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ORIGINAL ARTICLE

# Efficacy and safety of acupuncture combined with bone-setting in the treatment of cervical vertigo: A systematic review and meta-analysis

Wei Chen, MD*, Zhenzhen Ning, MD*, Wei Li, MD, Hao Wang, MD, Lianghua Zhang, MD, Shuang Li, MD, Xiaogang Yu, MD

Department of TCM Acupuncture, Beijing Hospital of Integrated Traditional Chinese and Western Medicine, Beijing City, China

Cervical vertigo (CV) refers to a clinical syndrome with vertigo as the main manifestation caused by abnormal cervical spine structure or function. Its pathogenesis is complex and may involve various factors, such as cervical proprioception, the vestibular system and the vertebral artery (VA) blood supply. As its symptoms are often similar to those of other types of vertigo (e.g., vestibular vertigo, central vertigo), the clinical diagnosis is somewhat controversial.[1] This study focuses on CV caused by VA-type cervical spondylosis, which is a symptom of vertigo caused by degenerative compression of the vertebral arteries in the cervical spine and insufficient blood supply to the vertebral basilar artery (BA). In recent years, with lifestyle

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**Correspondence**: Xiaogang Yu, MD. Department of TCM Acupuncture, Beijing Hospital of Integrated Traditional Chinese and Western Medicine, Beijing City, 100039, China.

E-mail: yuxg2025xg@163.com

** These authors contributed equally to this work.*

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## ABSTRACT

**Objectives:** In this meta-analysis, we aimed to evaluate systematically the effectiveness and safety of acupuncture combined with bone-setting in the treatment of cervical vertigo (CV).

**Materials and methods:** A systematic search was conducted across three English databases (PubMed, the Web of Science and the National Library of Medicine) and two Chinese databases (the China National Knowledge Infrastructure and the Wanfang Database). The search timeframe spanned from the inception of each database until 31 January 2025. The search terms were as follows: *(i)* 'Bone-setting' OR 'Bone Setting' OR 'Chinese Osteopathy' OR 'Chiropractic manipulation'; *(ii)* 'Acupuncture and Moxibustion' OR 'Acupuncture' OR 'Traditional Chinese acupuncture' OR 'Electroacupuncture' OR 'fire acupuncture' OR 'warm acupuncture'; *(iii)* 'Cervical Vertigo' OR 'Vertebral Artery Cervical Spondylosis' OR 'CV'.

**Results:** A total of 15 articles were included, all of which were randomized-controlled trials (RCTs), involving 2,320 participants. The meta-analysis results showed that, compared to using acupuncture alone or bone-setting alone for CV, the combined therapy demonstrated a significantly higher overall clinical efficacy rate (odds ratio [OR]=3.88, 95% confidence interval [CI]: 2.89, 5.19, p<0.001), significantly better symptoms and functional assessment scores for CV (mean difference [MD]=4.01, 95% CI: 3.19, 4.83, p<0.001), significantly better mean flow velocity (Vm) in the vertebral artery (MD=3.21, 95% CI: 1.58, 4.84, p<0.001), significantly better Vm in the basilar artery (MD=5.09, 95% CI: 0.78, 9.40, p=0.02) and better quality of life scores (MD=9.83, 95% CI: 5.89, 13.77, p<0.001).

**Conclusion:** Acupuncture combined with bone-setting may be superior to monotherapy in improving symptoms, function and cerebral blood flow in patients with CV, with fewer and milder adverse effects. However, due to the limited methodological quality of the included studies, more high-quality, large-sample RCTs are needed to further validate these results.

***Keywords:*** Acupoint, acupuncture therapy, cervical vertigo.

changes, the incidence of CV has shown an upward trend and is affecting young individuals at an increasingly early age.[2]

Currently, acupuncture (including electroacupuncture, warm needling and other techniques) is one of the common methods for treating CV. A systematic review and meta-analysis included 11 randomized-controlled trials (RCTs) to evaluate the clinical efficacy of acupuncture for CV. The results indicated that the clinical efficacy rate of acupuncture was higher than that of other treatments, such as tuina.[3] Furthermore, traditional Chinese medicine bone-setting can alleviate symptoms by adjusting the position of the cervical spine and reducing the compression of vertebral arteries and sympathetic nerves.[4] Currently, there are various methods of acupuncture treatment for CV, and the main principle is to improve the blood supply of the compressed VA in the cervical vertebrae as to improve the posterior circulation disorder of the brain and achieve the purpose of treating vertigo.[5] Through changing the abnormal mechanical relationship of cervical vertebrae bones and eliminating the stimulating factors, bone-setting can effectively improve the clinical symptoms of CV. However, due to the close relationship between tendons and bones, the clinical efficacy of relying solely on bone-setting treatment is limited. If bone-setting is combined with acupuncture treatment for CV, the bone-setting treatment can adjust the cervical vertebrae arrangement, and acupuncture can improve the blood supply of the VA. The clinical efficacy of the combination of the two may be better than using acupuncture alone or bone-setting alone. The combined treatment of the two is also the practical application of the theory of 'synergistic adjustment of tendons and bones'. However, there are no relevant systematic evaluation results to confirm this. The study by Hu et al.[6] reported that, compared to conventional needle-knife dissection treatment, the combination of needle-knife and three-dimensional positioning balance chiropractic manipulation for patients with CV can significantly improve the hemodynamic indicators of the VA, and the clinical efficacy and safety are also higher.

In this systematic review and meta-analysis, we aimed collect the published literature at home and abroad regarding the clinical efficacy of acupuncture combined with bone-setting for CV and to systematically evaluate the effectiveness and safety of acupuncture combined with bone-setting for CV, with the aim of providing a basis for future research and clinical practice.

## MATERIALS AND METHODS

### Literature search strategy

This study registration has now been completed, and the registration number is INPLASY202580026.

In accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guideline manual, systematic searches were conducted in five English databases (PubMed, the Cochrane Library, Embase, the Web of Science and the National Library of Medicine) and four Chinese databases (the China National Knowledge Infrastructure, the Wanfang Database, the China Biomedical Literature Database and the VIP Chinese Science and Technology Journal Full-text Database). The search period covered from the establishment of the databases until 31 January 2025. The search was conducted using a combination of subject terms and free words, and the search strategy was determined after multiple pre-searches. Additionally, a grey literature search was carried out; this involves contacting experts in the field and corresponding authors to obtain important information that was not obtained through the above search. A manual search of relevant journals and books was also conducted, and the references of the included studies were traced to supplement the acquisition of relevant literature. The search terms were as follows: *(i)* 'Bone-setting' OR 'Bone Setting' OR 'Chinese Osteopathy' OR 'Chiropractic manipulation'; *(ii)* 'Acupuncture and Moxibustion' OR 'Acupuncture' OR 'Traditional Chinese acupuncture' OR 'Electroacupuncture' OR 'fire acupuncture' OR 'warm acupuncture'; *(iii)* 'Cervical Vertigo' OR 'Vertebral Artery Cervical Spondylosis' OR 'CV'.

### Inclusion and exclusion criteria for the literature

*Inclusion criteria:*

1. Study type: RCTs

2. Study participants: patients with CV who met the diagnostic criteria of Western and traditional Chinese medicine[7]

3. Interventions: control group received either traditional acupuncture therapy (including electroacupuncture, fire needling and warm needling) or bone-setting therapy (including bone-setting, chiropractic manipulation and manual reduction tuina); experimental group received

bone-setting therapy combined with traditional acupuncture therapy; for acupuncture specifics, selection of acupoints, manipulation techniques and needle retention time were unrestricted; for bone-setting specifics, school/sect affiliation of bone-setting or chiropractic practitioners was not restricted. Other interventions were consistent between both groups.

Acupuncture and bone-setting therapy are common methods of traditional Chinese medicine to treat this disease; however, their efficacy is substantially affected by the operator's experience. To this end, the studies included in this study all adopted the standard operating procedures described in the Diagnostic Efficacy Standards for Traditional Chinese Medicine Syndromes issued by the State Administration of Traditional Chinese Medicine or expert consensus to maximize the reproducibility of treatment.[7]

4. Outcome measures: primary outcome-overall clinical efficacy rate, classified as 'clinical cure' (disappearance of clinical symptoms and signs, restoration of normal neck function), 'markedly effective' (substantial disappearance or alleviation of clinical symptoms and signs and restoration of normal neck function, with only mild symptoms occurring during fatigue or weather changes that do not affect daily life), 'effective' (reduction in clinical symptoms and signs compared to pre-treatment but with some residual symptoms/signs or functional impairment), 'ineffective' (no improvement or worsening of symptoms and signs compared to pre-treatment). Total effective rate = clinical cure + markedly effective + effective. Secondary outcomes-postoperative CV symptom and functional assessment score,[8] postoperative mean flow velocity (Vm) in the VA and BA and the postoperative quality of life score.

*Exclusion criteria:*

1. Studies investigating the mechanisms of CV,

2. Clinical studies primarily focusing on cervicogenic cervical spondylosis, lumbar disc herniation, sacroiliac joint dysfunction or other cervical/lumbosacral spine disorders,

3. Studies with non-compliant diagnostic criteria or irrelevant outcome measures,

4. Studies using non-traditional acupuncture therapies (e.g. acupotomy, traction),

5. Duplicate publications.

**Literature screening and data extraction**

Two researchers independently conducted the literature screening. Initially, the screening was carried out based on the titles and abstracts. Then, the full texts were read and re-screened according to the inclusion and exclusion criteria. In case of disagreement, the opinion of a third researcher was sought for discussion to reach a consensus. After the literature screening was completed, two researchers independently extracted the data. The extracted content included the basic characteristics of the included studies: the first author, publication year, publication region, study type, intervention measures, sample size and outcome indicators.

**Evaluation of literature quality**

The risk of bias in RCTs was assessed using the tool recommended by the Cochrane Handbook 5.1.0.[9] The evaluation contents included the following: *(i)* random sequence generation; *(ii)* allocation concealment; *(iii)* blinding of participants and personnel; *(iv)* blinding of outcome assessment; *(v)* incomplete outcome data; *(vi)* selective reporting; *(vii)* other biases. Each criterion was evaluated using 'low risk bias', 'high-risk bias' or 'unclear'. The quality of the literature was classified into three levels: A (indicating complete compliance with the criteria), B (partial compliance) or C (complete non-compliance). In case of disagreement in the evaluation results, the third researcher was consulted.

**Statistical analysis**

Statistical analysis was performed using the Stata version 16.0 (StataCorp LLC, College Station, TX, USA) and RevMan version 5.4.1 software (The Cochrane Collaboration, Copenhagen, Denmark). Count data were expressed in odds ratio (OR) or rate (%) as the effect indicator, and measurement data were expressed as mean difference (MD) as the effect indicator. All effect values were presented as point estimates and 95% confidence intervals (CIs). Heterogeneity was tested using the chi-square test to determine the magnitude of heterogeneity. If $<50\%$ or $p>0.1$, it was considered that the included studies were homogeneous and the fixed effect model (Mantel-Haenszel) was used for analysis; if $>50\%$ or $p\leq0.1$, it was considered that there was some heterogeneity among the included studies, and the DerSimonian-Laird random effect model was used for analysis. Funnel plots and Egger's test were used for publication bias analysis. Sensitivity

analysis was performed by eliminating studies one by one to assess the impact of each included study on the combined effect indicators. A $p$ value of <0.05 was considered statistically significant.

## RESULTS

### Literature search results

A total of 118 literature studies were retrieved through the database search. After initial screening, 17 duplicate literature studies were eliminated. Based on the inclusion and exclusion criteria, 15 literature studies were finally included for meta-analysis.[10-24] The flowchart of literature screening is shown in Figure 1.

### Baseline characteristics of the included literature and results of literature quality evaluation

The 15 included literature studies were published between 2007 and 2025, and all were from China; they were all RCTs. A total of 2,320 research participants were included in the 15 literature studies, with 1,160 in the experimental group and 1,160 in the control group. The age of the experimental group members ranged from 31.8 to 58.7 years, and that of the control group members ranged from 31.4 to 62.6 years. The basic characteristics of the included literature and the assessment results of bias risk are shown in Table I.

