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Mini-plate fixation versus suture suspensory fixation in cervical laminoplasty

A meta-analysis

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Abstract

Background: Both the mini-plate fixation and suture suspensory fixation techniques are extensively applied in cervical laminoplasty, but which technique is superior has not been ascertained. The purpose of this meta-analysis is to compare the results between mini-plate fixation and suture suspensory fixation in cervical laminoplasty for the patients with multilevel cervical compressive myelopathy.

Methods: PubMed, Embase, the Cochrane library, CNKI, and WANFANG were searched for studies that compared mini-plate fixation and suture suspensory fixation in cervical laminoplasty up to November 1, 2016. We calculated odds ratio (OR) with 95% confidence interval (CI) for dichotomous outcomes and mean difference (MD) with 95% CI for continuous outcomes. Review Manager 5.3 was used for the statistical analyses.

Results: A total of 25 studies, involving 1603 participants, were included in this review. The results of this meta-analysis indicated that there were statistically significant differences in postoperative Japanese Orthopedic Association (JOA) scores (MD = 0.67, 95% CI: 0.34–0.99, $P < 0.001$), JOA scores improvement rate (MD = 4.00, 95% CI: 2.51–5.50, $P < 0.001$), postoperative Visual Analogue Score (VAS) (MD = −0.81, 95% CI: −1.36 to −0.26, $P = 0.004$), postoperative range of motion (ROM) (MD = 4.15, 95% CI: 2.06–6.23, $P < 0.001$), postoperative cervical lordosis (MD = 3.1, 95% CI: 2.02–4.18, $P < 0.001$), postoperative anteroposterior diameter of the spinal canal (MD = 1.53, 95% CI: 0.11–2.95, $P = 0.03$), postoperative open angle (MD = 1.93, 95% CI: 0.14–3.71, $P = 0.03$), postoperative cross-sectional area of the spinal canal (MD = 37.10, 95% CI: 26.92–47.29, $P < 0.001$), axial symptoms (OR = 0.28, 95% CI: 0.20–0.37, $P < 0.001$), operation time (MD = 4.46, 95% CI: 0.74–8.19, $P = 0.02$), and blood loss (MD = 9.24, 95% CI: 6.86–11.62, $P < 0.001$). However, there was no statistically significant difference in C5 palsy (OR = 0.82, 95% CI: 0.37–1.84, $P = 0.63$).

Conclusions: As compared with suture suspensory fixation, mini-plate fixation in cervical laminoplasty appears to achieve better clinical and radiographic outcomes with fewer surgical complications. However, mini-plate fixation is associated with bigger surgical trauma. This conclusion should be interpreted cautiously and more high-quality, randomized controlled trials are needed in the future.

Abbreviations: CCS = cervical canal stenosis, CI = confidence interval, CSM = cervical spondylotic myelopathy, JOA = Japanese Orthopedic Association, MCCM = multilevel cervical compressive myelopathy, MD = mean difference, OPLL = ossification of the posterior longitudinal ligament, OR = odds ratio, ROM = range of motion, VAS = Visual Analogue Score.

Keywords: fusion, laminoplasty, meta-analysis, mini-plate, suture

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1. Introduction

Multilevel cervical compressive myelopathy (MCCM), including multisegment cervical spondylotic myelopathy (CSM), cervical canal stenosis (CCS), or ossification of the posterior longitudinal ligament (OPLL), usually lead to stepwise deterioration of neurologic function.[1] Surgical treatment especially posterior approaches can get satisfactory clinical results. Cervical laminoplasty has been well established for the treatment of MCCM and can achieve satisfactory long-term clinical outcomes.[2]

Hirabayashi et al[3] introduced unilateral open-door laminoplasty, which allowed extensive cord decompression with less substantial alteration to the natural biomechanics of the cervical spine and had been widely used. In the traditional method, the opened laminae are held by sutures between spinous process and facet capsule or paravertebral muscle. Although this technique has proven to be effective, several complications have been observed including axial symptoms and lamina closure.[4]

O'Brien et al[5] adapted maxillofacial miniplates and screws to fix the free lamina and lateral mass in their new positions. Mini-plate fixation is efficient to prevent lamina closure by offering the lamina immediately rigid fixation.[6]

Some studies compared clinical outcomes of mini-plate fixation versus suture suspensory fixation in cervical laminoplasty for treating MCCM.[7] However, results of those studies were different or contradictory owing to small sample sizes or low statistical power. Meta-analysis is a good statistical method to combine the results from multiple studies in an effort to increase statistical power, improve estimates of the magnitude of an effect, and resolve uncertainty across conflicting reports. So, we conducted a meta-analysis to compare complication, clinical, and radiographic outcomes of 2 surgical procedures in cervical laminoplasty for treating MCCM.

2. Methods

2.1. Ethics statement

As all analyses were based on previously published studies, ethical approval was not necessary in this review.

2.2. Search strategy and study selection

An extensive search of literature was performed in PubMed, Embase, the Cochrane library, CNKI (Chinese database), and WANFANG (Chinese database) up to November 1, 2016. The languages were restricted to Chinese or English and only the published articles were included. The following key words were used for search: "cervical," "laminectomy," "plate," "suture," and "fusion" with various combinations of the operators "AND," "NOT," and "OR." The reference lists of included studies were also hand-searched for additional qualified studies.

3. Inclusion and exclusion criteria

Studies were included if they met the following criteria:

(1) Participants: patients with MCCM, including CSM, CCS, and OPLL.

(2) Interventions: the intervention in the experimental group was cervical laminoplasty with mini-plate fixation.

(3) Comparisons: the intervention in the control group was cervical laminoplasty with suture suspensory fixation.

(4) Outcomes: Japanese Orthopedic Association (JOA) scores, Visual Analogue Score (VAS), range of motion (ROM), cervical lordosis, anteroposterior diameter of the spinal canal, open angle, cross-sectional area of the spinal canal, axial symptoms, C5 palsy, operation time, and blood loss were collected as the outcomes.

(5) Study design: randomized or nonrandomized controlled study.

The exclusion criteria were as follows: case reports, reviews, or letters; the same data had been published repeatedly; and outcomes of interest did not be reported. Two reviewers (Feng-Yu Liu and Lei Ma) independently selected the potentially qualified studies according to the inclusion and exclusion criteria. Any disagreement was resolved by discussion and the conformity was reached.

4. Data extraction and management

Two reviewers (Feng-Yu Liu and Li-Shuang Huo) extracted data independently. The data extracted included the following categories: study design, patients' demographic data (sample size, diagnoses, age, and sex), duration of follow-up, clinical evaluation (JOA and VAS), radiography evaluation (ROM, cervical lordosis, anteroposterior diameter of the spinal canal, open angle, and cross-sectional area of the spinal canal), complications (axial symptoms and C5 palsy), blood loss, and operation time.

4.1. Quality assessment

As all studies included were nonrandomized controlled studies, the Newcastle–Ottawa Scale (NOS) was used to assess the quality of each study. This scale for nonrandomized case controlled studies and cohort studies was used to allocate a maximum of 9 points for the quality of selection, comparability, exposure, and outcomes for study participants.[1]

4.2. Statistical analysis

We calculated odds ratio (OR) with 95% confidence interval (95% CI) for dichotomous outcomes and mean difference (MD) with 95% CI for continuous outcomes. P values less than 0.05 denoted significant differences. I^2 statistic was used to quantify heterogeneity, where I^2 greater than 50% implied significant heterogeneity. The random-effects model was used if there was significant heterogeneity. Otherwise, the fixed-effects model was used. Sensitivity analysis was conducted to examine the influence of excluding each study. Funnel plot was used to test the publication bias when more than 10 publications were included. Review Manager 5.3 (The Nordic Cochrane Center, The Cochrane Collaboration, Copenhagen, Denmark) was used for the statistical analyses.

