Postprint of a Meta-Analysis on the Efficacy and Safety of Manual Therapy for Frozen Shoulder

Authors: Fang Yide, Hu Hao, Xu Jinhai, Ding Xing, Ma Qingshan, Zhang Yayun, Wang Yanni, Mowen, Mo Wen

Date: 2023-11-01T00:00:00+00:00

Abstract

Background: In recent years, numerous randomized controlled trials (RCTs) on specialized manual therapy techniques for frozen shoulder have emerged, yet updated systematic reviews evaluating the efficacy and safety of manual therapy for this condition are lacking. Objective: To evaluate the efficacy and safety of manual therapy for frozen shoulder through Meta-analysis, and to determine through subgroup analysis whether techniques incorporating "rotational manipulation" yield superior outcomes compared to those without it. Methods: Computerized searches were conducted in PubMed, Cochrane Library, Embase, Medline, CNKI (including China Doctoral Dissertations Full-text Database and China Master's Theses Full-text Database), Chinese Biomedical Literature Database, and Wanfang Data Knowledge Service Platform for RCTs investigating the efficacy and safety of manual therapy for frozen shoulder. The experimental group received manual therapy interventions, while the control group received non-pharmacological therapies. The search timeframe spanned from database inception to March 1, 2023. Data extraction and quality assessment were performed independently by two researchers. Meta-analysis was conducted using RevMan 5.3 software. Results: A total of 12 studies involving 893 patients with frozen shoulder were included, with 451 in the experimental group and 442 in the control group. Meta-analysis results demonstrated that for the Visual Analogue Scale (VAS), manual therapy was superior to physical therapy, acupuncture, and conventional treatment in improving VAS scores (SMD=1.09, 95%CI=0.81~1.37, P<0.00001; SMD=1.05, 95%CI=0.31~1.79, P=0.006; SMD=0.96, 95%CI=0.67~1.26, P<0.00001). Subgroup analysis of manual therapy versus physical therapy revealed a significant difference between techniques incorporating "rotational manipulation" and those without it (Z=4.39, P=0.04). For Constant-Murley (C-M) scores, manual therapy was superior to physical therapy (MD=2.79, 95%CI=2.27~3.32, P<0.00001). Regarding range of motion, manual therapy was superior to physical therapy in improving passive flexion, passive abduction, and passive external rotation (SMD=1.40, 95%CI=0.10~2.70, P=0.03; SMD=1.45, 95%CI=0.18~2.71, P=0.02; SMD=1.77, 95%CI=0.18~3.36, P=0.03). Subgroup analysis showed significant differences between manual therapy with and without "rotational manipulation" in improving passive flexion and passive abduction (Z=7.34, P=0.007; Z=2.25, P=0.03). The overall effective rate was higher with manual therapy than physical therapy (RR=1.16, 95%CI=1.02~1.32, P=0.03); no statistically significant difference was observed between manual therapy and acupuncture (RR=1.24, 95%CI=1.00~1.54, P=0.05). The cure rate was superior with manual therapy compared to both physical therapy and acupuncture (RR=3.71, 95%CI=1.29~10.67, P=0.01; RR=1.79, 95%CI=1.09~2.94, P=0.02). Egger's test and Begg's test indicated no significant publication bias (P=0.66, 0.66). No cases of fractures or other trauma resulting from manual manipulation were reported in the included studies. Conclusion: Current evidence indicates that manual therapy can effectively alleviate pain and shoulder dysfunction, improve shoulder range of motion, overall effective rate, and cure rate in patients with frozen shoulder. Manual therapy incorporating "rotational manipulation" can further enhance therapeutic efficacy in VAS improvement, passive flexion, and passive abduction. The overall safety profile of manual therapy is high; however, further validation through additional large-scale, high-quality RCTs is required.