The 15 RCT literature studies included in this current study were evaluated using the RCT bias risk assessment tool recommended by the Cochrane Handbook 5.1.0. The quality evaluation results of 10 literature studies were classified as A,[11,12,14-16,19-21,23,24] and those of five literature studies were classified as B.[10,13,17,18,22] See Supplementary Table I for details.

### Meta-analysis

#### *Overall clinical efficacy rate*

A total of 15 literature studies reported the overall clinical efficacy rate. There was no heterogeneity among the studies ($I^2$=0.0%). A meta-analysis using the fixed-effect model was conducted as shown in Figure 2. The difference in the overall clinical efficacy rate between the treatment group and the control group was statistically significant (OR=3.88,

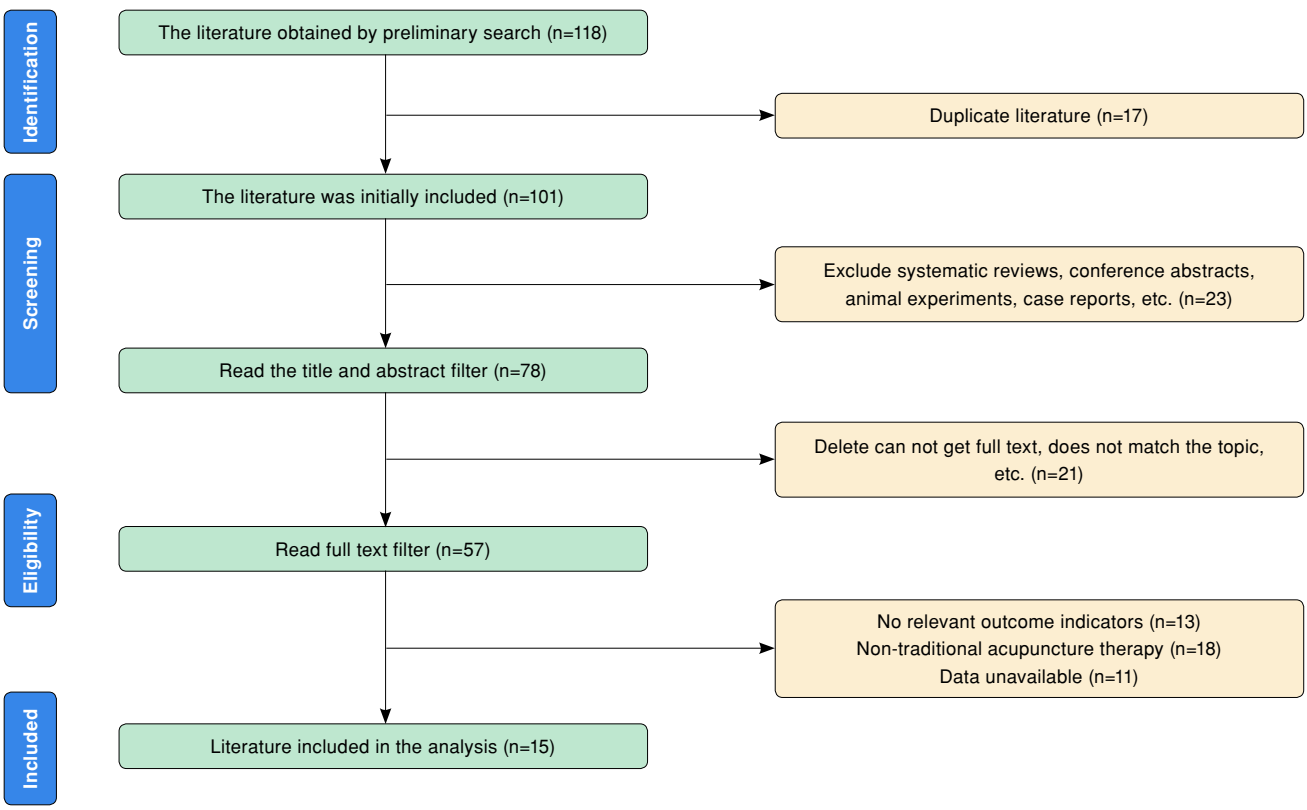



**FIGURE 1.** Literature screening flowchart.

**TABLE I**

Basic characteristics of included studies and Risk of bias assessment

| Included literature | Year of publication | Sample size | | Age | | Intervention measures | | Outcome index | Risk of bias assessment |
|---|---|---|---|---|---|---|---|---|---|
| | | E | C | E | C | E | C | | |
| She et al.[10] | 2013 | 31 | 31 | 41.5±9.8 | 39.2±9.2 | "Three Needles for the Neck" + Bone-setting | "Three Needles for the Neck" | 1,2 | B |
| Liang et al.[11] | 2021 | 45 | 45 | 45.5±7.6 | 45.6±7.5 | Acupuncture + Bone-setting | Cephalo-jaw traction and reduction | 1,2 | A |
| Liu et al.[12] | 2019 | 30 | 30 | 58.7±10.4 | 62.6±9.8 | Cluster and parallel stabbing technique + cervicoaxial joint reduction technique | Massage and manipulation | 1,3 | A |
| Fu[13] | 2018 | 100 | 100 | 54.2±10.9 | 54.6±10.3 | Acupuncture + massage and manipulation | Acupuncture | 1,2,4 | B |
| Cheng et al.[14] | 2018 | 450 | 450 | 33.28±5.21 | 34.56±4.78 | Acupuncture + Tuina technique | Acupuncture | 1,2,3 | A |
| Li[15] | 2009 | 33 | 32 | 47.1+15.0 | 48.4+17.3 | Acupuncture + bone-setting | Acupuncture | 1,2,3,5 | A |
| Hu[16] | 2013 | 40 | 40 | 51.5±8.6 | 50.9 ±10.4 | Acupuncture + long-style chiropractic manipulation | Acupuncture | 1,2,3,5 | A |
| Zhao et al.[17] | 2007 | 120 | 120 | 31.4±12.3 | 31.4±12.3 | Electroacupuncture + three-dimensional orthopedics | Three-dimensional orthopedics | 1,3 | A |
| Teng and Duan[18] | 2010 | 69 | 70 | 48.2±14.6 | 46.4±15.3 | Acupuncture + bone-setting | Bone-setting | 1,3 | B |
| Zeng et al.[19] | 2016 | 48 | 48 | 51.2±10.8 | 50.4±11.2 | Acupuncture + reset massage | Reset massage | 1,2 | B |
| Ma and Zheng[20] | 2021 | 52 | 52 | 52.9±3.1 | 52.4±3.7 | Acupuncture + bone-setting | Acupuncture | 1,4 | A |
| Wang et al.[21] | 2011 | 35 | 35 | 50.8±6.3 | 49.1±5.9 | Silver needle + bone-setting | Bone-setting | 1,2 | A |
| Yu[22] | 2015 | 34 | 34 | 51.8±11.2 | 51.8±10.9 | Acupuncture + long-style chiropractic manipulation | Long-style chiropractic manipulation | 1,2 | B |
| Ca et al.[23] | 2010 | 48 | 48 | 45.7±3.1 | 46.9±2.9 | Acupuncture + long-style chiropractic manipulation | Long-style chiropractic manipulation | 1,2 | A |
| Zhang and Lin[24] | 2025 | 25 | 25 | 51.6±12.8 | 50.52±12.9 | Acupuncture + long-style chiropractic manipulation | Acupuncture | 1,4 | A |