5. Results

5.1. Search results

A total of 105 records were identified by the initial database search. Of these, 23 were discarded due to duplicate reports and 51 were excluded after reviewing the titles and abstracts. Another 6 studies were excluded for repeated data, incorrect data, or data could not be extracted. Finally, a total of 25 studies were included in our meta-analysis. The literature search procedure is shown in Fig. 1.

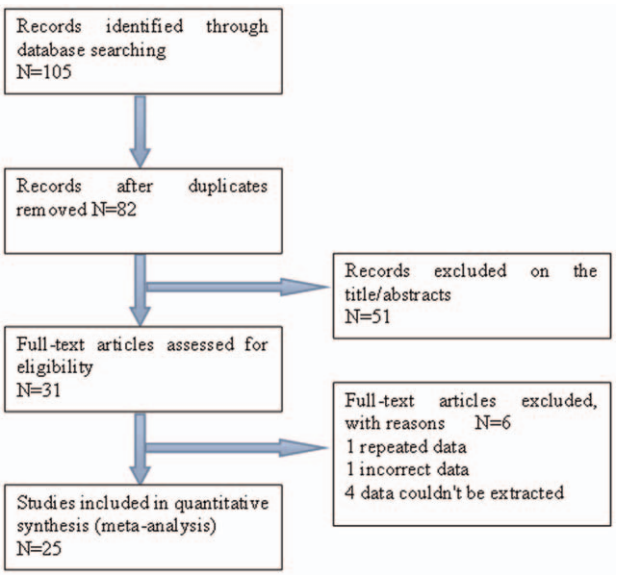

Figure 1. Flow diagram of study selection.

Table 1

Characteristics of included studies.

Study	Design	Diagnosis	No. of patients		Mean age, y		No. of males/Females		Mean follow-up, mo
			Mini-plate	Suture	Mini-plate	Suture	Mini-plate	Suture	
Wei et al[9]	Retrospective	CSM/OPLL	33	35	59.4	58.1	17/16	18/17	24
Wu et al[10]	Retrospective	CSM	15	17	59.5	61.3	8/7	9/8	12.5
Liu et al[11]	Retrospective	CSM/OPLL	26	30	55.4	57.4	15/11	17/13	13
Zhang et al[12]	Retrospective	CCS	16	14	51.2	50.7	10/6	7/7	31
Sun et al[13]	Retrospective	CSM	27	28	68.3	67.5	16/11	15/13	24
Zhang et al[14]	Retrospective	CSM	34	32	55.1	55.3	22/12	23/9	31.8
Jiang et al[15]	Retrospective	CSM	20	25	62.9	63.7	11/9	14/11	12
Hao et al[16]	Retrospective	CSM	96	46	59.9	59.6	56/40	27/19	24
He et al[17]	Retrospective	CSM	25	20	59.3	59.9	17/8	13/7	6
Zhou et al[18]	Retrospective	CSM	23	23	65.3	66.2	17/6	19/4	13.5/14.1
Huang et al[19]	Retrospective	CSM	40	40	62.0	63.0	24/16	22/18	6
Li et al[20]	Retrospective	CSM	43	49	56.6	58.0	32/11	37/12	24
Yang et al[21]	Retrospective	CCS	21	16	58.0	63.5	17/4	14/2	12
Li et al[22]	Prospective	CSM/CCS	31	31	56.7	55.4	20/11	18/13	6
Xie et al[23]	Retrospective	CSM	24	24	58.8	60.7	13/11	14/10	24
Zhang et al[24]	Retrospective	CSM	75	60	61.2	62.4	57/18	47/13	12.3/13.7
Zhang et al[25]	Retrospective	CSM/CCS/OPLL	16	18	58.3	62.4	12/4	13/5	6
Zeng et al[26]	Retrospective	CSM/CCS/OPLL	65	53	55.3	56.5	45/20	36/17	12
Chen et al[27]	Retrospective	CSM/CCS	22	30	59.1	53.8	14/8	14/16	12
Chen et al[8]	Prospective	CSM/CCS/OPLL	34	23	60.1	62.2	24/10	17/6	64
Xie et al[28]	Retrospective	CSM/CCS	27	40	59.3	57.6	17/10	27/13	18.3/17.6
Wang et al[29]	Retrospective	CSM	30	48	44.3	46.2	13/17	22/26	17/18
Jiang et al[2]	Retrospective	CCS	32	17	56.0	59.0	20/12	13/4	19/20.5
Chen et al[6]	Retrospective	CSM	29	25	61.2	63.2	25/4	20/5	23.3/25.8
Hu et al[4]	Prospective	CSM/CCS	25	30	54.8	56.3	12/13	17/13	20.1/21.5

CCS = cervical canal stenosis, CSM = cervical spondylotic myelopathy, OPLL = ossification of the posterior longitudinal ligament.

5.2. Baseline characteristics and quality assessment

There were 25 studies included in this meta-analysis. These studies were published between 2012 and 2016. The number of study patients in mini-plate group and suture suspensory group ranged from 15 to 96 (total 829) and from 14 to 60 (total 774), respectively. Four studies were published in English, and the other 21 studies were in Chinese. Characteristics of included studies are presented in Table 1.[9–29]

As all studies included were nonrandomized controlled studies (3 in prospective and 22 in retrospective), the NOS was used to assess the quality of each study. Of these, 20 studies scored 8 points and 5 studies scored 7 points. Therefore, the quality of each study was relatively high (Table 2).

5.3. Clinical evaluation

Twenty-four studies reported the JOA scores (n = 733 in mini-plate group, and n = 728 in suture group). There was no statistically significant difference between mini-plate group and suture group in preoperative JOA scores [$P = 0.72$, MD = −0.03 (−0.22, 0.15); heterogeneity: $P = 0.98$, $I^2 = 0\%$, Fixed-effect model]. However, there were statistically significant differences between mini-plate group and suture group in postoperative JOA scores [$P < 0.001$, MD = 0.67 (0.34, 0.99); heterogeneity: $P < 0.001$, $I^2 = 64\%$, Random-effect model] (Fig. 2).

Thirteen studies reported the JOA scores improvement rate (n = 497 in mini-plate group, and n = 433 in suture group). There were statistically significant differences between mini-plate group and suture group in JOA scores improvement rate [$P < 0.001$, MD = 4.00 (2.51, 5.50); heterogeneity: $P = 0.09$, $I^2 = 37\%$, Fixed-effect model] (Fig. 2).

Table 2

The quality assessment according to the Newcastle Ottawa Scale (NOS) of each study.

Study	Selection	Comparability	Exposure	Total score
Wei et al [9]	3	2	3	8
Wu et al [10]	3	2	3	8
Liu et al [11]	3	2	2	7
Zhang et al [12]	3	2	3	8
Sun et al [13]	3	2	2	7
Zhang et al [14]	3	2	2	7
Jiang et al [15]	3	2	3	8
Hao et al [16]	3	2	3	8
He et al [17]	3	2	3	8
Zhou et al [18]	3	2	3	8
Huang et al [19]	3	2	2	7
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Xie et al [23]	3	2	3	8
Zhang et al [24]	3	2	2	7
Zhang et al [25]	3	2	3	8
Zeng et al [26]	3	2	3	8
Chen et al [27]	3	2	3	8
Chen et al [8]	3	2	3	8
Xie et al [28]	3	2	3	8
Wang et al [29]	3	2	3	8
Jiang et al [2]	3	2	3	8
Chen et al [6]	3	2	3	8
Hu et al [4]	3	2	3	8