Full Text

Efficacy and Safety of Manipulative Therapy for Frozen Shoulder: A Meta-Analysis

Yide Fang[1], Hao Hu[1], Jinhai Xu[1,2], Xing Ding[1], Qingshan Ma[1], Yayun Zhang[1], Yanni Wang[1], Wen Mo[1,2*]

[1]Department of Orthopedics and Traumatology, Longhua Hospital Affiliated to Shanghai University of Chinese Medicine, Shanghai 200032, China
[2]Research Institute of Spine Diseases, Shanghai University of Traditional Chinese Medicine, Shanghai 200032, China

Corresponding author: Wen Mo, Chief Physician; E-mail: mw2218@126.com

Abstract

Background: In recent years, numerous randomized controlled trials (RCTs) featuring distinctive manipulation techniques for frozen shoulder have emerged, yet updated systematic reviews evaluating the efficacy and safety of manipulative therapy for this condition remain lacking.

Objective: To evaluate the efficacy and safety of manipulative therapy for frozen shoulder through meta-analysis, and to determine whether manipulation techniques incorporating "rotation methods" yield superior outcomes compared to those without such methods through subgroup analysis.

Methods: We systematically searched PubMed, Cochrane Library, Embase, Medline, CNKI (including Chinese Master's and Doctoral Dissertations Full-Text Database), China Biomedical Literature Database, and Wanfang Data Knowledge Service Platform for RCTs examining the efficacy and safety of manipulative therapy for frozen shoulder. The experimental group received manipulative therapy, while the control group received non-pharmacological interventions. The search timeframe spanned from database inception to March 1, 2023. Two researchers independently extracted data and assessed study quality. Meta-analysis was performed using RevMan 5.3 software.

Results: A total of 12 RCTs involving 893 patients with frozen shoulder were included, with 451 patients in the experimental group and 442 in the control group. Meta-analysis results demonstrated that manipulative therapy produced superior Visual Analogue Scale (VAS) improvements compared to physical therapy (SMD=1.09, 95%CI=0.81–1.37, P<0.00001), acupuncture (SMD=1.05, 95%CI=0.31–1.79, P=0.006), and conventional treatment (SMD=0.96, 95%CI=0.67–1.26, P<0.00001). Subgroup analysis of manipulative versus physical therapy revealed a significant difference between techniques with and without rotation methods (Z=4.39, P=0.04). For Constant-Murley (C-M) scores, manipulative therapy showed greater improvement than physical therapy (MD=2.79, 95%CI=2.27–3.32, P<0.00001). Regarding range of motion, manipulative therapy yielded superior improvements in passive forward flexion (SMD=1.40, 95%CI=0.10–2.70, P=0.03), passive abduction (SMD=1.45, 95%CI=0.18–2.71, P=0.02), and passive external rotation (SMD=1.77, 95%CI=0.18–3.36, P=0.03) compared to physical therapy. Subgroup analyses indicated significant differences between rotation-inclusive and rotation-exclusion techniques for passive forward flexion (Z=7.34, P=0.007) and passive abduction (Z=2.25, P=0.03). The overall effective rate was higher for manipulative therapy versus physical therapy (RR=1.16, 95%CI=1.02–1.32, P=0.03), though no significant difference emerged when compared to acupuncture (RR=1.24, 95%CI=1.00–1.54, P=0.05). Cure rates favored manipulative therapy over both physical therapy (RR=3.71, 95%CI=1.29–10.67, P=0.01) and acupuncture (RR=1.79, 95%CI=1.09–2.94, P=0.02). Egger's test and Begg's test detected no significant publication bias (P=0.66 for both). No cases of fractures or other trauma resulting from manipulative procedures were reported in the included studies.

Conclusion: Current evidence indicates that manipulative therapy effectively reduces pain and shoulder dysfunction while improving range of motion, overall effective rate, and cure rate in patients with frozen shoulder. Techniques incorporating rotation methods demonstrate enhanced efficacy for VAS improvement, passive forward flexion, and passive abduction. The overall safety profile of manipulative therapy appears high, though further confirmation through large-sample, high-quality RCTs is warranted.