E: Experimental group; C: Control group; 1: Overall clinical efficacy rate; 2: Symptoms and functional assessment scores of cervical vertigo; 3: Changes in hemorheology (vertebral artery, basilar artery); 4: Quality of life; 5: Adverse reaction.

95% CI: 2.89, 5.19, p<0.001), and the overall clinical efficacy rate of the treatment group was higher than that of the control group. The sensitivity analysis was performed by eliminating each study individually. No study was found to have an impact on the combined effect value.

### *Symptoms and functional assessment scores of cervical vertigo*

A total of 10 literature studies reported the symptoms and functional assessment scores of CV. There was a high degree of heterogeneity among the studies ($I^2$=92.0%). A meta-analysis was conducted using the random effects model, as shown in Figure 3. Compared to acupuncture alone or osteopathy treatment, the combination of acupuncture and osteopathy for treating CV resulted in significantly better symptoms and functional assessment scores of CV in the experimental group than in the control group (MD=4.01, 95% CI: 3.19, 4.83, p<0.001). Through sensitivity analysis by eliminating studies one by one, it was found that after excluding Fu,[13] the heterogeneity decreased to 84%, and the combined

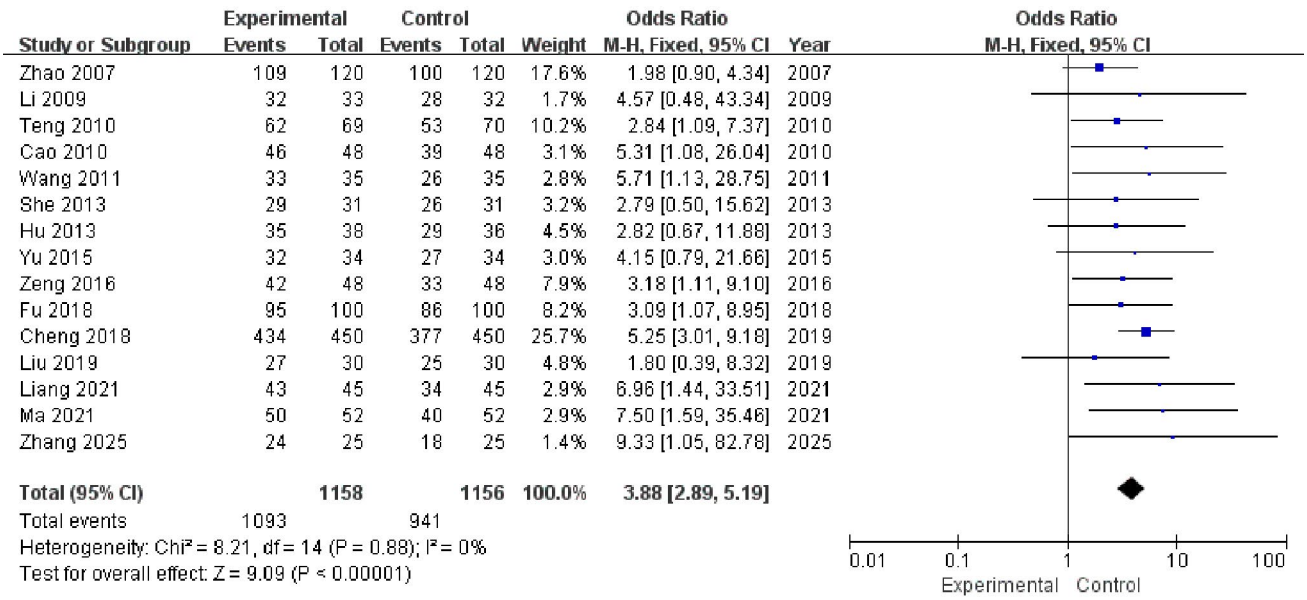



**FIGURE 2.** Forest plot comparing the overall clinical efficacy rate of bone-setting combined with acupuncture and acupuncture or bone-setting alone in the treatment of CV.
CI: Confidence interval; CV: Cervical vertigo.