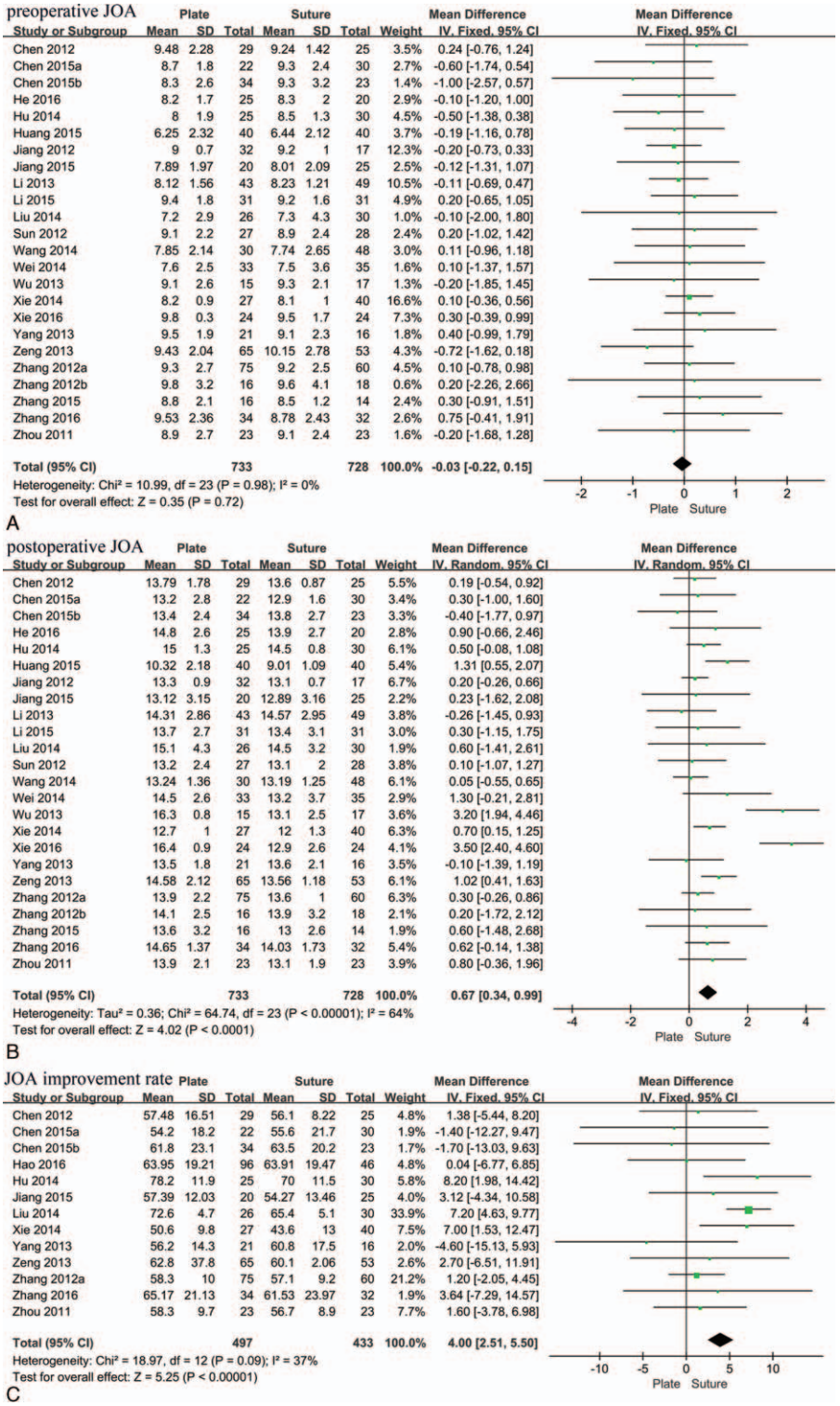

Figure 2. Forest plots of preoperative JOA (A), postoperative JOA (B), and JOA scores improvement rate (C) in the mini-plate fixation group and suture suspensory fixation group.

Four studies reported the VAS (n = 148 in mini-plate group and n = 126 in suture group). There was no statistically significant difference between mini-plate group and suture group in preoperative VAS [$P = 0.82$, MD = −0.05 (−0.37, 0.46); heterogeneity: $P = 0.85$, $I^2 = 0\%$, Fixed-effect model]. However, there were statistically significant differences between mini-plate group and suture group in postoperative VAS [$P = 0.004$, MD = −0.81 (−1.36, −0.26); heterogeneity: $P = 0.006$, $I^2 = 76\%$, Random-effect model] (Fig. 3).

5.4. Complications

Sixteen studies reported axial symptoms (n = 518 in mini-plate group and n = 459 in suture group). There were statistically

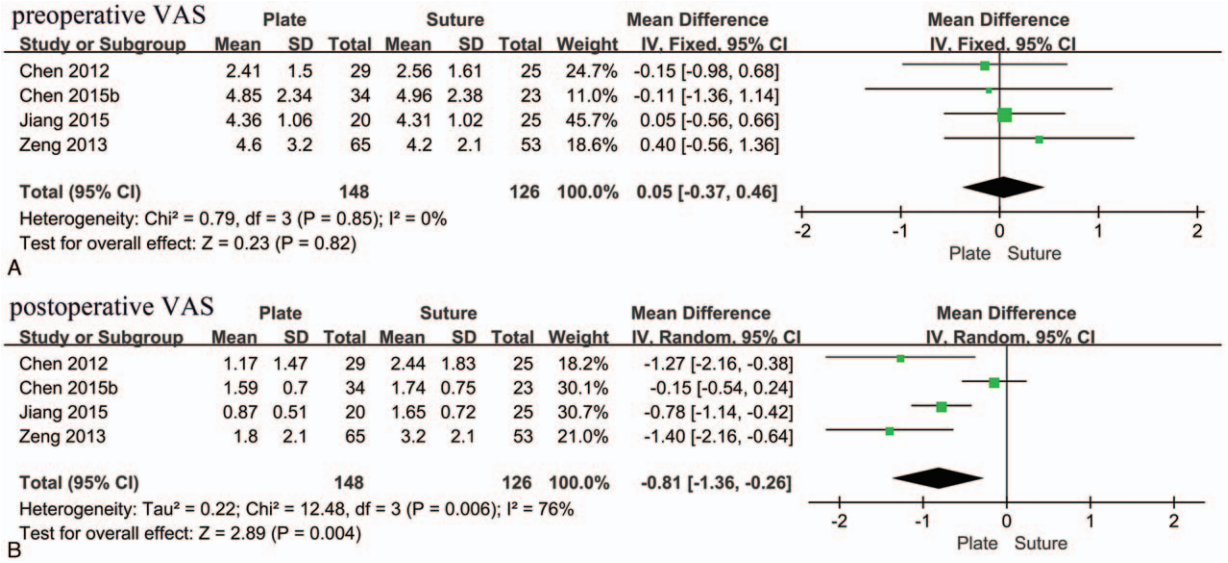

Figure 3. Forest plots of preoperative VAS (A) and postoperative VAS (B) in the mini-plate fixation group and suture suspensory fixation group.

