[All Fields] OR "microscopes"[All Fields] OR "microscopic"[All Fields] OR "microscopical"[All Fields] OR "microscopically"[All Fields] OR "microscopics"[All Fields]) AND ("decompress"[All Fields] OR "decompressed"[All Fields] OR "decompresses"[All Fields] OR "decompressing"[All Fields] OR "decompression"[MeSH Terms] OR "decompression"[All Fields] OR "decompressions"[All Fields] OR "decompressive"[All Fields]))).

3.2. Inclusion criteria

Randomized controlled trials and cohort studies comparing UBE with MD therapy; at least one of the following results was compared: hospital stay; operation time; back visual analogue score (VAS); lower limb VAS score; Oswestry Disability Index (ODI) score; incidence of complications; revision rates; cross sectional area of thecal sac; postoperative C-reactive protein level.

3.3. Exclusion criteria

The main exclusion criteria of literature are as follows: repeat publication, unable to get full text, the result report is incomplete, case report, one-arm study, cadaver study, etc.

3.4. Data extraction and quality assessment

The following date were extracted from each study: author, year of publication, country, study design, number of UBE and MD groups, age, follow-up time, etc. The literature quality of the cohort study was evaluated with the Newcastle–Ottawa Scale (NOS). The total NOS score is 9, and studies with a score greater than 7 are considered to be of high quality. The quality of the included RCTs was assessed according to the tools used by Cochrane Collaboration to assess the risk of bias. The evaluation includes 7 items: random sequence generation, allocation concealment, blinding of participants, blinding of outcome assessment, incomplete outcome date, selective reporting, and other bias. Each project is evaluated with "high," "Low," and "unclear". If there are differences, they will be resolved through group discussion.

3.5. Statistical analysis

Meta-analysis was performed with Stata 13.0 software. The continuous outcomes are presented as weighted mean difference and 95% confidence interval (CI), and odds ratio (OR) and 95% CIs are presented for counting outcomes. Chi-Squared test and I^2 were used to evaluate the heterogeneity. When $P > .1$ and $I^2 \leq 50\%$, the heterogeneity was small, and the fixed effect model was selected. If $P < .1$ and $I^2 > 50\%$ indicate greater heterogeneity, the subgroup analysis is carried out according to different conditions, and the random effect model is selected. We examined the publication biases by Egger linear regression test.

3.6. Ethics approval statement

This study does not need to be approved by moral and ethical clerks.

4. Results

4.1. Search results

A total of 171 articles were retrieved in each database. After removing repetition and screening, the articles that did not conform to the inclusion criteria were removed, and the final number of articles included was 7 (Fig. 1).

4.2. Study characteristics and quality assessment

The characteristics of the inclusion trial are shown in Table 1. There were 288 patients in UBE group and 234 patients in MD group. All the studies were from South Korea. The quality evaluation of the cohort study is shown in Table 1, and the RCTs is shown in Table 2.

4.3. Results of meta-analysis

4.3.1. Hospital stays. Among the 7 studies included, 3 studies[4,11,12] reported the results of hospital stay, and the results showed that there was a large heterogeneity among the studies ($I^2=96.7\%$). Therefore, the random effect model is selected. The meta-analysis results demonstrated that there was no significant difference in hospital stay between UBE and MD [SMD = −1.436, 95%CI (−3.184–0.311), $P=.107$] (Fig. 2).

4.3.2. Operation time. Six articles[4,11–15] reported the results of operation time, and the results showed that there was a large heterogeneity among the studies ($I^2=94.3\%$) (Fig. 3). After sensitivity analysis, it was found that it was the heterogeneity produced by Heo2019,[15] Heo2018,[14] and kang2019.[11] By reading the full text of the article, we found that there is not only 1 surgical surgeon in these 3 articles, which may be the cause of

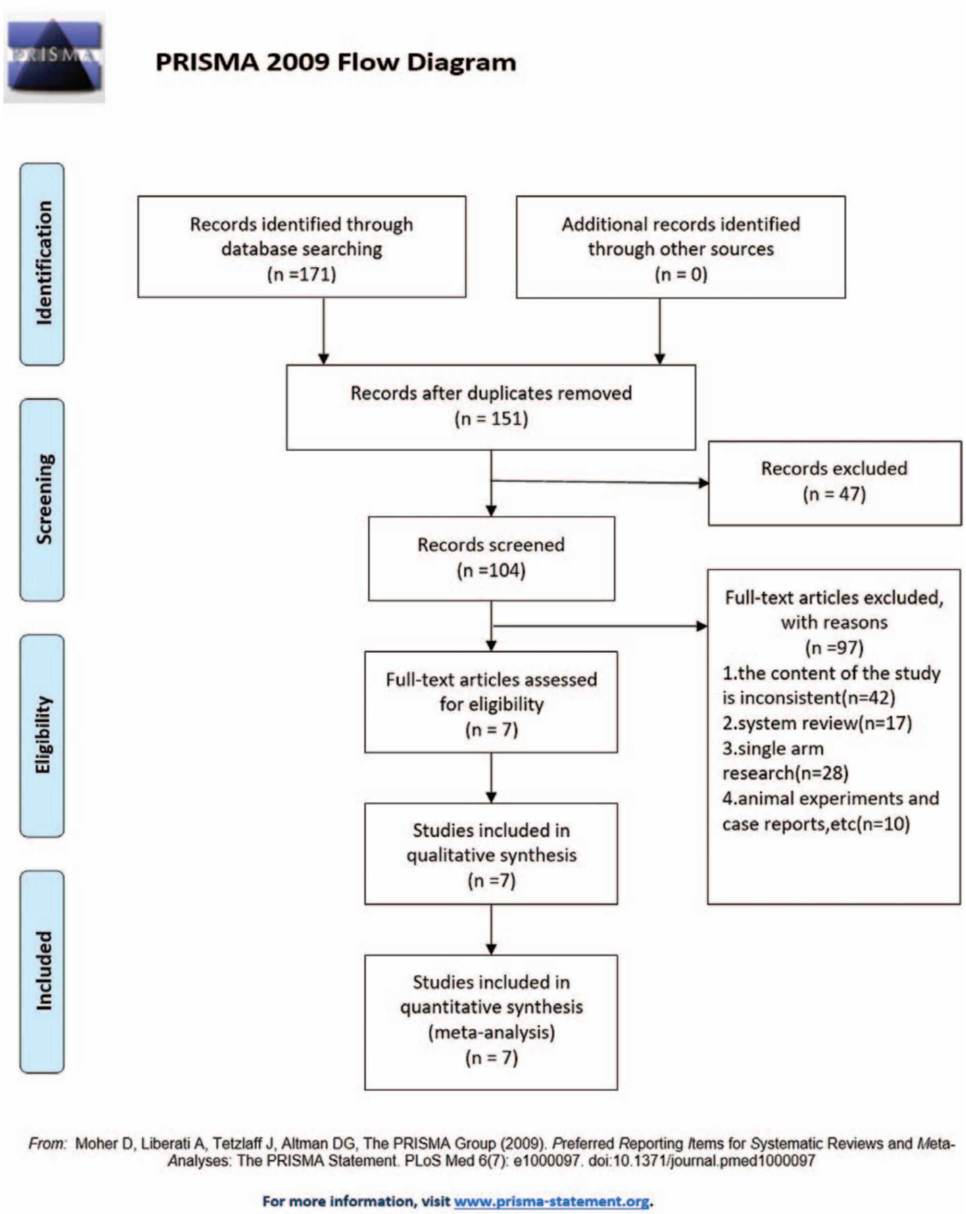

Figure 1. The flow chart of the literature screening process.

Table 1

Baseline characteristics of included stdies.

Author	Year	Country	Study design	Treated level	Follow-up time	Age	Number of patients	Outcomes	NOS score
Dong Hwa Heo	2019	Korea	RCS	Single level (L4-L5)	12	66.7±9.4/63.4±11.1	ULBD37/MD33	②③④⑤⑥⑧	8
Dae-Jung Choi	2019	Korea	RCS	Single level (L1-L4)	6	65.4±11.8/65.21±2.0	ULBD35/MD30	③④⑥⑨	7
Dong Hwa Heo	2018	Korea	PCS	Single level (L2-S1)	14.5±2.3	65.8±8.9/63.6±10.5	ULBD46/MD42	②③④⑤⑥⑧	7
Taewook Kang	2019	Korea	RCT	Single level (L3-S1)	6	65.1±8.6/67.2±9.5	ULBD32/MD30	①②⑤⑥⑦	Table 2
Woo-Kie Min	2020	Korea	RCS	Single level (L2-S1)	24	65.74±10.52/66.74±7.96	ULBD32/MD32	①②③④⑤⑥	8
Sang-Min Park	2020	Korea	RCT	Single level (L1-S2)	12	66.2/67.2	ULBD54/MD37	①②③④⑤⑥⑦	Table 2
Hyeun-Sung Kim	2020	Korea	RCS	Single level (L2-S1)	12月	64.23±5.26/66.20±2.01	ULBD30/MD30	②⑤⑥⑧⑨	8

①hospital stay; ②operation time; ③back Vas score; ④lower limb VAS score; ⑤Oswestry Disability Index (ODI) score; ⑥Incidence of complications; ⑦revision rates; ⑧Cross sectional area of thecal sac; ⑨Postoperative C-reactive protein level.