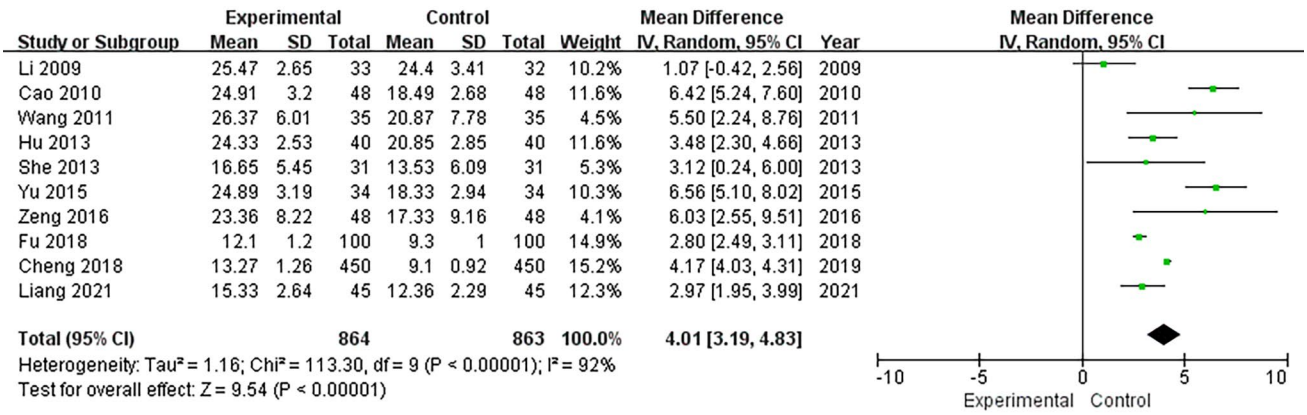



**FIGURE 3.** Forest plot comparing the symptoms and functional assessment scores of CV of bone-setting combined with acupuncture and acupuncture or bone-setting alone in the treatment of CV.
SD: Standard deviation; CI: Confidence interval; CV: Cervical vertigo.

effect value still had statistical significance (Supplementary Figure 1).

### *Mean flow velocity of the vertebral artery*

A total of six literature studies reported the Vm of the VA. There was a high degree of heterogeneity among the studies ($I^2$=84.0%). A meta-analysis was conducted using the random effects model, as shown in Figure 4. Compared to acupuncture alone or bone-setting alone, the combination of acupuncture and bone-setting resulted in significantly higher Vm of VA in the experimental group than in the control group (MD=3.21, 95% CI: 1.58, 4.84, p<0.001). A sensitivity analysis was performed by eliminating studies one by one. It was found that after excluding Liu et al.[12] the heterogeneity decreased to 78%, and the combined effect value still had statistical significance (Supplementary Figure 2).

### *Mean flow velocity of the basilar artery*

Five studies reported the Vm of the BA. There is a high degree of heterogeneity among these studies ($I^2$=92.0%). A meta-analysis using the random effects model was conducted as shown in Figure 5. Compared to acupuncture alone or bone-setting alone, the combination of acupuncture and bone-setting resulted in significantly higher Vm of the BA in the experimental group than in the control group (MD=5.09, 95% CI: 0.78, 9.40, p=0.02). Through sensitivity analysis by eliminating studies one by one, it was found that after removing Teng and Duan,[18] the heterogeneity decreased to 86%, and the combined effect value was not statistically significant, which had a certain impact on the results (Supplementary Figure 3).

### *Quality of life score*

Three studies reported the quality-of-life scores of the experimental group and the control group after treatment. There was a high degree of heterogeneity among the studies ($I^2$=76.0%). A meta-analysis using the random effects model was conducted, as shown in Figure 6. Compared to acupuncture alone or orthopedic treatment alone, the combination of acupuncture and bone-setting resulted in significantly better quality of life scores in the experimental group after CV treatment (MD=9.83, 95% CI: 5.89, 13.77, p<0.001). Through a sensitivity analysis involving eliminating studies

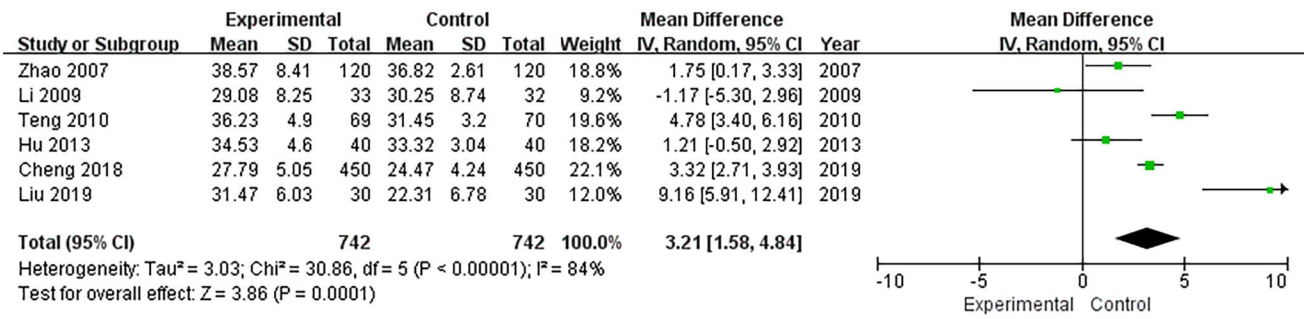



**FIGURE 4.** Forest plot comparing the vertebral artery (Vm) of CV of bone-setting combined with acupuncture and acupuncture or bone-setting alone in the treatment of CV.
SD: Standard deviation; CI: Confidence interval; CV: Cervical vertigo.

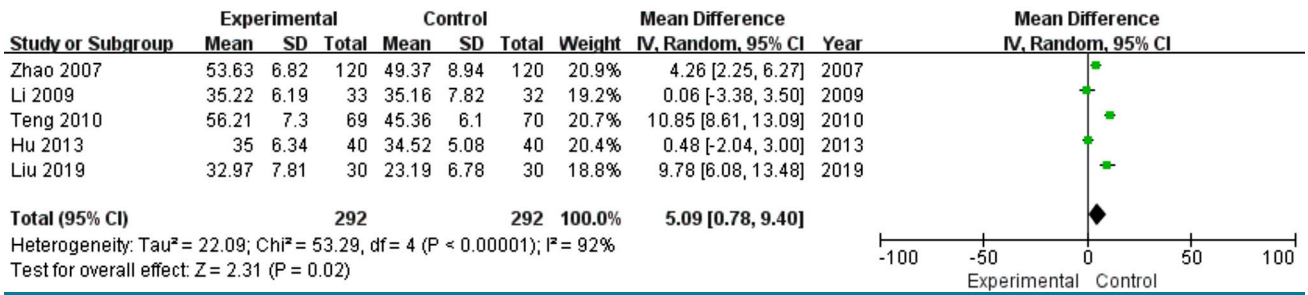



**FIGURE 5.** Forest plot comparing the basilar artery (Vm) of CV of bone-setting combined with acupuncture and acupuncture or bone-setting alone in the treatment of CV.
SD: Standard deviation; CI: Confidence interval; Vm: Flow velocity; CV: Cervical vertigo.