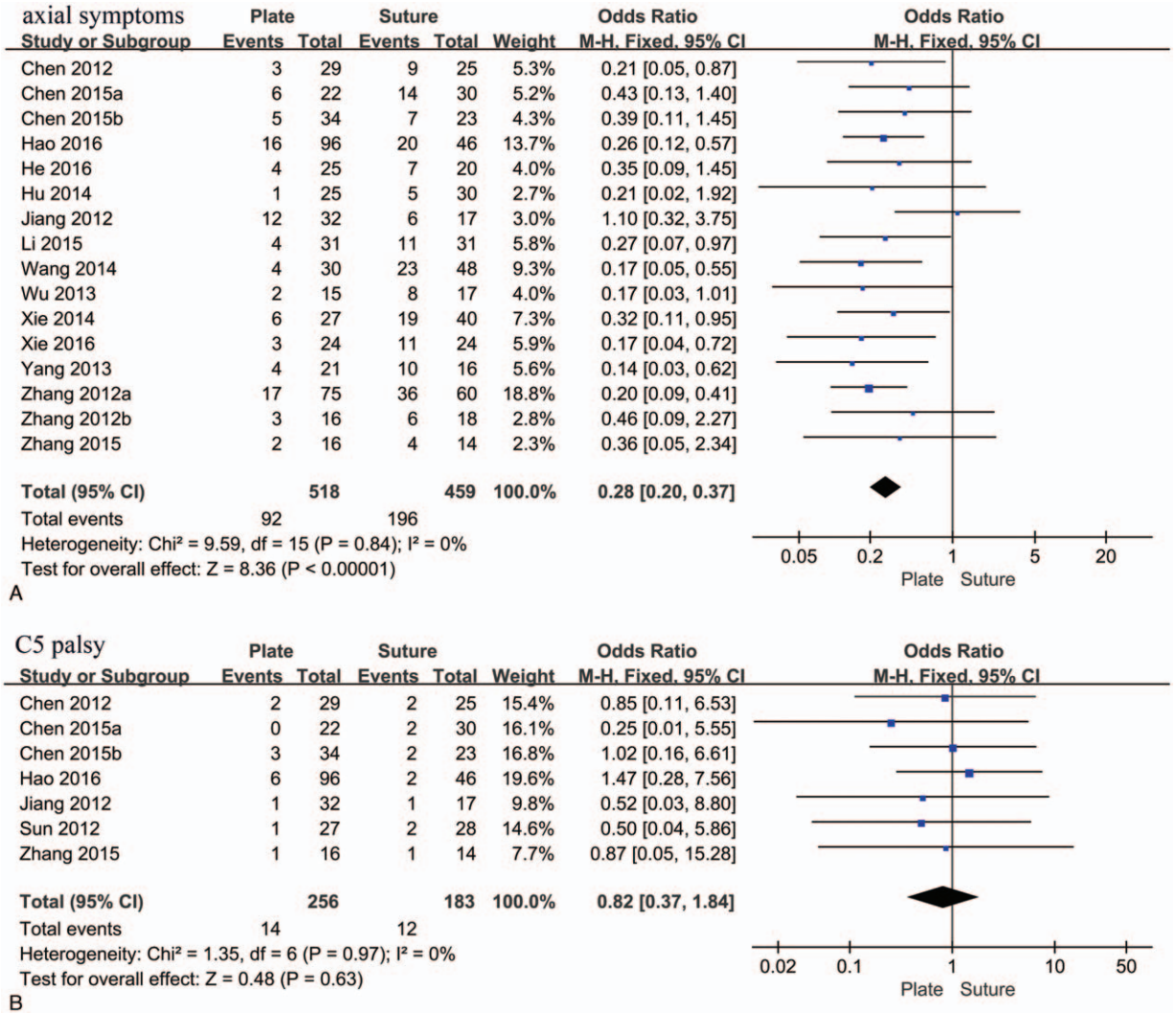

Figure 4. Forest plots of axial symptoms (A) and C5 palsy (B) in the mini-plate fixation group and suture suspensory fixation group.

significant differences between mini-plate group and suture group in axial symptoms [$P < 0.001$, OR = 0.28 (0.20, 0.37); heterogeneity: $P = 0.84$, $I^2 = 0\%$, Fixed-effect model].

Seven studies reported C5 palsy (n = 256 in mini-plate group and n = 183 in suture group). There was no statistically significant difference between mini-plate group and suture group in C5 palsy [$P = 0.63$, OR = 0.82 (0.37, 1.84); heterogeneity: $P = 0.97$, $I^2 = 0\%$, Fixed-effect model] (Fig. 4).

6. Radiography evaluation

Nine studies reported the ROM (n = 229 in mini-plate group and n = 210 in suture group). There was no statistically significant difference between mini-plate group and suture group in preoperative ROM [$P = 0.44$, MD = −0.32 (−1.13, 0.49); heterogeneity: $P = 0.72$, $I^2 = 0\%$, Fixed-effect model]. However, there were statistically significant differences between mini-plate group and suture group in postoperative ROM [$P < 0.001$, MD = 4.15 (2.06, 6.23); heterogeneity: $P < 0.001$, $I^2 = 84\%$, Random-effect model] (Fig. 5).

Fifteen studies reported the cervical lordosis (n = 493 in mini-plate group and n = 482 in suture group). There was no statistically significant difference between mini-plate group and suture group in preoperative cervical lordosis [$P = 0.91$, MD = 0.03 (−0.51, 0.57); heterogeneity: $P = 0.89$, $I^2 = 0\%$, Fixed-effect model]. However, there were statistically significant differences between mini-plate group and suture group in postoperative cervical lordosis [$P < 0.001$, MD = 3.10 (2.02, 4.18); heterogeneity: $P < 0.001$, $I^2 = 75\%$, Random-effect model] (Fig. 6).

Six studies reported anteroposterior diameter of the spinal canal (n = 150 in mini-plate group and n = 120 in suture group). There was no statistically significant difference between mini-plate group and suture group in preoperative anteroposterior diameter of the spinal canal [$P = 0.08$, MD = −0.39 (−0.81, 0.04); heterogeneity: $P = 0.56$, $I^2 = 0\%$, Fixed-effect model]. However, there were statistically significant differences between mini-plate group and suture group in postoperative anteroposterior diameter of the spinal canal [$P = 0.03$, MD = 1.53 (0.11, 2.95); heterogeneity: $P < 0.001$, $I^2 = 86\%$, Random-effect model] (Fig. 7).

Six studies reported open angle (n = 208 in mini-plate group and n = 193 in suture group). There were statistically significant differences between mini-plate group and suture group in postoperative open angle [$P = 0.03$, MD = 1.93 (0.14, 3.71); heterogeneity: $P = 0.03$, $I^2 = 61\%$, Random-effect model] (Fig. 7).

Four studies reported cross-sectional area of the spinal canal (n = 109 in mini-plate group and n = 102 in suture group). There was no statistically significant difference between mini-plate group and suture group in preoperative cross-sectional area of the spinal canal [$P = 0.57$, MD = −2.26 (−11.69, 6.64); heterogeneity: $P = 0.96$, $I^2 = 0\%$, Fixed-effect model]. However, there were statistically significant differences between mini-plate group and suture group in postoperative cross-sectional area of the spinal canal [$P < 0.001$, MD = 37.10 (26.92, 47.29); heterogeneity: $P = 0.15$, $I^2 = 44\%$, Fixed-effect model] (Fig. 8).