Table 2

Risk of bias assessment of randomized controlled trials.

Author	Year	Country	Random sequence generation	Allocation concealment	Blinding of participants	Blinding of outcome assessment	Incomplete outcome date	Selective reporting	Other bias
Taewook Kang	2019	Korea	Low	Unclear	Low	unclear	Low	Unclear	Low
Sang-Min Park	2020	Korea	Low	Low	Low	unclear	Low	Low	Low

heterogeneity. After excluding these 3 articles, we carried out meta-analysis again, and the results showed that the heterogeneity among the studies was small (I^2=43.8%). Fixed effect model was used for merging. The results of meta-analysis showed that UBE decompression required less operation time [SMD=−0.443, 95% CI (−0.717, −0.169), P=.002] (Fig. 4).

4.3.3. Back visual analogue score score. Five articles[4,12,14–16] reported the results of postoperative back VAS score, the results showed that the heterogeneity among the studies was large (I^2=86.9%), so the random effect model was used for meta-analysis. The results of meta-analysis showed that the VAS score of patients after UBE was lower than that of MD, and the

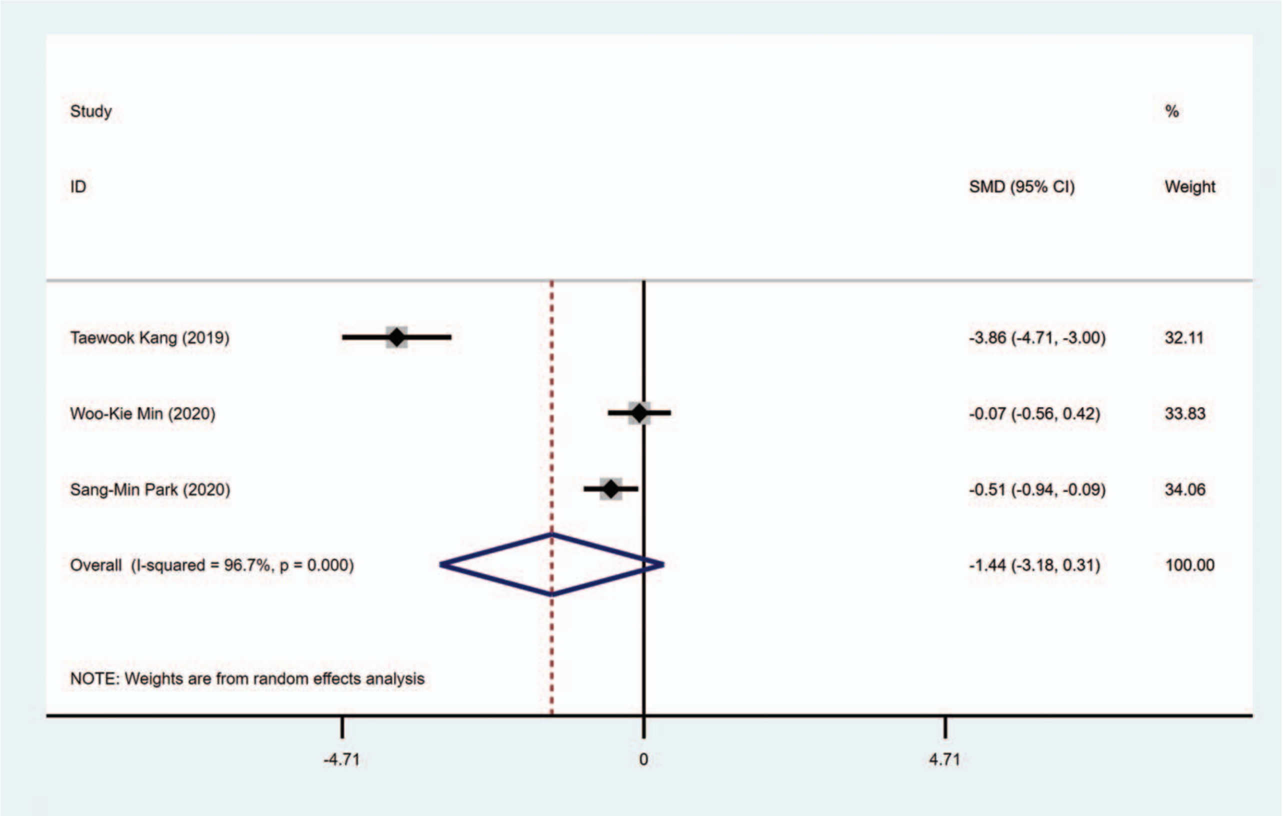

Figure 2. Forest plot of the comparison of the hospital stay between UBE and MD.

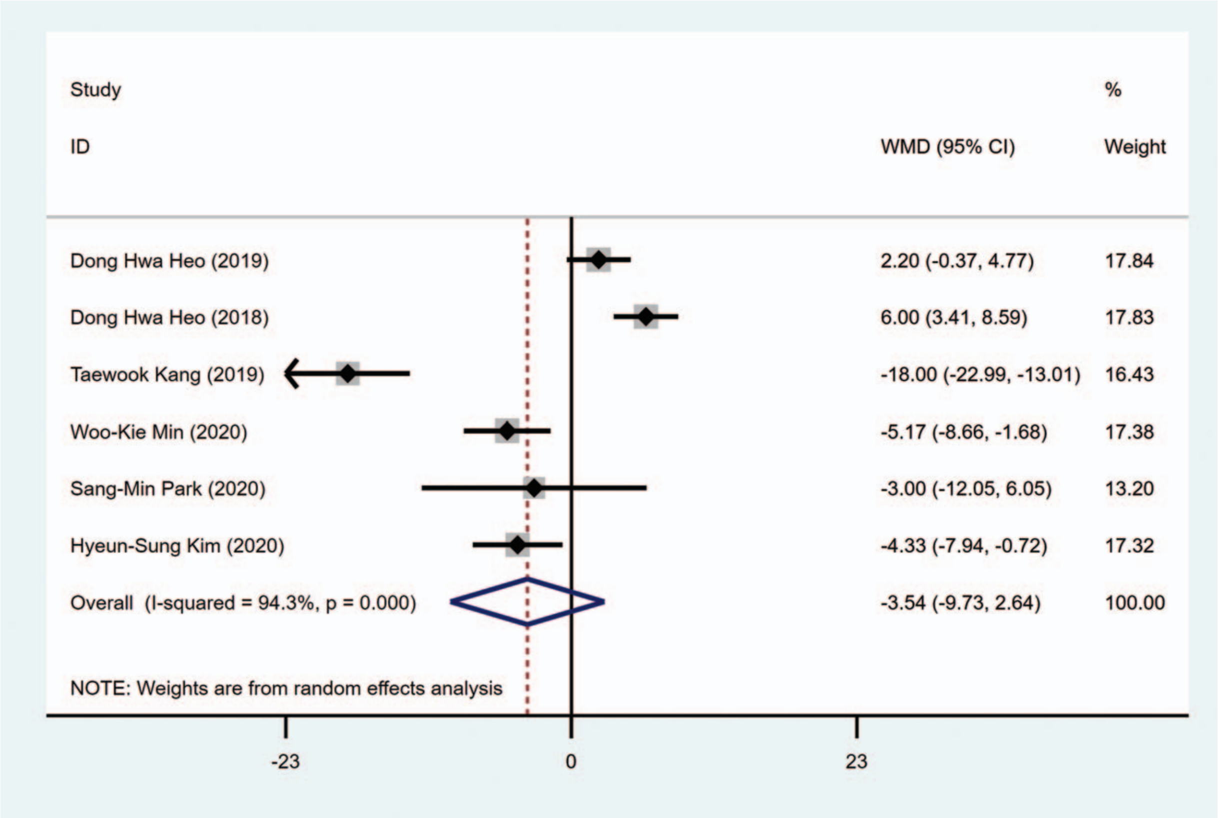

Figure 3. Forest plot of the comparison of the operation time between UBE and MD.