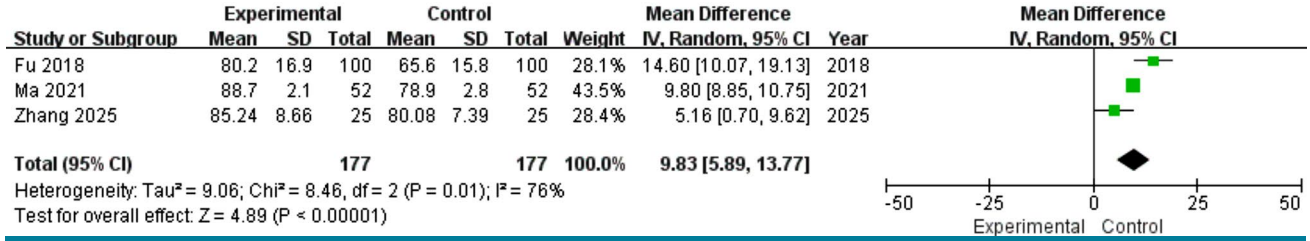



**FIGURE 6.** Forest plot comparing the quality of life score (Vm) of CV of bone-setting combined with acupuncture and acupuncture or bone-setting alone in the treatment of CV

SD: Standard deviation; CI: Confidence interval; CV: Cervical vertigo.

one by one, it was found that after eliminating Ma and Zheng,[20] the heterogeneity increased to 88%; however, the combined effect value still had statistical significance (Supplementary Figure 4).

### *Adverse reactions*

Two studies reported adverse reactions.[15,16] In one study,[15] a total of seven adverse reactions occurred during the treatment period (two cases in the experimental group and five cases in the control group). After acupuncture, local bruising occurred in the skin, which disappeared within two to four days after local heat application; however, there were no adverse reactions, such as dizziness or stuck needles. In the other study,[16] during the treatment process, two patients experienced dizziness and mild nausea caused by changes in body position. These symptoms could be relieved by rest, and no other adverse reactions were found afterwards.

### *Publication bias*

Publication bias was analyzed for all five outcome indicators. The funnel plot of VA was significantly asymmetrical, suggesting the possibility of publication bias (Figure 7). Further, Egger's test results showed that p=0.032<0.05, indicating the presence of publication bias. No obvious publication bias was found for the other outcome indicators.

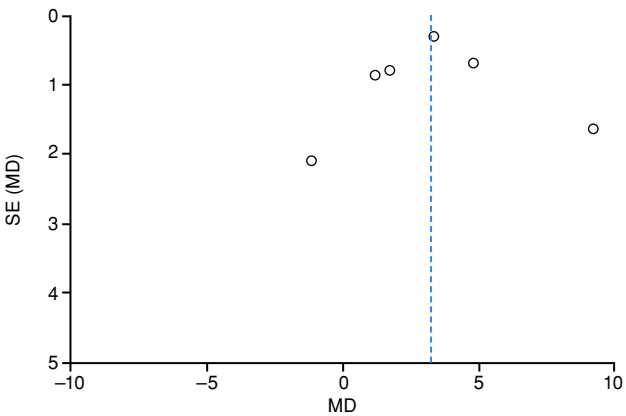



**FIGURE 7.** Funnel plot of vertebral artery.

SE: Standard error; MD: Mean difference.

## DISCUSSION

Cervical vertigo is also known as VA-BA insufficiency and posterior circulation ischemia.[1] In recent years, due to the growing usage of computers and mobile phones, as well as poor postures, the incidence of this disease has been increasing year by year and showing a younger trend. In addition, the specific causes and pathogenesis of CV have always been controversial. How to treat CV effectively and safely is an urgent problem to be solved in clinical practice. This article uses the methods of systematic review and meta-analysis to collect the literature published at home and abroad on the efficacy and safety of acupuncture combined with orthopedic treatment for CV. The analysis results showed that, compared to simply using bone-setting or acupuncture treatment alone, the combination of acupuncture and bone-setting for CV could significantly improve the overall clinical efficacy rate, significantly improve the symptoms and functions of CV, improve the Vm of postoperative VA and BA and improve the quality of life. In terms of safety, only two articles[15,16] reported the occurrence of adverse reactions, which were mild and disappeared after treatment and rest, indicating that the safety of bone-setting combined with acupuncture is relatively high.

The results of this meta-analysis showed that acupuncture combined with bone-setting can significantly improve the overall clinical efficacy rate. The possible reason is that acupuncture, by selecting different acupoints, can effectively enhance the blood supply capacity of the carotid artery, improve the blood supply to the VA-BA and reduce vertigo caused by insufficient blood supply

to the carotid artery. Combined with bone-setting methods, the correction effect on the position of the atlas vertebra is improved. Compared to simple orthopedic treatment, it can more effectively improve atlantoaxial dislocation and other conditions. It has the effects of warming and circulating blood and qi, activating blood and removing stasis and reinforcing the body's defenses and eliminating pathogenic factors.[11] Combined with bone-setting, it significantly improves the treatment efficiency and alleviates postoperative vertigo symptoms.

Among the included literature in this article, a specific bone-setting technique called the Long-style chiropractic manipulation technique was employed.[25] This technique combines traditional Chinese medicine bone injury theory with modern spinal anatomy and biomechanics knowledge and is often used to treat cervical facet joint disorders, VA insufficiency and other related symptoms. Previous studies have shown that the long-style chiropractic manipulation technique can improve VA blood flow velocity, relieve symptoms such as dizziness and headache and improve the quality of life of patients. Compared to pure bone-setting alone, combined acupuncture may improve the overall efficacy by dredging meridians, relieving muscle spasms and synergistically correcting cervical spine force line abnormalities, thereby improving the overall efficacy.