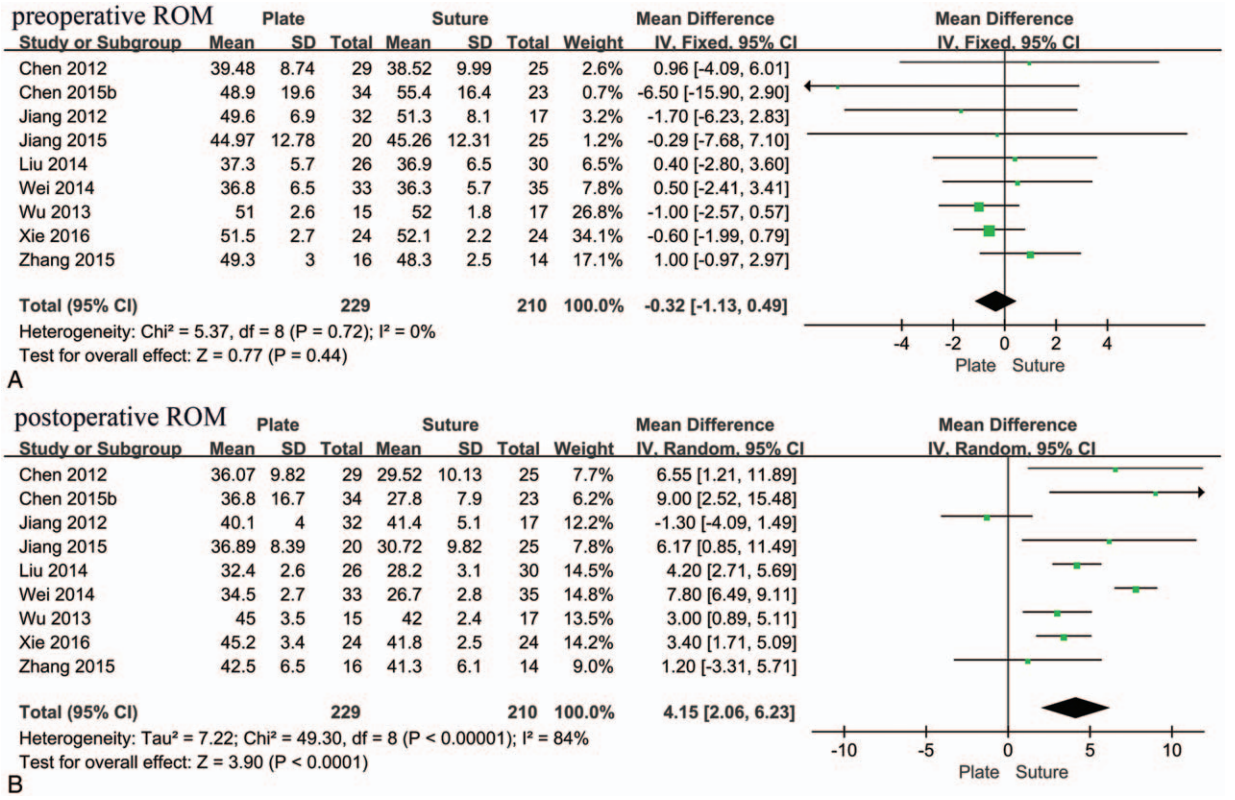

Figure 5. Forest plots of preoperative ROM (A) and postoperative ROM (B) in the mini-plate fixation group and suture suspensory fixation group.

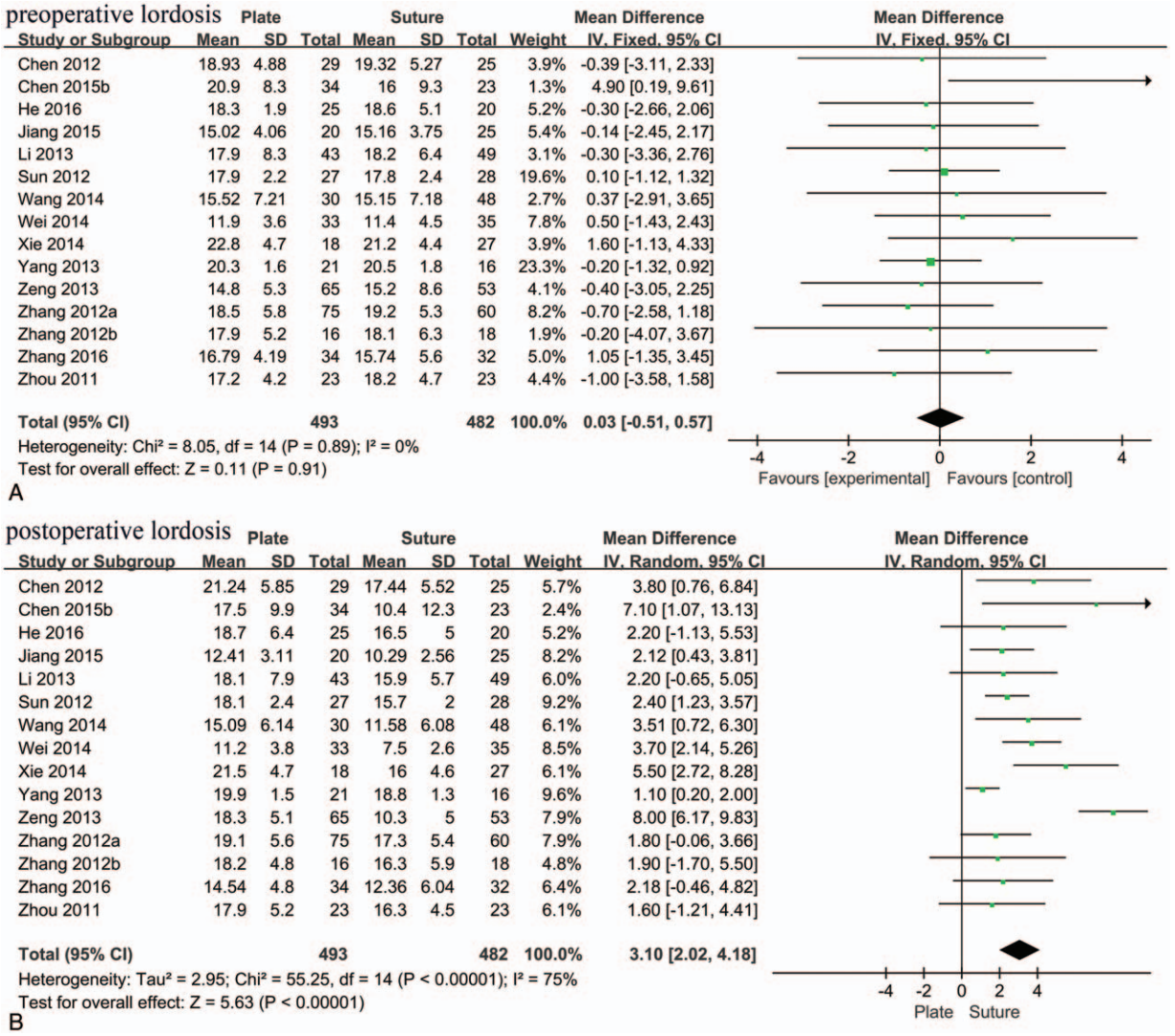

Figure 6. Forest plots of preoperative cervical lordosis (A) and postoperative cervical lordosis (B) in the mini-plate fixation group and suture suspensory fixation group.

6.1. Operation time and blood loss

Twenty studies reported operation time and blood loss (n = 644 in mini-plate group and n = 597 in suture group). There were statistically significant differences between mini-plate group and suture group in operation time [$P = 0.02$, MD = 4.46 (0.74, 8.19); heterogeneity: $P = 0.002$, $I^2 = 54\%$, Random-effect model]. There were statistically significant differences between mini-plate group and suture group in blood loss [$P < 0.001$, MD = 9.24 (6.86, 11.62); heterogeneity: $P = 0.02$, $I^2 = 44\%$, Fixed-effect model] (Fig. 9).

6.2. Sensitivity analysis

To confirm the stability of the meta-analysis, sensitivity analysis was performed by sequentially omitting individual eligible studies. The pooled results were not materially changed after any single study was excluded that indicated the stability of the results.

6.3. Publication bias

Assessment of publication bias for included studies was performed by funnel plots on visual inspection (Fig. 10). Funnel plots showed nearly symmetric for operation time, blood loss, preoperative JOA, axial symptom, and preoperative cervical lordosis, indicating no significant publication bias among the included studies.