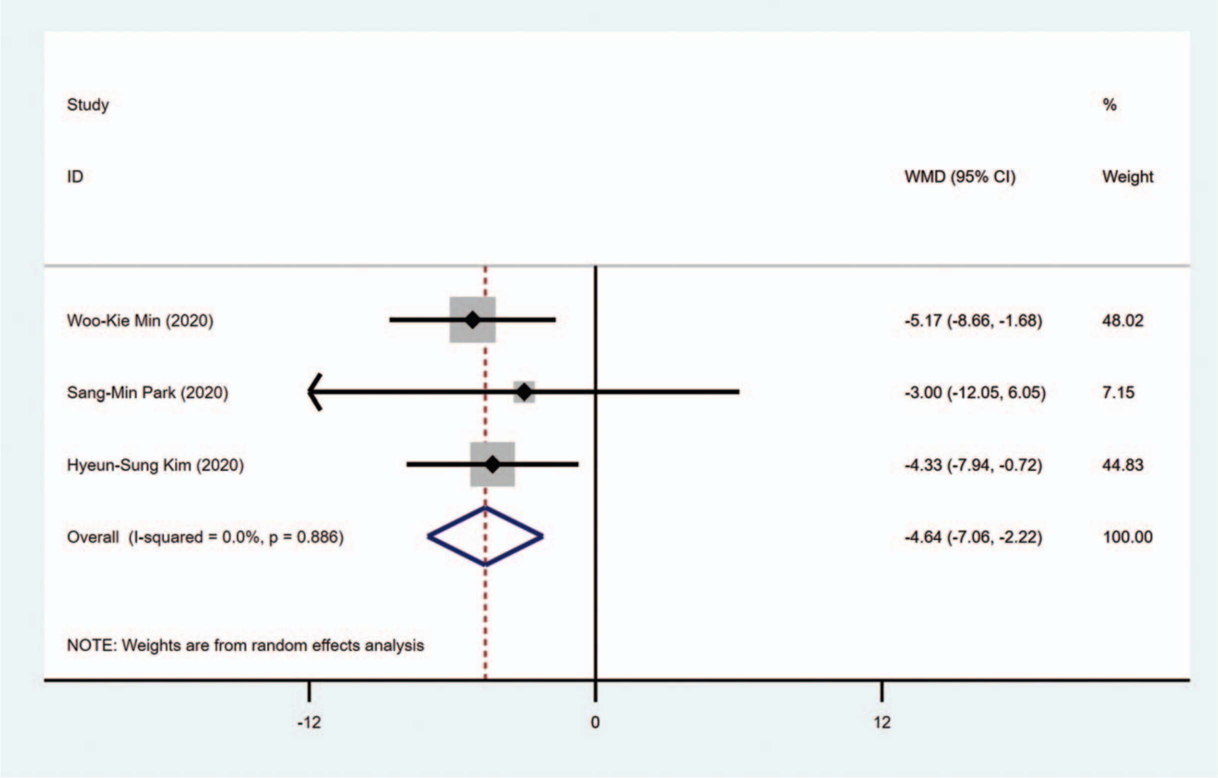

Figure 4. Forest plot of the comparison of the operation time between UBE and MD (Exclude Heo2019, Heo2018, and kang2019).

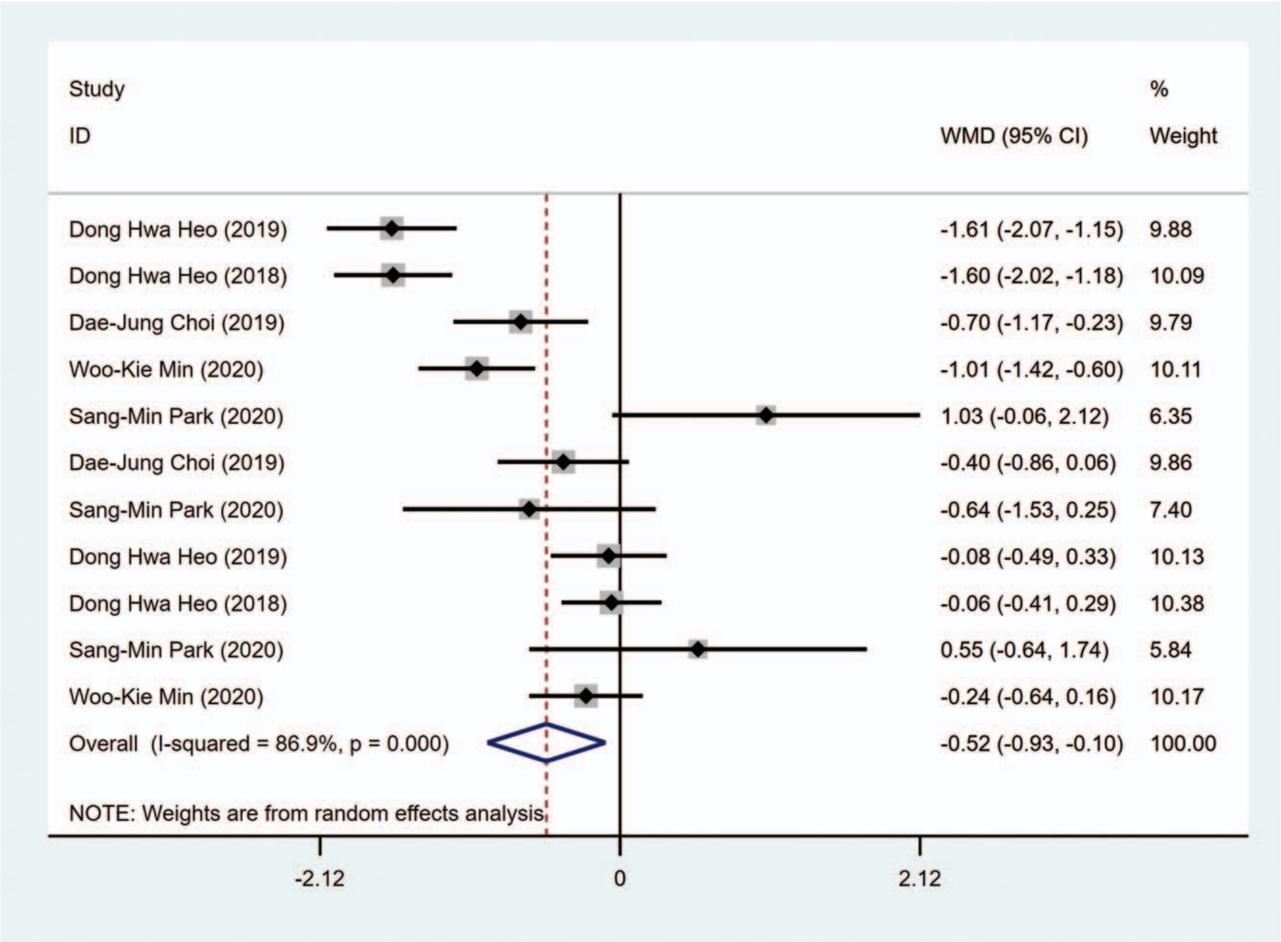

Figure 5. Forest plot of the comparison of the back VAS score between UBE and MD.

difference was statistically significant [SMD = −0.519, 95% CI (−0.934, −0.104), P = .014] (Fig. 5). According to the different follow-up time, we performed a subgroup analysis, and the results of meta-analysis showed that the early back VAS score of patients after UBE was lower than that of MD (Fig. 6).

4.4. Lower limb visual analogue score score

Five articles[4,12,14–16] reported the results of postoperative lower limb VAS score. The results showed that there was great heterogeneity among the studies (I^2 = 59.3%). Therefore, the random effect model was used for meta-analysis. The results showed that there was no significant difference in postoperative lower limb VAS scores between UBE and MD [SMD = −0.105, 95% CI (−0.356, 0.146), P = .412] (Fig. 7). According to the different follow-up time, we conducted a subgroup analysis. The results of meta-analysis showed that only on the first day after operation, the lower limb VAS score of patients after UBE was lower than that of MD (Fig. 8).

4.5. Oswestry disability index score

Six articles[4,11–15] reported the results of ODI score. The results showed that the heterogeneity among the studies was small (I^2 = 0.0%), so the fixed effect model was used for meta-analysis. The results showed that there was no significant difference in ODI score between UBE and MD (Fig. 9).

4.6. Incidence of complications

Seven articles[4,11–16] reported the incidence of complications, and the results showed that the heterogeneity among the studies was small (I^2 = 0%), so the fixed effect model was used for meta-analysis. The results showed that there was no significant difference in the incidence of complications between UBE and MD [OR = 0.634, 95%CI (0.317, 1.268), P = .198] (Fig. 10).

4.7. Revision rates

Two articles[11,12] reported the results of the revision rate. The results showed that the heterogeneity among the studies was small (I^2 = 0%), so the fixed effect model was used for meta-analysis. The results showed that there was no significant difference in complication revision rate between UBE and MD [OR = 0.481, 95% CI (0.063) 3.662), P = .480] (Fig. 11).