The results of this study show that after acupuncture combined with bone-setting, the Vms of BA and VA in patients were significantly improved. Two possible reasons are as follows: *(i)* applying acupuncture or needle insertion to the neck can treat local superficial range Bi syndrome (a type of disorder characterized by restricted blood circulation), specifically improving local congestion and blockage, loosening local ligaments and soft tissues and stimulating a larger area with a strong sensation. This can strengthen the circulation of meridians to improve blood circulation and achieve the purpose of promoting blood circulation and resolving blood stasis; *(ii)* the bone-setting used for treating CV has obvious effects, is easy to operate and causes less damage. For example, atlantoaxial joint reduction surgery can adjust the bony structure of the atlantoaxial joint, correct abnormal postures and promote the balance of the cervical structure. It can rotate the joint capsule and deep tissues, such as the cranial base and intervertebral ligaments, improving the patient's symptoms. In addition, atlantoaxial joint reduction surgery can relieve the spasm caused by excessive fatigue of the small neck muscles, control local inflammatory exudation and reduce the stimulation of the VA-BA and sympathetic nerves.

Although all the articles included in this study were from China, CV is a common condition worldwide. The results of this study are not only of great significance to Chinese medical professionals, but also provide important references for other countries and regions. Especially in the fields of integrative medicine, physical therapy, and manual therapy, the potential of acupuncture combined with osteopathy deserves further exploration. In recent years, there have been many international studies exploring the use of acupuncture and manual therapy in the treatment of cervical spine-related diseases, such as the study by Plener et al.,[26] which found that acupuncture treatment can reduce pain in cervical radiculopathy. The study by Pujalte et al.[27] pointed out that acupuncture and manual therapy are expected to be effective in treating musculoskeletal pain and neuropathy in athletes of different ages and addressing injuries in various sports. Therefore, the results of this study may provide preliminary evidence for international scholars to support further exploration of the global applicability of traditional Chinese medicine law. Given the regional limitations of this study, we call for a multicenter, cross-border RCT to validate the efficacy of acupuncture combined with osteopathy on an international scale. At the same time, it is recommended that international scholars pay attention to the integration path of traditional medicine and modern medicine to promote the diversified development of CV treatment.

This study has the following limitations: *(i)* all the included studies were small-sample RCTs or semi-RCTs. Some of the randomization methods used in the studies were inappropriate, and the allocation concealment method and whether blinding was used were not reported. Therefore, there may be biases, such as selection or implementation bias. Furthermore, due to the characteristics of traditional Chinese medicine intervention, there are objective difficulties in the implementation of blind methods, and future studies can consider using sham acupuncture, sham techniques and other control methods to improve the scientific and reproducibility of the research; *(ii)* the outcome indicators included in the study were mainly subjective indicators, such as CV symptoms and functional assessment; therefore, there may be recall bias and measurement bias; *(iii)* heterogeneity may stem from differences in study design, sample size,

measurement tools and intervention modalities. High heterogeneity suggests that some pooled effect values should be interpreted with caution, and the standardization and reporting specifications of research design still need to be strengthened in subsequent high-quality studies; *(iv)* all the studies included in this study were from China and were published in traditional Chinese medicine journals, and the study population, intervention methods and research background were regional. Nevertheless, the current state of international application of acupuncture and manual therapy suggests that the results of this study may provide new research perspectives for the international academic community, in accordance with the requirements of the Consolidated Standards of Reporting Trails (CONSORT) statement and the Standards for Reporting Interventions in Controlled Trials of Acupuncture (STRICTA) standard.[28]

In conclusion, our meta-analysis demonstrates that the combined treatment of bone-setting and acupuncture for CV is significantly more effective than acupuncture or bone-setting alone. The pooled results for the primary outcome, overall clinical efficacy, showed a notable advantage for the combination therapy group (OR=3.88, 95% CI: 2.89, 5.19, $p<0.001$). This approach also led to significantly better symptom and functional improvement, as evidenced by the analysis of functional assessment scores (MD=4.01, 95% CI: 3.19, 4.83, $p<0.001$) and quality of life scores (MD=9.83, 95% CI: 5.89, 13.77, $p<0.001$). Furthermore, the combined therapy showed a favorable safety profile with fewer and milder adverse reactions reported.

However, due to limitations in the number and quality of the included studies, it is hoped that future international clinical researchers will conduct multi-centre, large-sample, prospective randomised controlled trials in accordance with the requirements of the CONSORT and STRICTA standards to further evaluate its effectiveness and safety with stronger data.

**Data Sharing Statement:** All data generated or analysed during this study are included in this article. Further enquiries can be directed to the corresponding author.

**Author Contributions:** Conceived of the study: C.W., N.Z.Z.; Participated in its design and data analysis and statistics: L.W., W. H., Z.L.H.; Helped to draft the manuscript: L.S., Y.X.G. All authors read and approved the final manuscript.

**Conflict of Interest:** The authors declared no conflicts of interest with respect to the authorship and/or publication of this article.

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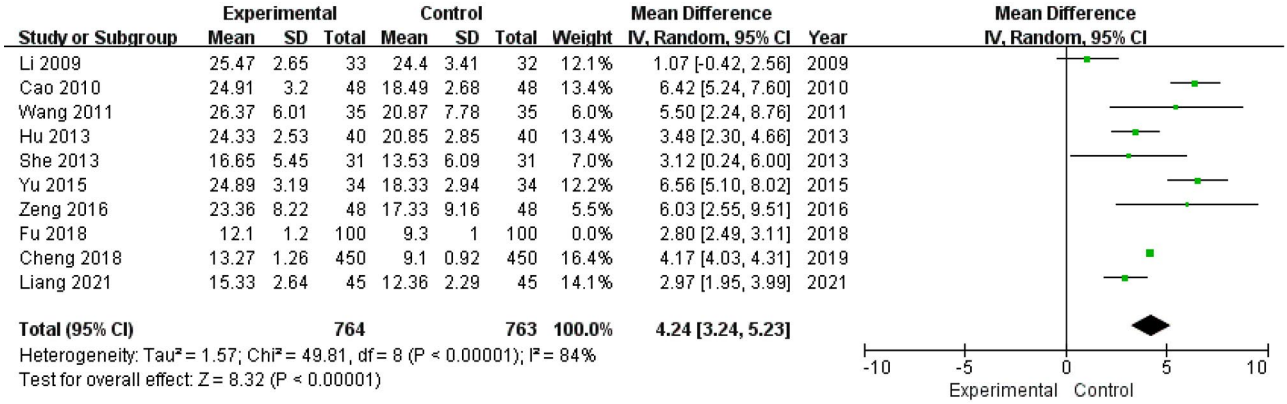
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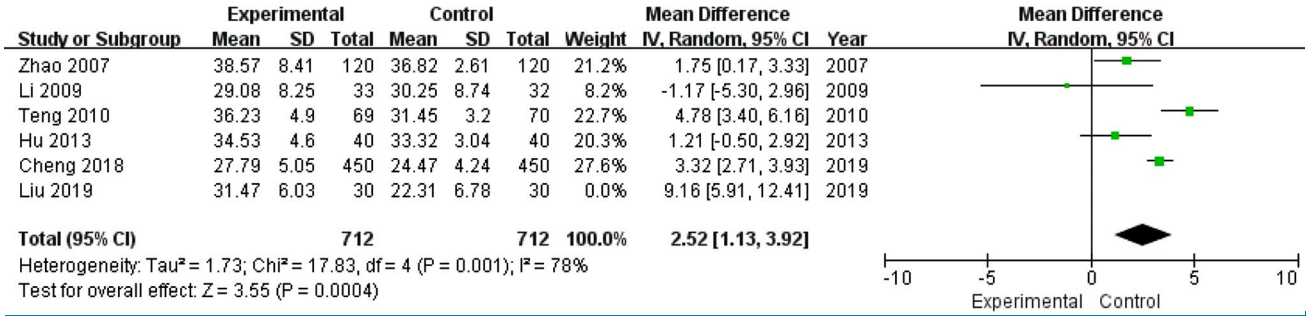
**SUPPLEMENTARY TABLE I**