Keywords: Frozen shoulder; Bursitis; Manipulation; Shoulder rotation; Randomized controlled trial; Meta-analysis

Introduction

Frozen shoulder, characterized by shoulder pain and limited mobility, results from pathological changes in soft tissues including periaricular muscles, bursae, tendons, and joint capsules. Research indicates that diabetes, obesity, and hypothyroidism significantly increase the prevalence of frozen shoulder, with diabetes showing the strongest association (prevalence rate of 10%–39%) [1]. While most scholars consider frozen shoulder a benign, self-limiting condition, studies demonstrate that over 60% of patients experience residual pain or functional impairment at 2–20 years follow-up [2], substantially impacting daily activities and quality of life [3]. Therefore, treatment should focus on pain alleviation, range of motion improvement, and disease duration reduction.

Current management remains primarily conservative, encompassing manipulative therapy, acupuncture, physical therapy, and appropriate functional exercises [4]. The 2019 *Clinical Diagnosis and Treatment Guidelines for Orthopedics and Traumatology in Chinese Medicine: Periarthritis of Shoulder (T/CACM 1179–2019)* [5] recommends manipulative therapy as first-line treatment. Manipulative techniques exhibit considerable diversity, with the Shi 氏 Traumatology school emphasizing "rotation methods" to achieve the therapeutic state of "relaxation eliminates pain." Rotation techniques enable extensive stretching and release of adhesions. This study systematically collected domestic and international RCTs of manipulative therapy for frozen shoulder to evaluate its superiority over conventional treatments and assess whether the inclusion of rotation methods influences therapeutic efficacy, thereby providing high-level evidence for clinical practice.

Methods

1.1 Inclusion Criteria

(1) Study design: Clinical RCTs published in Chinese or English; (2) Participants: Patients with definitive frozen shoulder diagnosis; (3) Interventions: Experimental group received manipulative therapy, control group received non-pharmacological treatments; (4) Outcome measures ($ $2 required): Including overall effective rate (per *Diagnostic and Therapeutic Efficacy Standards for Chinese Medical Conditions: ZY/T001.1-001.9-94* issued by the State Administration of Traditional Chinese Medicine in 1994) [6], Visual Analogue Scale (VAS) score, Shoulder Pain and Disability Index (SPADI), Constant-Murley (C-M) shoulder function score, range of motion measurements, and safety indicators (adverse event incidence).

1.2 Exclusion Criteria

(1) Animal studies, mechanism studies, case reports, or reviews; (2) Studies with modified Jadad score [7] of 0; (3) Duplicate publications or abstracts without accessible full text; (4) Experimental groups involving manipulation under anesthesia or combined with acupuncture/medication; (5) Control groups containing manipulative therapy.

1.3 Data Sources and Search Strategy

1.3.1 Databases: We searched PubMed, Cochrane Library, Embase, Medline, CNKI (including Chinese Master's and Doctoral Dissertations Full-Text Database, Chinese Excellent Master's Dissertations Full-Text Database), China Biomedical Literature Database, and Wanfang Data Knowledge Service Platform from inception to March 1, 2023.

1.3.2 Search Strategy: Chinese search terms: #1 "randomized controlled" OR "random" OR "RCT" OR "clinical observation"; #2 "frozen shoulder" OR "adhesive capsulitis" OR "periarthritis of shoulder" OR "shoulder bi syndrome" OR "leaking shoulder wind" OR "fifty-year shoulder"; #3 "manipulation" OR "massage" OR "tuina" OR "operation" OR "joint mobilization"; #4 #1 AND #2 AND #3. English search terms: #1 "Randomized Control" OR "Random" OR "Clinical Trial"; #2 "Manipulation" OR "Massage"; #3 "adhesive capsulitis" OR "frozen shoulder" OR "periarthritis of shoulder"; #4 #1 AND #2 AND #3. The final results used the database with the most retrieved entries. Multi-arm RCTs were converted to two-arm trials using the method recommended by the Cochrane Handbook [8].