4.8. Cross sectional area of thecal sac

Three articles[13–15] reported the results of postoperative cross-sectional area of thecal sac, and the results showed that the heterogeneity among the studies was small (I^2 = 0%), so the

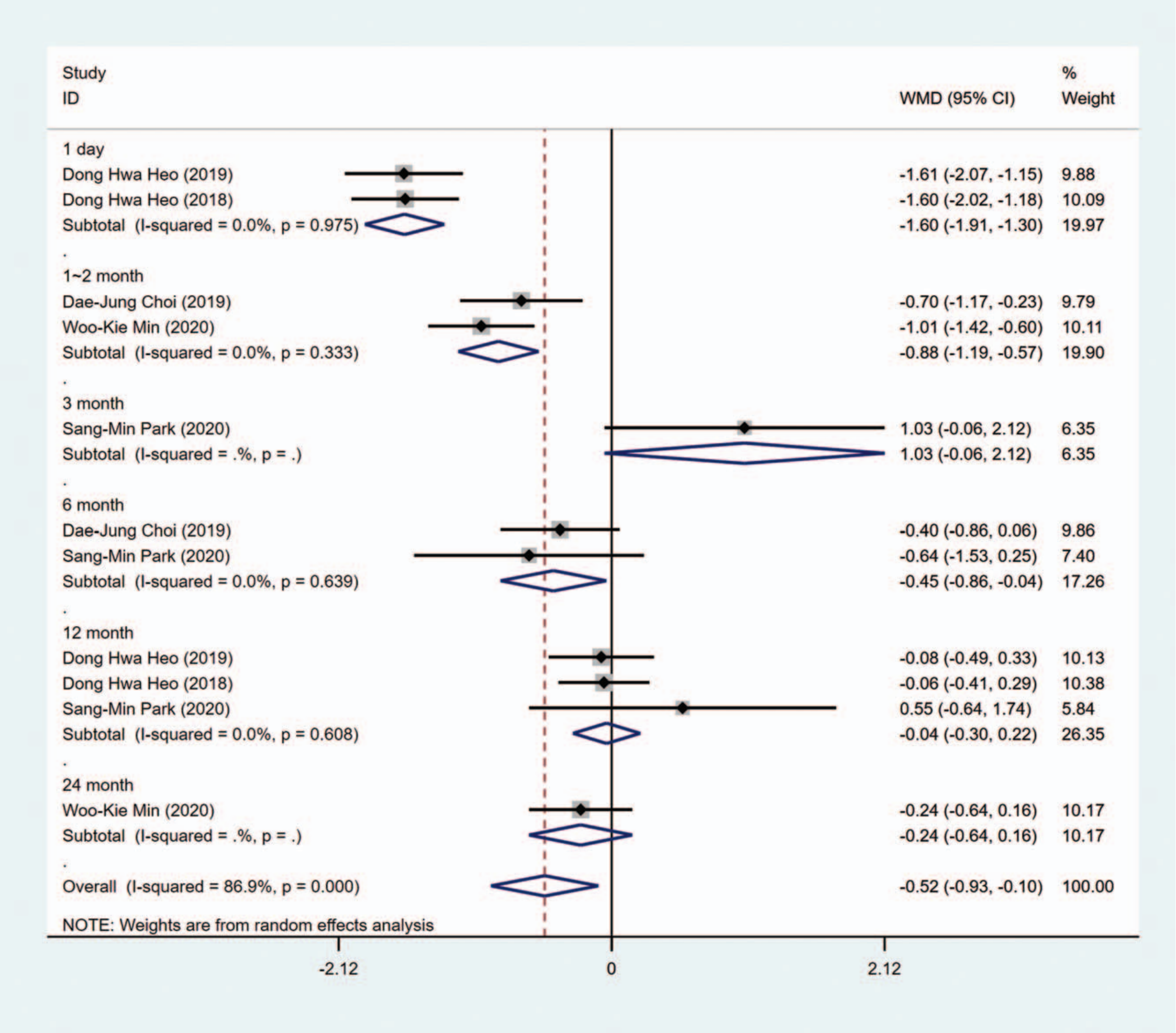

Figure 6. Forest plot of the comparison of the back VAS score between UBE and MD (by follow-up month).

fixed effect model was used for meta-analysis. The results showed that there was no significant difference in postoperative cross-sectional area of thecal sac between UBE and MD [SMD = −0.037, 95% CI (−0.303, 0.229), purge 0.785] (Fig. 12).

4.9. Postoperative C-reactive protein level

The results of postoperative C-reactive protein (CRP) were reported in 2 articles.[13,17] The results of meta-analysis showed that the heterogeneity among the studies was large (I^2 = 97.4%), so the random effect model was used for meta-analysis. The results showed that the CRP level of patients after UBE was lower than that of MD [weighted mean difference = −1.437, 95% CI (−2.347), *P* = .002] (Fig. 13). According to the different testing time, we carried out a subgroup analysis. The results of meta-analysis showed that the level of CRP in patients with UBE on the first day was lower than that in MD. One week later, and there was no significant difference between the 2 groups (Fig. 14).

4.10. Sensitivity analyses and publication bias

Sensitivity analysis is conducted by omitting 1 study at a time to assess the robustness of our results. The sensitivity analyses also show the stability of the results (Fig. 15). Egger and Begg test results showed that there is no evidence that the results of hospital stay (*P* = .255; *P* = 1.0) and operation time (*P* = .170; *P* = .707) have evidence of publication bias. We also made an inverted funnel chart to detect publication bias, and the results showed that the funnel chart was basically symmetrical, suggesting that there was no publication bias (Fig. 16).

5. Discussion and conclusion

At present, there is still some controversy on the choice of treatment for lumbar spinal stenosis.

For the first diagnosed patients with mild symptoms, conservative treatment is usually adopted to reduce edema and inflammatory reaction and relieve the symptoms of the patients. Surgery is usually needed when there are persistent symptoms of

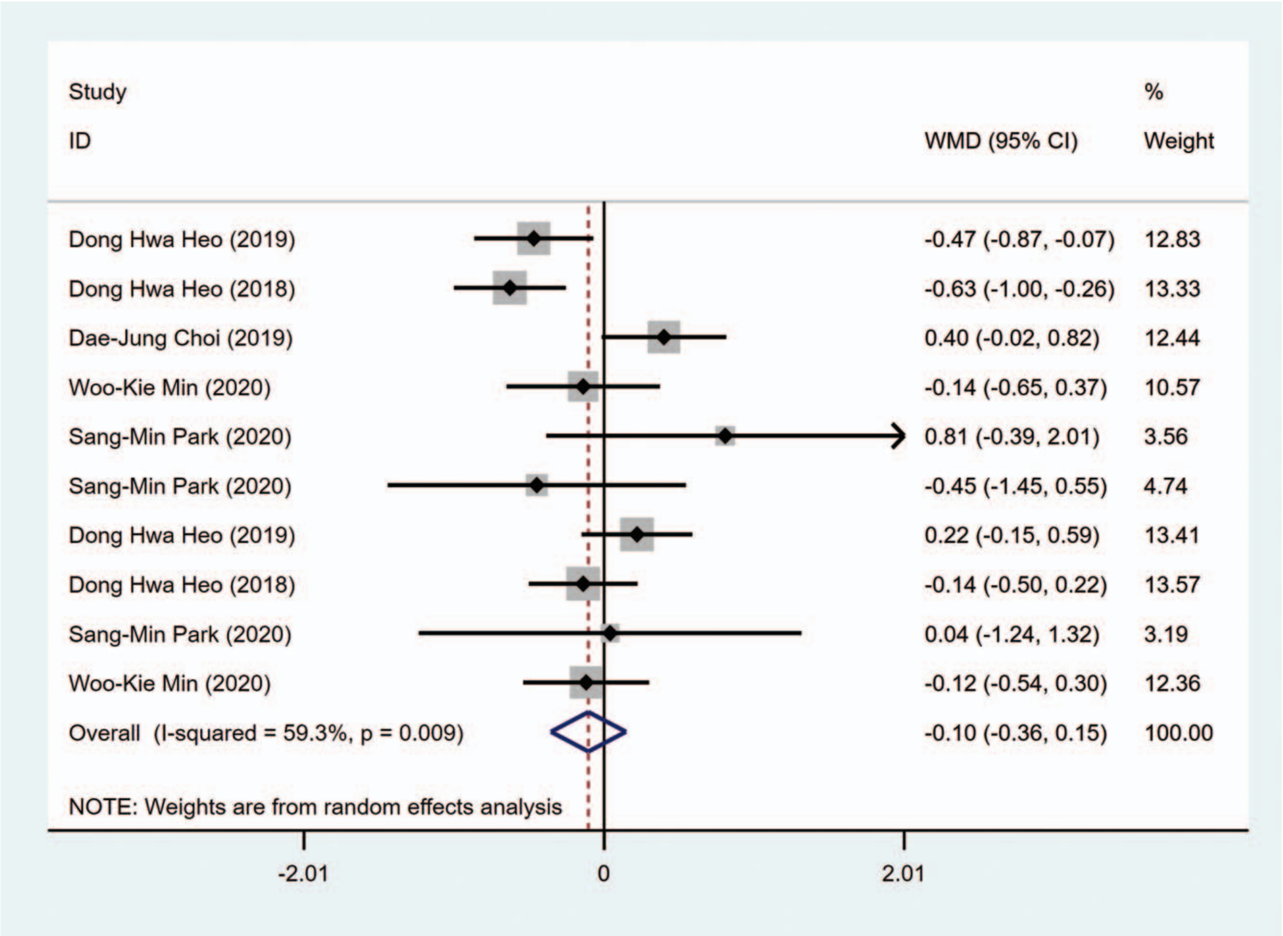

Figure 7. Forest plot of the comparison of the lower limb VAS score between UBE and MD.