Results of risk of bias assessment of included studies (Randomized-controlled study)

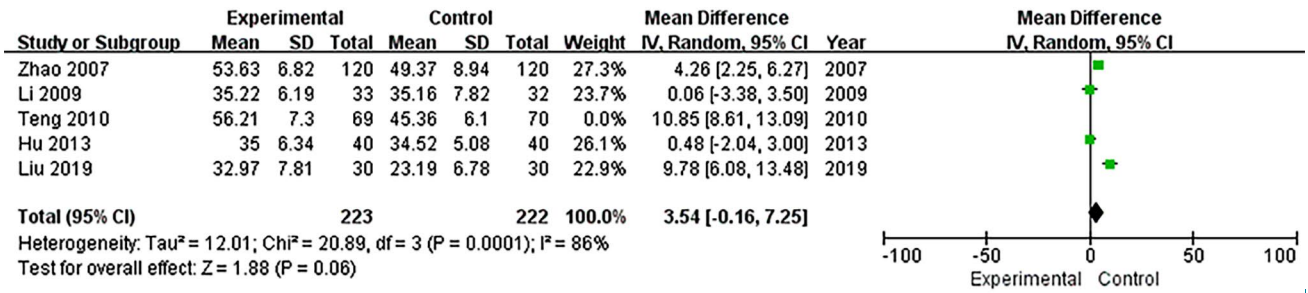
| Included literature | Random sequence generation | Allocation concealment | Blinding of participants and personnel | Blinding of outcome assessment | Incomplete outcome data | Selective reporting | Other bias | Level of evidence |
|---|---|---|---|---|---|---|---|---|
| She et al.[10] | Not clear | Low | Low | Low | Low | Low | Low | B |
| Liang et al.[11] | Low | Low | Low | Low | Low | Low | Low | A |
| Liu et al.[12] | Low | Low | Low | Low | Low | Low | Low | A |
| Fu[13] | Low | Not clear | Low | Low | Low | Low | Low | B |
| Cheng et al.[14] | Low | Low | Low | Low | Low | Low | Low | A |
| Li[15] | Low | Low | Low | Low | Low | Low | Low | A |
| Hu[16] | Low | Low | Low | Low | Low | Low | Low | A |
| Zhao et al.[17] | Not clear | Low | Low | Low | Low | Low | Low | B |
| Teng and Duan[18] | Low | Not clear | Low | Low | Low | Low | Low | B |
| Zeng et al.[19] | Low | Low | Low | Low | Low | Low | Low | A |
| Ma and Zheng[20] | Low | Low | Low | Low | Low | Low | Low | A |
| Wang et al.[21] | Low | Low | Low | Low | Low | Low | Low | A |
| Yu[22] | Low | Low | Low | Not clear | Low | Low | Low | B |
| Ca et al.[23] | Low | Low | Low | Low | Low | Low | Low | A |
| Zhang and Lin[24] | Low | Low | Low | Low | Low | Low | Low | A |



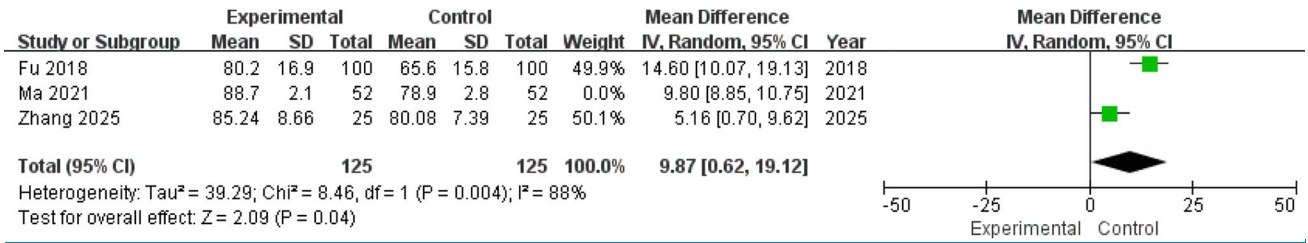

**SUPPLEMENTARY FIGURE 1.** Sensitivity analysis of symptoms and functional assessment scores of CV.
SD: Standard deviation; CI: Confidence interval; CV: Cervical vertigo.




**SUPPLEMENTARY FIGURE 2.** Sensitivity analysis of mean flow velocity of vertebral artery (Vm).
SD: Standard deviation; CI: Confidence interval.




**SUPPLEMENTARY FIGURE 3.** Sensitivity analysis of mean flow Velocity of basilar artery (Vm).
SD: Standard deviation; CI: Confidence interval.




**SUPPLEMENTARY FIGURE 4.** Sensitivity analysis of quality of life score.
SD: Standard deviation; CI: Confidence interval.