1.4 Data Extraction

Retrieved literature was imported into EndNote to establish a reference management database. Following PRISMA guidelines, two researchers independently screened titles, abstracts, and full texts. Detailed data extraction was performed using Excel spreadsheets, capturing: rotation method inclusion, publication year, randomization method, diagnostic criteria, intervention details, outcome measures, sample size, and adverse events. Rotation method was defined as techniques explicitly mentioning "shoulder shaking," "passive shoulder rotation," or rotational mobilization of the glenohumeral joint.

1.5 Literature Quality Assessment

All included studies were evaluated using the modified Jadad scale, which assesses appropriate randomization methods, allocation concealment, and blinding implementation. Scores of 1–3 indicated low quality, while $ $4 indicated high quality; only studies scoring $ $1 were included. The Cochrane risk-of-bias tool was also applied, evaluating: proper random sequence generation; adequate allocation concealment; blinding implementation; completeness of outcome data (withdrawals, dropouts, loss to follow-up); selective outcome reporting; and sample size estimation.

Results

2.1 Literature Search Results

The initial search yielded 1,393 articles (1,164 Chinese, 229 English). After abstract screening, 37 full-text articles were retrieved for detailed evaluation. Ultimately, 12 studies [9–20] met inclusion criteria [Figure 1: see original paper].

2.2 Characteristics of Included Studies

The 12 included studies comprised 893 patients (451 experimental, 442 control), with sample sizes ranging from 32 to 120 participants. Three English studies originated from India [17], Chile [18], and Turkey [19]; nine Chinese studies [9–16, 20] completed the dataset. Treatment duration varied: three studies [14, 17, 19] administered 2 weeks of treatment at 3 sessions/week; three studies [11, 15, 20] provided 3 weeks at 1 session/day; remaining studies employed 10 days, 4 weeks, 6 weeks, or 8 weeks with inconsistent frequencies. All experimental groups received manipulative therapy, while control groups received acupuncture (4 studies [9–12]), physical therapy (7 studies [13–19]), or intra-articular injection (1 study [20]). Rotation methods were absent in 3 studies [9, 16, 19] and present in 9 studies [10–15, 17, 19–20]. VAS was reported in 11 studies [9–14, 16–20]; overall effective rate in 8 studies [9–13, 15–16, 20]; specific joint angles in 4 studies [17–20]; and C-M scores in 3 studies [13, 18, 20] .

2.3 Quality Assessment of Included Studies

Methodological evaluation revealed one study scored 4 points [18], three scored 3 points [14–15, 17], six scored 2 points [9–13, 16], and two scored 1 point [19–20]. Ten studies [9–18] described random number table methods, while two [19–20] only mentioned "randomization." Allocation concealment using sealed envelopes was reported in four studies [14–15, 17–18]. One study [18] implemented blinding of assessors; the remaining 11 [9–17, 19–20] did not mention blinding. No studies addressed selective reporting or other potential bias sources [FIGURE:2, FIGURE:3].

2.4 Meta-Analysis Results

2.4.1 Visual Analogue Scale (VAS) 2.4.1.1 Manipulation versus Physical Therapy: Six studies [13–14, 16–19] reported VAS outcomes for 322 patients. Heterogeneity was moderate (I^2=28%); random-effects models with subgroup analysis were applied. Meta-analysis demonstrated superior VAS improvement in the manipulation group (SMD=1.09, 95%CI=0.81–1.37, Z=7.57, P<0.00001). Subgroup analysis revealed significantly greater improvement with rotation-inclusive versus rotation-exclusion techniques (Z=4.39, P=0.04) [Figure 4: see original paper].