lower extremities, nerve root compression, and cauda equina syndrome after 3 months of conservative treatment. In traditional open surgery, it is often necessary to pull and peel off the muscles to expose the lamina as much as possible, which often destroys the structure of the spine and often leads to segmental instability after operation, which is usually used in combination with fusion surgery. With the continuous deepening of the concept of minimally invasive surgery in clinical work, percutaneous endoscopic spine has been concerned by spinal surgeons, and it has achieved satisfactory clinical results with less injury. At present, the most widely used is the coaxial spinal endoscopic operating system created by Yeung.[18] Satisfactory results have been obtained in spinal canal decompression and lumbar fusion. However, there are still some shortcomings in the system. This system integrates video recording, flushing, lighting system, and operating tools in the same pipeline. Although the surgical incision is reduced, there are some problems, such as reduced visual field, limited movement of instruments, inefficiency. In 1996, De Antoni [2] used the translaminar lumbar epidural endoscopy technique performed by arthroscopic system and surgical instruments to remove herniated intervertebral discs through unilateral biportal endoscopic spinal endoscopy. In 1997, Osman reported a unilateral and dual-channel technique for the treatment of L5/S1 segments via iliac approach. In the following 2 years, satisfactory results were obtained in thoracic discectomy and thoracic fusion. Osman pointed out that the working channel is independent of the observation channel and can be used with larger surgical instruments.[19] In the following decade, after the development of chiropractors in various countries represented by South Korea, unilateral dual-channel technology was named UBE technology in 2013 by the international spinal minimally invasive society, which is also known as BESS (biportal endoscopic spinal surgery) technology.[20] Compared with the coaxial spinal endoscopic system, UBE/BESS has the advantages of smooth learning curve, convenient operation of instruments, and wide field of vision. At present, it has achieved satisfactory results in the treatment of spinal canal stenosis. Heo et al[14] pointed out that UBLD has the same principle as bilateral decompression under microscope, but can better retain normal spinal structure. It can provide a clearer operative field when decompressing the ipsilateral, contralateral and sublaminar space. During decompression, a slightly tilted endoscope can show the contralateral ligamentum flavum and nerve root without tilting the patient's position. In the process of exploring UBE/BESS technology, its indications are expanding, from unilateral decompression to bilateral decompression, complex discectomy,[21] and interbody fusion.[22] The evidence of meta-analysis showed that there was no significant difference

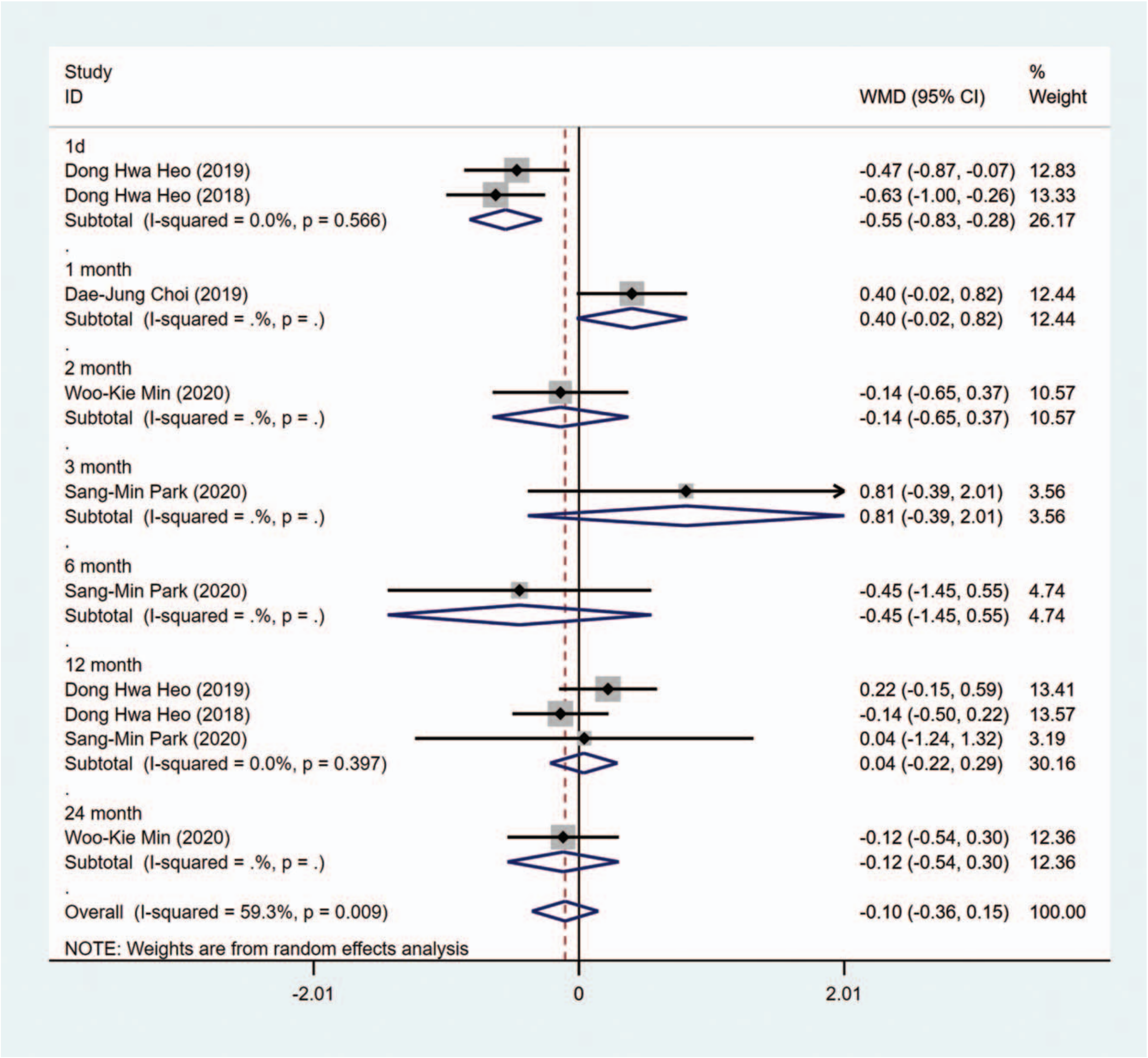

Figure 8. Forest plot of the comparison of the lower limb VAS score between UBE and MD (by follow-up month).

in operation time between UBE and MD, and the degree of decompression of dural sac was similar. CRP is an acute inflammatory protein that increases significantly when there is infection or stress stimulation. In this meta-analysis, it was found that the level of CRP in patients with UBE within 1 week after operation was significantly lower than that under microscope decompression. Some scholars have pointed out that the low level of CRP after UBE may be due to the mild tissue damage caused by UBE and the continuous washing of inflammatory debris during operation.[16] Choi et al[23] believe that previous studies have ignored the importance of muscles and ligaments in maintaining the internal stability of the spine, and pointed out that UBE technology can protect the muscle groups that maintain the stability of the spine to the greatest extent with the help of the "multifid triangle." Kim et al[13] pointed out that the change of serum CK level was not only related to the length and depth of incision, but also significantly related to the pressure and duration of paraspinal muscle. Serum CK was used to evaluate muscle injury during operation. After comparison, it was found that the muscle damage caused by UBE was mild. Ahn et al[24] evaluated the injury of multifissure muscle caused by UBE by MRI, and pointed out that the injury of multifid muscle was directly related to the contraction time of muscle during operation, and the hydrostatic pressure caused by prolonged operation time and saline perfusion would cause the injury of multifida muscle. At the same time, it was also pointed out that the change of this kind of muscle injury was reversible. The meta-analysis also showed that UBE had the advantage of shorter operation time and lower back VAS score in the early stage after operation. During the long-term follow-up, there was no significant difference in VAS score and ODI score between UBE and MD. In terms of the incidence of complications and