7. Discussion

Cervical laminoplasty can achieve satisfactory outcomes in the treatment of MCCM by effectively decompressing the spinal cord.[8] To fix the opened laminae, both the mini-plate fixation and suture suspensory fixation techniques are widely used in cervical laminoplasty. It has not been ascertained for which technique is superior. Chen et al[6] reported that laminoplasty by mini-plate fixation preserved more cervical ROM and better cervical alignment, but there were no significant differences in

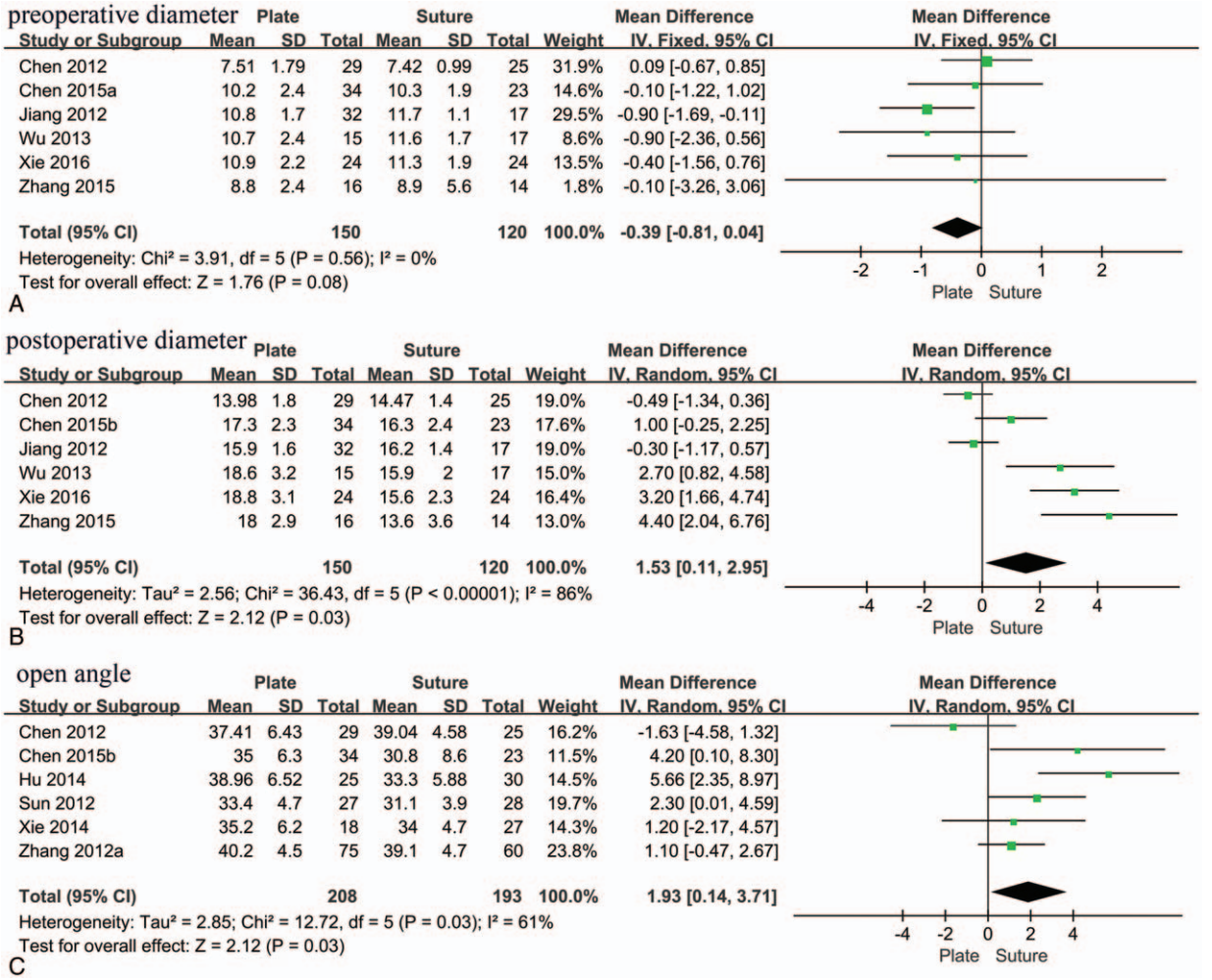

Figure 7. Forest plots of preoperative anteroposterior diameter of the spinal canal (A), postoperative anteroposterior diameter of the spinal canal (B), and open angle (C) in the mini-plate fixation group and suture suspensory fixation group.

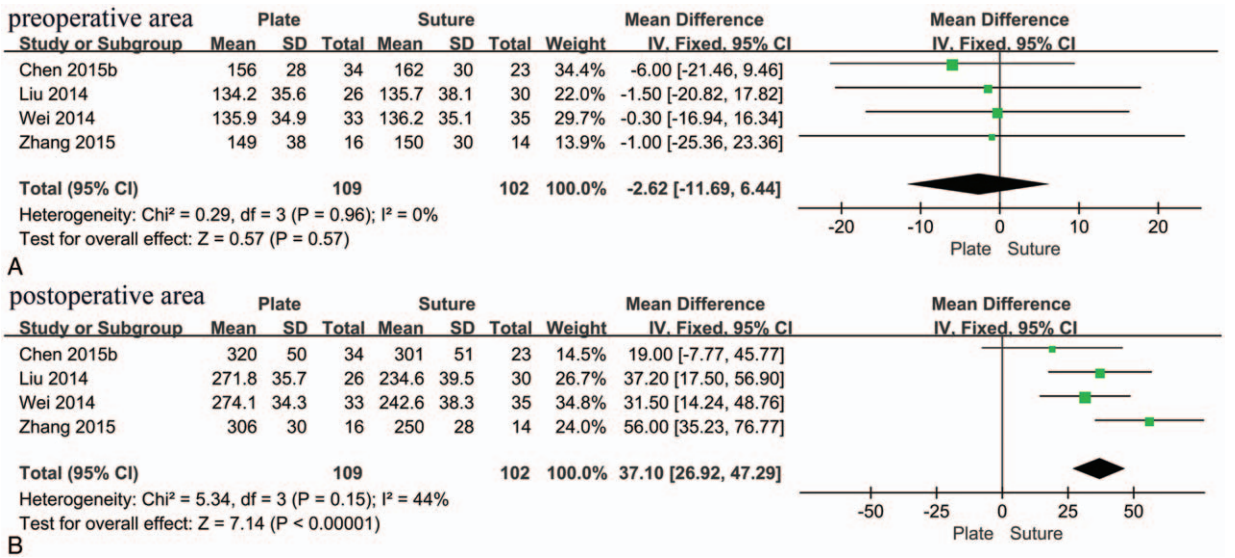

Figure 8. Forest plots of preoperative cross-sectional area of the spinal canal (A) and postoperative cross-sectional area of the spinal canal (B) in the mini-plate fixation group and suture suspensory fixation group.