2.4.1.2 Manipulation versus Acupuncture: Four studies [9–12] involving 371 patients reported VAS outcomes. High heterogeneity (I^2=88%) necessitated random-effects modeling. Results favored manipulation over acupuncture (MD=1.05, 95%CI=0.31–1.79, Z=2.77, P=0.006) [Figure 5: see original paper].

2.4.1.3 Manipulation versus Conventional Treatment: Eleven studies [9–14, 16–20] compared manipulation against conventional treatments (acupuncture, physical therapy, intra-articular injection). High heterogeneity (I^2=74%) was addressed with random-effects models. Manipulation demonstrated superior VAS improvement (SMD=0.96, 95%CI=0.67–1.26, Z=6.42, P<0.00001) [Figure 6: see original paper].

2.4.2 Constant-Murley (C-M) Score Two studies [13, 18] comparing manipulation to physical therapy (114 patients) showed significantly greater C-M score improvement in the manipulation group (MD=2.79, 95%CI=2.27–3.32, Z=10.41, P<0.00001) [Figure 7: see original paper].

2.4.3 Range of Motion Four studies [17–20] reported specific joint angles (243 patients total). Three studies [17–19] using physical therapy controls (183 patients) assessed passive forward flexion, abduction, and external rotation.

2.4.3.1 Passive Forward Flexion: High heterogeneity (I^2=91%) was managed with random-effects models. Manipulation showed superior improvement (SMD=1.40, 95%CI=0.10–2.70, Z=2.11, P=0.03). Subgroup analysis revealed significant differences between rotation-inclusive and rotation-exclusion techniques (Z=7.34, P=0.007) [Figure 8: see original paper].

2.4.3.2 Passive Abduction: With high heterogeneity (I^2=89%), random-effects analysis demonstrated superior abduction improvement with manipulation (SMD=1.45, 95%CI=0.18–2.71, Z=2.25, P=0.02). Subgroup analysis showed significant differences between rotation method groups (Z=2.25, P=0.03) [Figure 9: see original paper].

2.4.3.3 Passive External Rotation: High heterogeneity (I^2=92%) was addressed with random-effects modeling. Manipulation exhibited superior external rotation improvement (SMD=1.77, 95%CI=0.18–3.36, Z=2.18, P=0.03) [Figure 10: see original paper].

2.4.4 Overall Effective Rate **2.4.4.1 Manipulation versus Physical Therapy:** Three studies [13, 15–16] (189 patients) showed low heterogeneity (I^2=0). Random-effects analysis revealed higher overall effective rates for manipulation (RR=1.16, 95%CI=1.02–1.32, Z=2.21, P=0.03) [Figure 11: see original paper].

2.4.4.2 Manipulation versus Acupuncture: Four studies [9–12] (371 patients) with high heterogeneity (I^2=84%) showed no statistically significant difference in overall effective rates (RR=1.24, 95%CI=1.00–1.54, Z=1.94, P=0.05) [Figure 12: see original paper].

2.4.5 Cure Rate 2.4.5.1 Manipulation versus Physical Therapy: Three studies [13, 15–16] (189 patients) with low heterogeneity (I^2=29%) demonstrated superior cure rates for manipulation (RR=3.71, 95%CI=1.29–10.67, Z=2.44, P=0.01) [Figure 13: see original paper].

2.4.5.2 Manipulation versus Acupuncture: Four studies [9–12] (371 patients) with low heterogeneity (I^2=23%) showed superior cure rates for manipulation (RR=1.79, 95%CI=1.09–2.94, Z=2.29, P=0.02) [Figure 14: see original paper].

2.4.6 Publication Bias Funnel plot analysis of 8 studies reporting overall effective rates [9–13, 15–16, 20] showed substantial dispersion, likely attributable to generally low study quality and small sample sizes. However, Egger's test and Begg's test both yielded P=0.66, indicating no significant publication bias. Galbraith plots demonstrated all studies within the 95%CI (gray shaded area), further suggesting minimal publication bias [FIGURE:15, FIGURE:16].