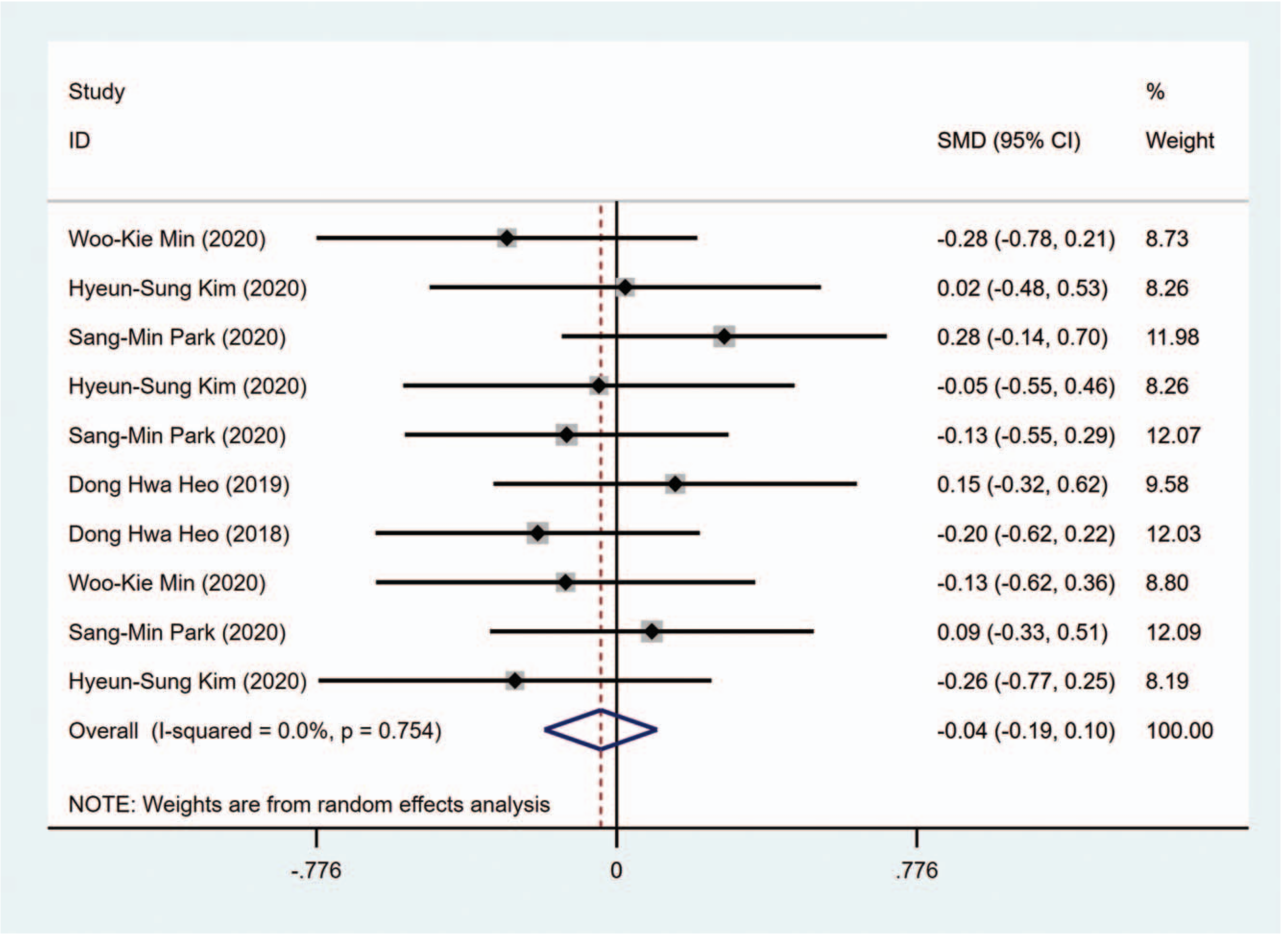

Figure 9. Forest plot of the comparison of the ODI score between UBE and MD.

revision rate, there was no statistical difference between the incidence of complications and the rate of revision and decompression under microscope.

The UBE technique can use orthopedic open surgical instruments, avoiding the problem that single-channel endoscopes are limited by instruments. Choi et al believe that UBE technique can only go through the interlaminar approach, so it is difficult to deal with bony stenosis in the intervertebral foramen, which may lead to incomplete decompression of the exit nerve root.[25] However, some scholars use extraforaminal approach to deal with intervertebral foramen stenosis and extreme lateral disc herniation, and further supplement the surgical indications of UBE technique.[26,27] The range of movement of the instruments for MD is limited, and the operation of surgical instruments is limited to fixed-size tubular retractors, so the removal of ligamentum flavum and some facet joints is necessary, which may lead to postoperative segmental instability.[28] When the UBE technique is used to decompress the spinal canal, there is a great degree of freedom in the operation of the instrument. When the instrument is placed under the lamina, less osteotomy and higher facet retention can be achieved.[29,30] At present, the indications of UBE technique and MD in the treatment of spinal canal stenosis are basically the same, and the scope of decompression can also reach the level of the inner edge of bilateral pedicle.[14]

There are some deficiencies in this study. First of all, there are only 2 articles with insufficient RCT, evidence level in the literature included in this study. Second, the included literature is published by foreign countries, and there is no literature published by Chinese scholars, which may be biased to a certain extent. It is hoped that high-quality RCTs with multicenters and large samples can be obtained to make the results more perfect.

Author contributions

Data curation: Fei Ju, Shangju Gao, Can Cao, Changren Li, Liang He, Xu Ma, Meng Li.
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Supervision: Wenyi Li.
Visualization: Chuntao Li.
Writing – original draft: Chuntao Li.
Writing – review & editing: Wenyi Li.

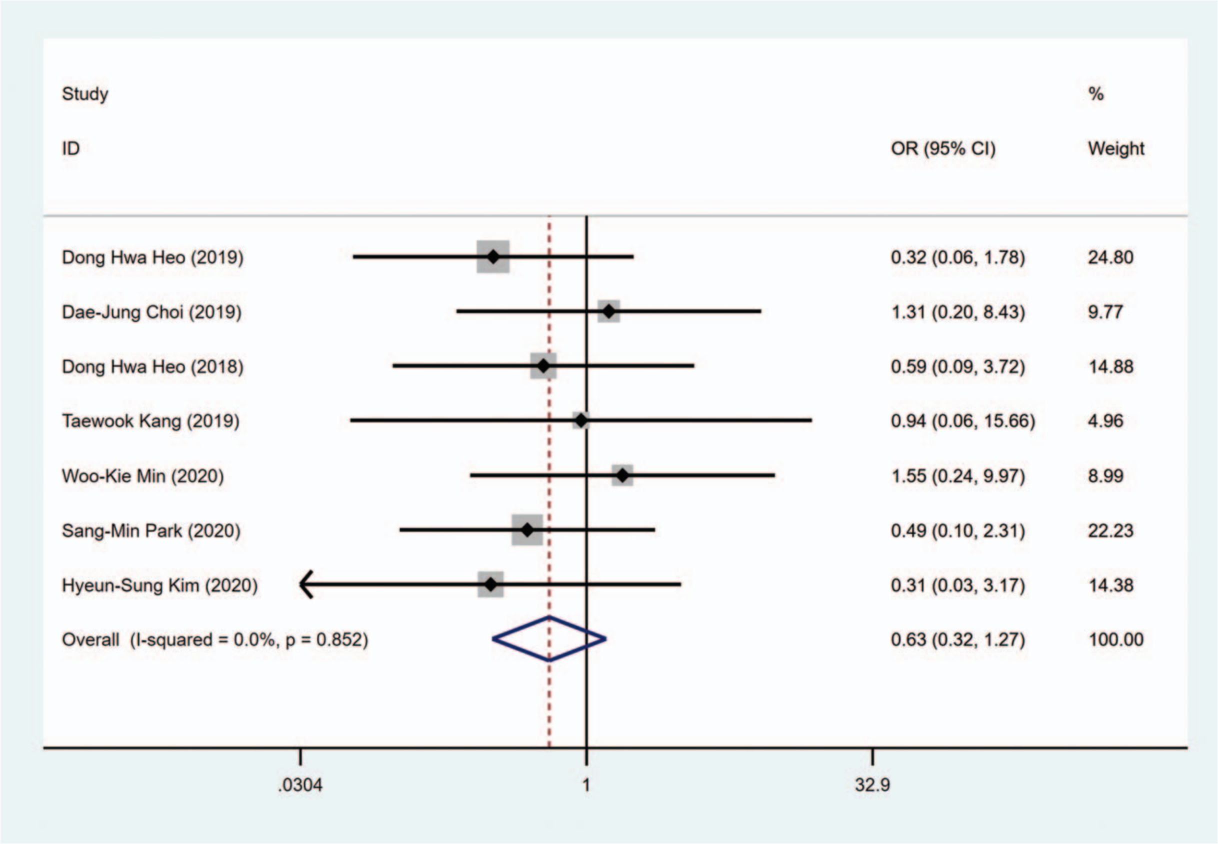

Figure 10. Forest plot of the comparison of the incidence of complications between UBE and MD.