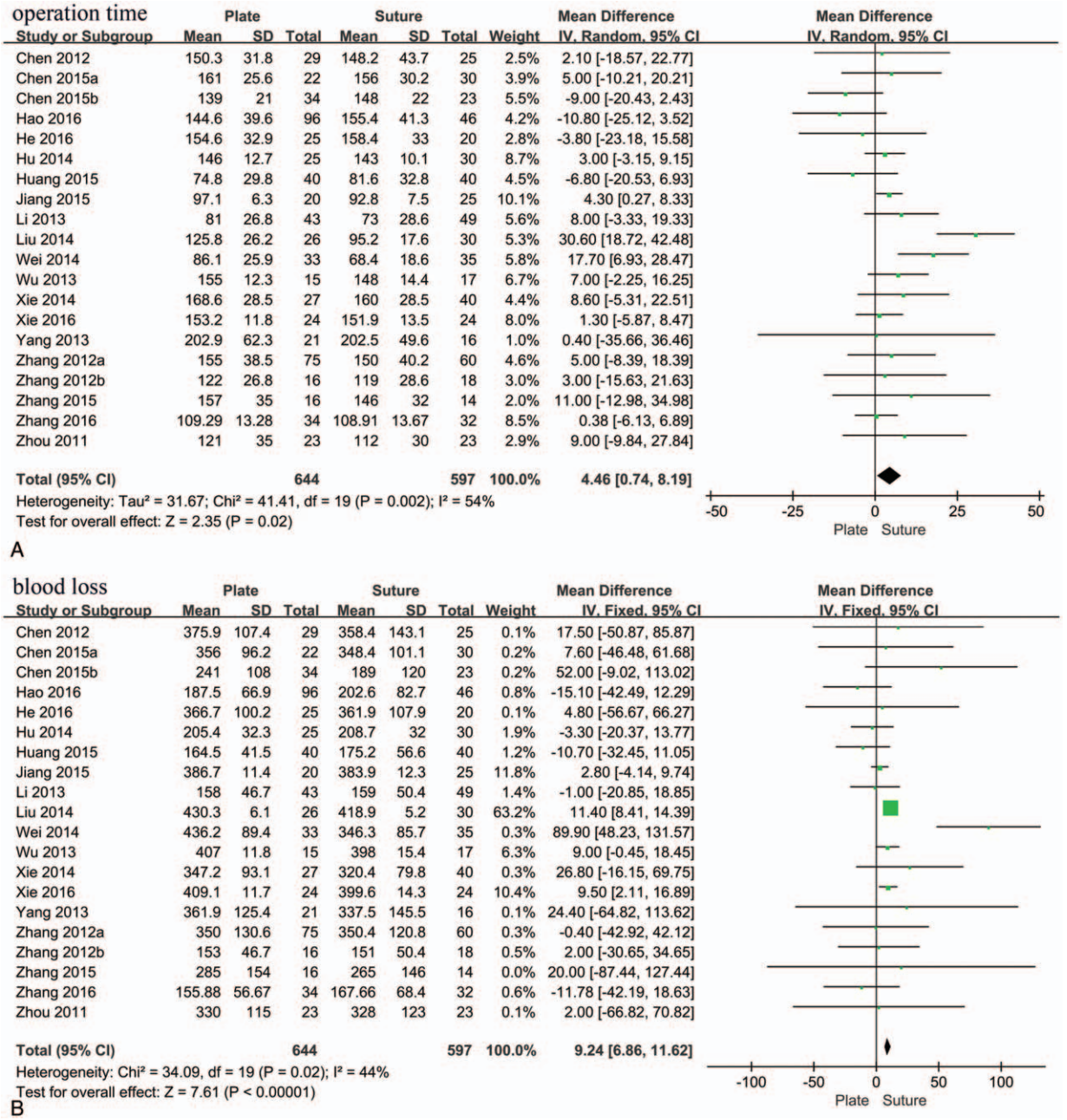

Figure 9. Forest plots of operation time (A) and blood loss (B) in the mini-plate fixation group and suture suspensory fixation group.

preoperative and postoperative JOA scores. Jiang et al[2] reported that no significant difference was found in mean cervical ROM reduction and axial symptoms between 2 groups. Qi et al[7] conducted a meta-analysis based on 6 studies, which showed that suture suspensory fixation was associated with better postoperative JOA scores and mini-plate fixation was superior in reducing the incidence of surgical complications.

In this meta-analysis, we combined 25 studies that included a total of 829 patients in mini-plate group and 774 patients in suture suspensory group. As compared with suture suspensory fixation in cervical laminoplasty, mini-plate fixation appears to achieve better clinical and radiographic outcomes with fewer surgical complications. However, operation time was long and blood loss was more in mini-plate fixation group.

JOA scores and VAS were often used to evaluate clinical outcomes.[9] The pooled data showed that there was no statistically significant difference in preoperative JOA scores and VAS between 2 groups. However, there were statistically significant differences in postoperative JOA scores, JOA score improvement rate, and VAS between 2 groups that indicated mini-plate fixation was superior to suture suspensory fixation in improving clinical outcomes.

Open angle, anteroposterior diameter, and cross-sectional area of the spinal canal were often used to evaluate drifting of the spinal cord and decompressive outcome.[10] The pooled data showed that there was no statistically significant difference in preoperative anteroposterior diameter and cross-sectional area of the spinal canal between 2 groups. However, there were

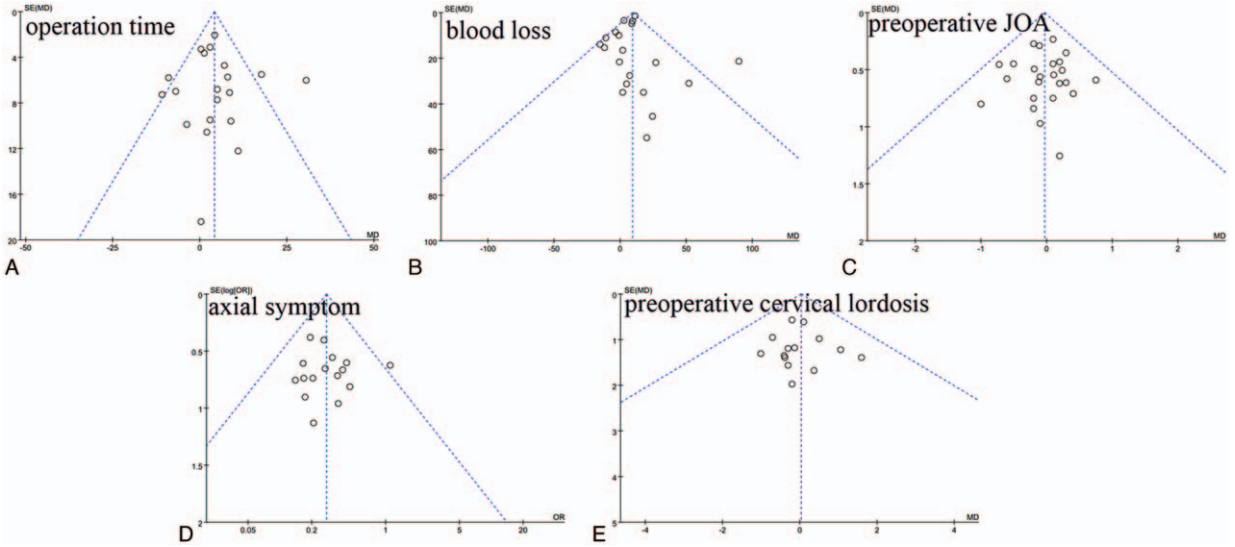

Figure 10. Funnel plots for operation time (A), blood loss (B), preoperative JOA (C), axial symptom (D), and preoperative cervical lordosis (E).

statistically significant differences in postoperative open angle, anteroposterior diameter, and cross-sectional area between 2 groups that indicated mini-plate fixation was superior to suture suspensory fixation in drifting of the spinal cord and decompressive outcome. Suture suspensory fixation do not provide enough rigid fixation, it may cut out or stretch over time, and the potential for lamina closure always exists.[11] However, mini-plate fixation is efficient to prevent lamina closure by offering the lamina immediately rigid fixation, to get greater drifting of the spinal cord and better postoperative JOA scores and VAS, and to improve clinical outcomes. So, mini-plate fixation is better than suture suspensory fixation in preventing laminar closure after cervical laminoplasty.[12]

ROM and cervical lordosis were selected for analysis. The pooled data showed that there was no statistically significant difference in preoperative ROM and cervical lordosis between 2 groups. However, there were statistically significant differences in postoperative ROM and cervical lordosis between 2 groups, which indicated mini-plate fixation was superior to suture suspensory fixation in preserving cervical ROM and cervical alignment. Patients with suture suspensory fixation need to immobilize for more time that cause cervical back muscle adhesion and atrophy.[13] However, mini-plate fixation can offer the lamina immediately rigid fixation and early functional exercise that may preserve cervical ROM and cervical alignment.[14]

Axial symptoms and C5 palsy were selected for analysis to evaluate postoperative complications.[15] The pooled data showed that there was no statistically significant difference in C5 palsy between 2 groups. However, there were statistically significant differences in axial symptoms between 2 groups, which indicated mini-plate fixation was superior to suture suspensory fixation in reducing the incidence of axial symptoms. Axial symptoms, including neck pain, neck stiffness, shoulder pain, and shoulder stiffness, are the most frequent complaints after cervical laminoplasty which reported to occur in as many as 60% to 80% of patients who undergo laminoplasty.[16] Three possible sources for axial symptoms have been proposed: the nuchal muscle, facet joints, and nerve root.[17] On one hand, suture suspensory fixation may damage the paravertebral muscle and facet joints.[18] On the other hand, patients with suture suspensory fixation need to immobilize for more time that cause cervical back muscle adhesion and atrophy may also case axial symptoms.[19]

Operation time and blood loss were important factors for assessing surgical trauma. The pooled data showed that there were statistically significant differences in operation time and blood loss that indicated mini-plate fixation was associated with bigger surgical trauma. For patients with underlying diseases, such as cardiovascular and cerebrovascular diseases, suture suspensory fixation may be more suit and safe.[20] However, the additional operation time and blood loss for mini-plate fixation averaged 5 minutes and 12 mL. Compared with total operative time and blood loss, the additional operation time and blood loss are tolerable.[21] At the same time, the proficiency of surgeon should also be considered.[22]

Although mini-plate fixation are superior to suture suspensory fixation in improving clinical outcomes, the cost of these mini-plate systems are high owing to the high costs of materials and processing technology.[23] According to China's national conditions, a big part of patients are from the countryside. They may not be able to pay high operation cost and suture suspensory fixation may be a good choice. So, we need to seek cheaper materials to replace titanium plate, which can be widely used in all patients.