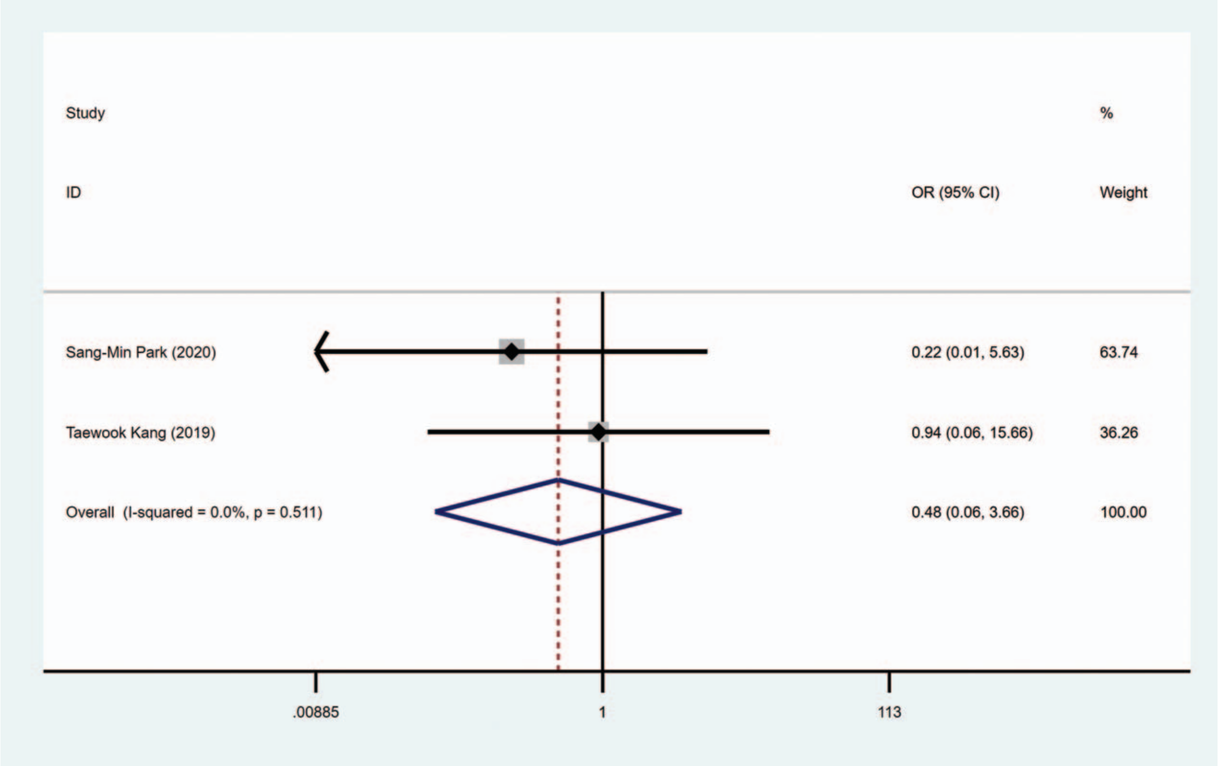

Figure 11. Forest plot of the comparison of the revision rates between UBE and MD.

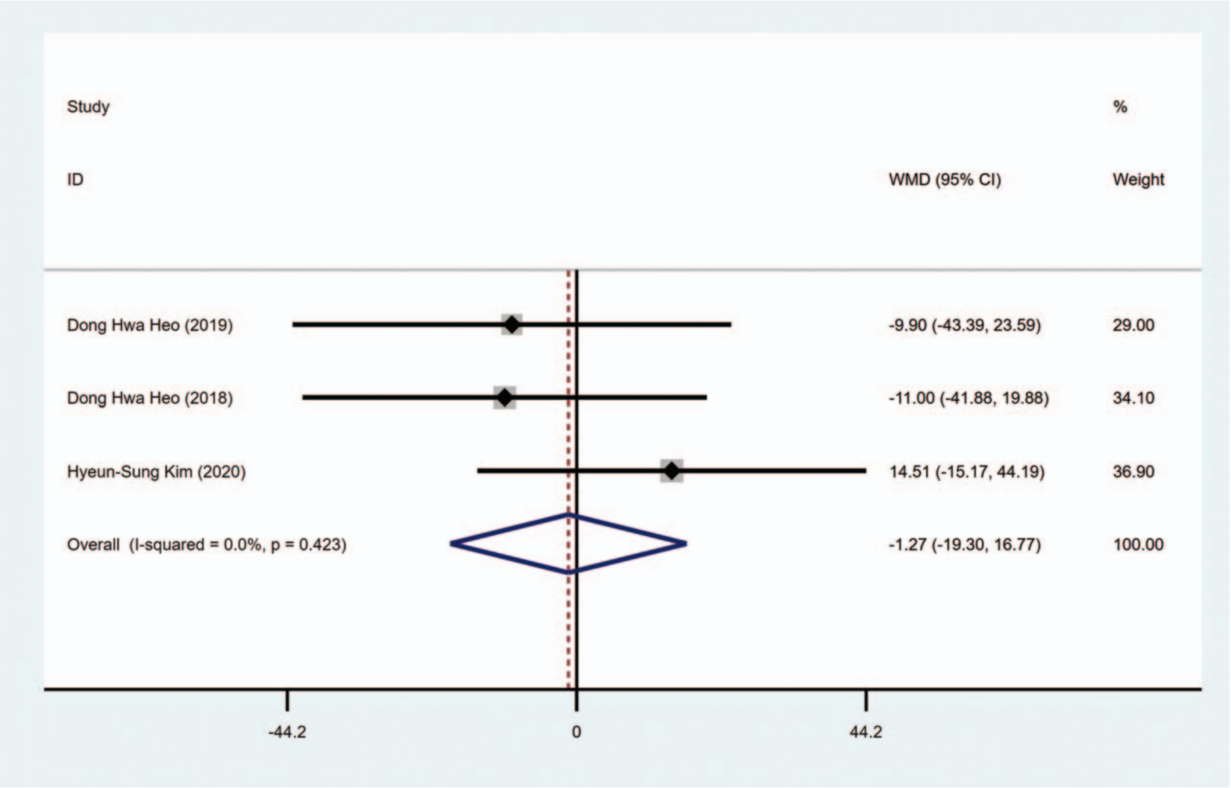

Figure 12. Forest plot of the comparison of the cross-sectional area of thecal sac between UBE and MD.

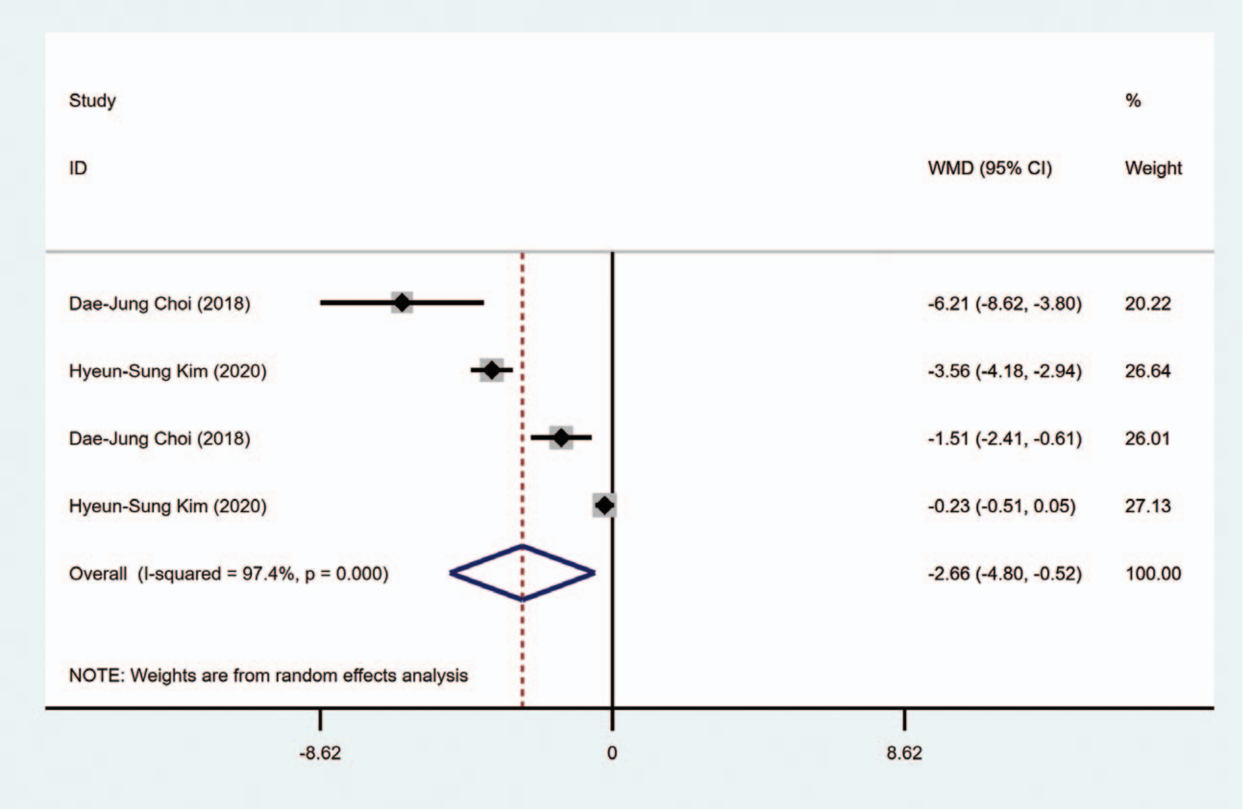

Figure 13. Forest plot of the comparison of the CRP level between UBE and MD.

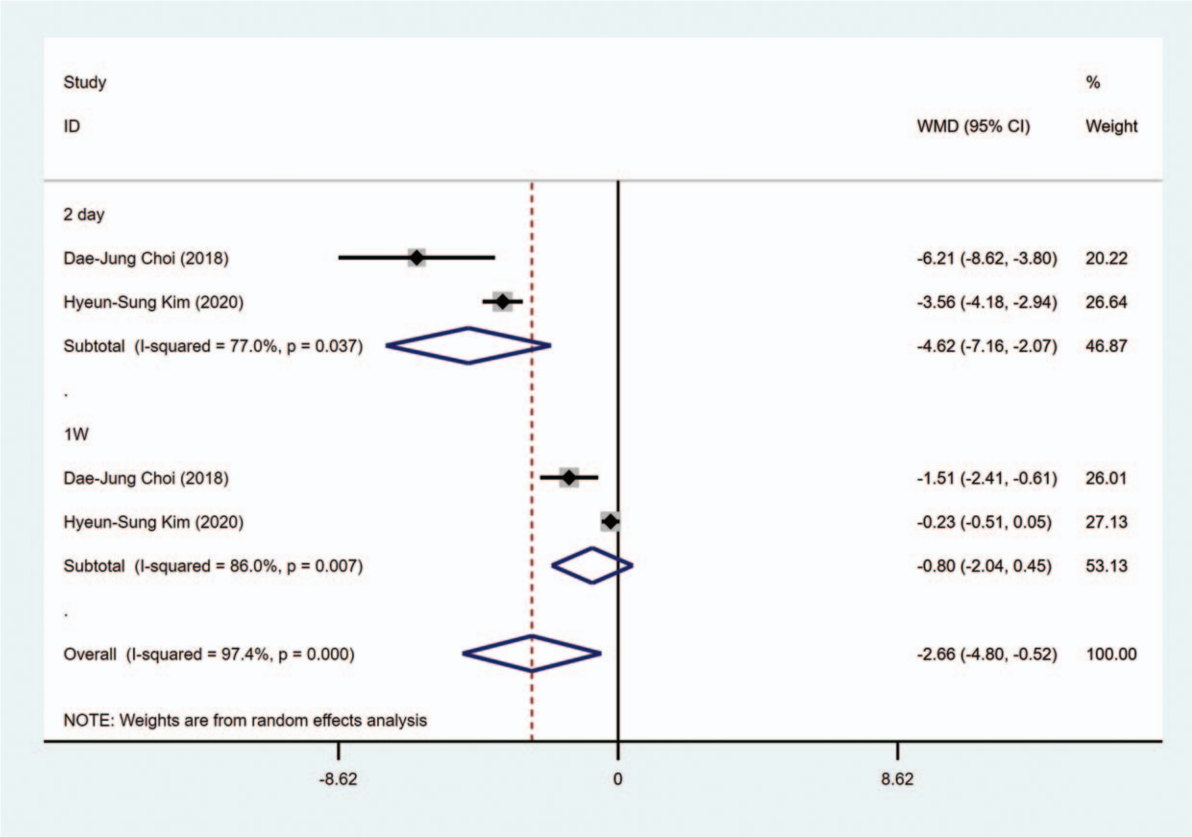

Figure 14. Forest plot of the comparison of the CRP level between UBE and MD (by different testing time).

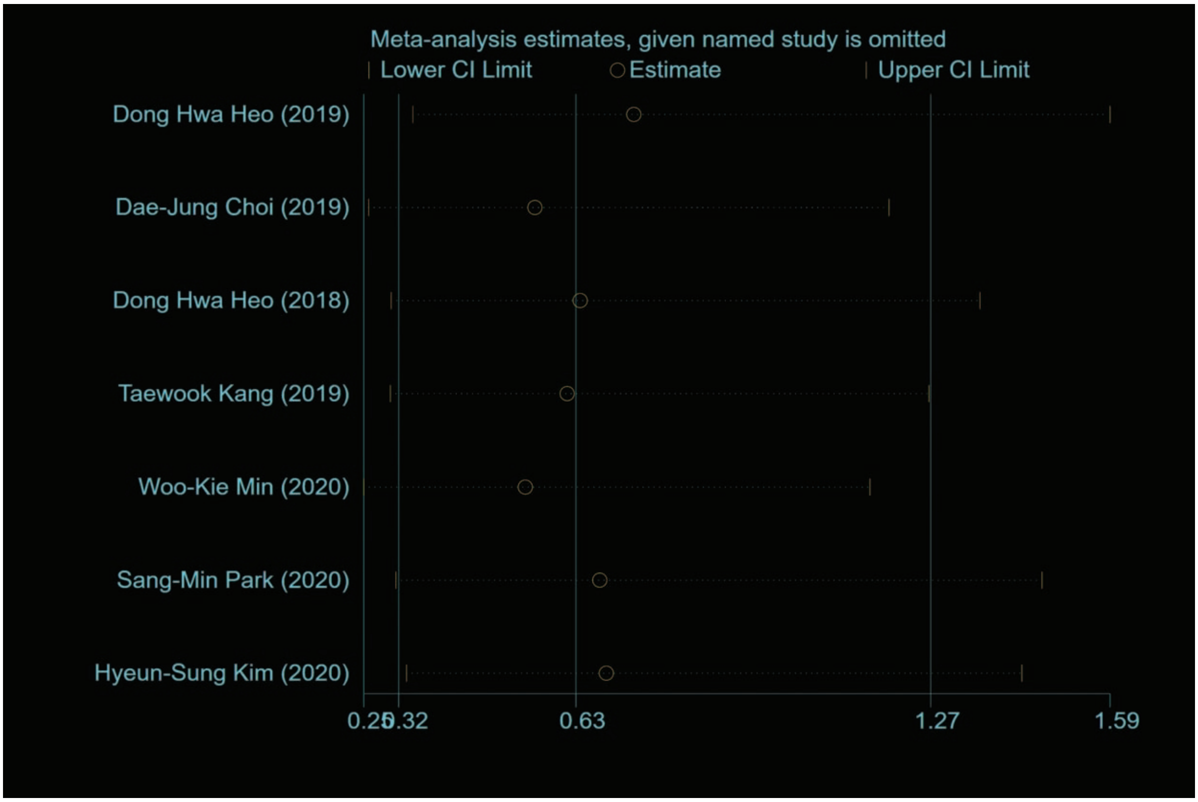

Figure 15. Sensitivity analyses by incidence of complications.

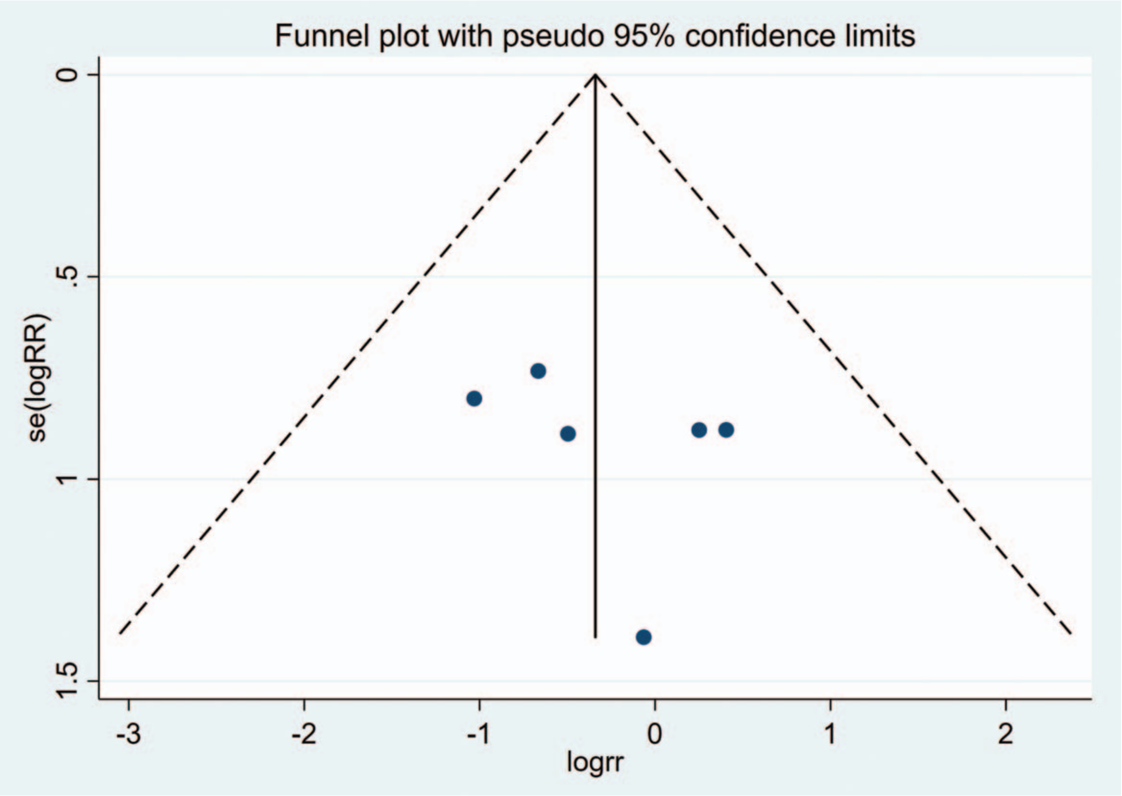

Figure 16. Funnel plots by incidence of complications.

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