8. Study limitations

There were several limitations in this study. First, none of the included studies was a randomized controlled study. Second, our meta-analysis presents substantial heterogeneity, and it may result some degrees of measurement bias, though we used a random-effects model for the statistical heterogeneity. Third, follow-up time varied between the studies and thus may have influenced our results. Finally, lamina closure was an important complication after cervical laminoplasty with suture suspensory fixation, but relevant data were few and meta-analysis could not be performed.

9. Conclusions

As compared with suture suspensory fixation in cervical laminoplasty, mini-plate fixation appears to achieve better clinical and radiographic outcomes with fewer surgical complications. So, mini-plate fixation may be a better choice during laminoplasty for patients with MCCM. Considering the limitations noted above, this conclusion should be interpreted cautiously and more high-quality, randomized controlled trials are needed in the future.

References

[1] Liu FY, Yang SD, Huo LS, et al. Laminoplasty versus laminectomy and fusion for multilevel cervical compressive myelopathy: a meta-analysis. Medicine (Baltimore) 2016;95:3588.

[2] Jiang L, Chen W, Chen Q, et al. Clinical application of a new plate fixation system in open-door laminoplasty. Orthopedics 2012;35: 225–31.

[3] Hirabayashi K, Miyakawa J, Satomi K, et al. Operative results and postoperative progression of ossification among patients with ossification of cervical posterior longitudinal ligament. Spine (Phila Pa 1976) 1981;6:354–64.

[4] Hu W, Shen X, Sun T, et al. Laminar reclosure after single open-door laminoplasty using titanium miniplates versus suture anchors. Orthopedics 2014;37:71–8.

[5] O'Brien MF, Peterson D, Casey AT, et al. A novel technique for laminoplasty augmentation of spinal canal area using titanium miniplate stabilization: a computerized morphometric analysis. Spine (Phila Pa 1976) 1996;21:474–83.

[6] Chen G, Luo Z, Nalajala B, et al. Expansive open-door laminoplasty with titanium miniplate versus sutures. Orthopedics 2012;35:543–8.

[7] Qi Q, Li L, Luo J, et al. Is mini-plate fixation superior to suture suspensory fixation in cervical laminoplasty? A meta-analysis. World Neurosurg 2016;93:144–53.

[8] Chen H, Deng Y, Li T, et al. Clinical and radiography results of miniplate fixation compared to suture suspensory fixation in cervical laminoplasty: a five-year follow-up study. Clin Neurol Neurosurg 2015;138:188–95.

[9] Wei XY, Chen YZ, Wang JX, et al. Evaluation of the clinical effect of three kinds of cervical unilateral open-door laminoplasty in posterior access. Zhong Yi Zheng Gu 2014;26:19–24.

[10] Wu ZW, Ren SJ, Sheng XY, et al. Centerpiece plating in the cervical spine open-door laminoplasty. China J Orthop Trauma 2013;26:252–6.

[11] Liu YP, Wang JX, Chen YZ, et al. Validity of centerpiece titanium plate in cervical laminoplasty. Zhong Guo Yi Yao Dao Bao 2014;11:30–3.

[12] Zhang X, Zhu YR, Tang JH, et al. Centerpiece plating in unilateral open-door cervical expansive laminoplasty. J Spinal Surg 2015;13:94–7.

[13] Sun L, Song YM, Liu LM, et al. Centerpiece titanium miniplate for senile cervical expansive open-door laminoplasty: a retrospective analysis of 27 cases. Chin J Mult Organ Dis Elderly 2012;11:917–21.

[14] Zhang RZ, Zhang XL, Hu W, et al. Effect of different vertebral lamina fixation methods of EOLP on cervical curvature and axial symptoms. Chong Qing Yi Xue 2010;45:782–6.

[15] Jiang LQ, Yue YL, Yan JY, et al. Effect of different fixation methods of cervical expansive laminoplasty on cervical curvature and range of motion. Modern Journal of Integrated Traditional Chinese and Western Medicine 2015;24:2445–7.

[16] Hao XR. The related efficacy comparison and analysis for different open-door laminoplasty. Shan Xi Medical University 2016; Academic Dissertation; Surgery: 1–26.

[17] He YZ. Open-door laminoplasty with titanium miniplate in the treatment of cervical spondylotic myelopathy. Shan Dong Yi Yao 2016;56:54–6.

[18] Zhou F, Yang HL, Wang GS, et al. Mini titanium plate fixation versus suture suspension fixation in ELAP for treatment of cervical spondylotic myelopathy. Orthop J China 2011;19:1761–4.

[19] Huang CH, Wu YQ, Lu HC. An investigation of clinical effects of different fixing approaches of vertebral plate in cervical vertebra open-door expansive laminoplasty in the treatment of multi-segmental cervical spondylotic myelopathy. China Modern Doctor 2015;53:12–8.

[20] Li YW, Wang HJ, Yan XY, et al. Posterior cervical iaminoplasty by using two different vertebral plates for multi segmental cervical spondylotie myelopathy. Chinese J Spine Spinal Cord 2013;23:973–8.

[21] Yang LQ, Shang Y, Yu PF. Comparison of clinical efficacy between titanium plate fixation and suture suspension fixation in the expansive open-door laminoplasty. J Shanxi Med Univ 2013;44:307–10.

[22] Li GW, Zhang XL, Zhu RS. Clinical efficacy of titanium plate fixation in the expansive open-door laminoplasty. World Clin Med 2015;9:57.

[23] Xie S, Zhu SB. Interval application of mini titanium plate in posterior single door surgery: a curative effect evaluation. Orthop J China 2016;24:204–7.

[24] Zhang SW, Fan CH, Wen JT. Evaluate the clinical effects of microplate fixation in open-door cervical expansive laminoplasty. Zhong Hua Zhong Yi Xue Hui Gu Shang Ke Fen Hui 2012;141–4.

[25] Zhang SM, Zhou W, Li X, et al. Clinical applicafion of titanium miniplate in cervical expansive open-door laminoplasty. China J Orthop Trauma 2012;25:4–8.

[26] Zeng SX, Zhan SQ, Chang YB. The application of using micro-titanium plate fixation in unilateral single-door laminoplasty and comparison of efficacy. Chinese J Clin Anat 2013;31:582–5.

[27] Chen JY, Liu ZL, Yang ZF, et al. Application of titanium miniplate internal fixation in the posterior cervical laminoplasty. Med J Qilu 2015;30:592–4.

[28] Xie BZ, Hua Q, Zhao HY. Application of titanium miniplate to posterior cervical laminoplasty: a short-term follow-up. Chinese J Tissue Eng Res 2014;18:5681–6.

[29] Wang JY, Zhang CL, Zhai FY, et al. Minimally invasive cervical laminoplasty versus single-door laminoplasty for treatment of cervical spondylotic myelopathy. Chinese J Tissue Eng Res 2014;18:1380–5.