2.4.7 Adverse Events None of the 12 included studies described adverse events. No cases of fractures or other trauma from manipulative procedures were reported, suggesting a favorable safety profile. However, specific statistical observation and analysis are still needed to definitively characterize adverse reactions.

Discussion

In traditional Chinese medicine, frozen shoulder belongs to the "bi syndrome" category. Its pathogenesis involves internal deficiency of essence and blood failing to nourish tendons, combined with external factors of strain and wind-cold-dampness invasion, manifesting as a pattern of root deficiency and branch excess [22]. Wind-cold-dampness evils invade meridians, causing qi and blood stagnation. As described in *Jin Gui Yao Lue Xin Dian*: "When yang bi fails to function, tendons lose nourishment and become either flaccid or contracted," leading to shoulder bi. Clinically, frozen shoulder presents with spontaneous shoulder pain and stiffness, reduced glenohumeral capsule volume, and typically lasts 10–36 weeks. The characteristic "carrying shoulder" phenomenon arises from synovial hyperplasia and fibrosis of the joint capsule, shoulder muscle rigidity, and capsular contracture during the frozen phase, causing humeral elevation [23]. Fibrosis, thickening, and contraction of the subscapularis muscle and coracohumeral ligament represent primary causes of limited external rotation and abduction [24].

Manipulative therapy offers unique advantages in improving adhesive capsulitis [25]. Despite widespread use and varied practitioner techniques, core manipulative approaches fundamentally involve "releasing" and "bone-tendon realignment" methods. Releasing techniques (including kneading, plucking, and bouncing) primarily target tendon nodules, myofascial tissue, rigid muscles, and tender points [26–27]. These targeted techniques, combined with appropriate functional exercises, enable thorough adhesion release, pain reduction, and improved range of motion. Bone-tendon realignment methods (including traction, rotation, pulling, and shaking) address not only local shoulder reduction but also regulate the overall cervical-shoulder relationship [28]. Increasingly, practitioners emphasize treating both tendon and bone, recognizing from a holistic pattern differentiation perspective that frozen shoulder involves tendon-bone imbalance—"tendons out of groove, bones out of alignment" [29]. Traction and rotation techniques not only release adhesions but also adjust spatial bone-tendon structure during the stretching and rotating process, achieving the goal of "realigning misplaced bones" and "returning tendons to their grooves." Research indicates that 97% of patients experience pain relief and near-complete restoration of joint movement [31], with no direct evidence of biceps tendon rupture, rotator cuff injury, fracture, dislocation, or nerve palsy resulting from manipulation. Thus, manipulation within patient tolerance is safe and effective, progressively achieving the therapeutic goal of "eliminating pain to induce relaxation, using relaxation to treat pain," ultimately reducing pain, increasing range of motion, and shortening disease duration.

The rotation method involves circumducting the joint along its axis of motion. Zhang Jiebin stated: "Daoyin means shaking bones and tendons, moving limbs and joints, to circulate qi and blood… When disease affects limbs and joints, this method is employed." Wang Ziping of the Shi 氏 Traumatology school advocated maintaining a "relaxed" state for soft tissue disorders, believing "obstruction causes pain, relaxation eliminates pain," and achieved "shoulder relaxation" through rotation methods [32]. National physician master Shi Qi considers traction and rotation helpful for improving frozen shoulder pain and mobility [33–34], highlighting the importance of rotation methods in treating tendon-bone disorders. Shoulder rotation methods primarily include hand-shaking shoulder rotation, elbow-supporting shoulder rotation, and large-amplitude circumduction, encompassing both mobilization and stretching effects [35]. Mobilization focuses on scapular movement; frozen shoulder patients exhibit altered scapulohumeral rhythm due to affected soft tissues around the joint capsule [36]. Research shows reduced scapular movement significantly contributes to elevation and abduction limitations [37], with improved scapular and glenohumeral joint motion enhancing functional status [38]. Stretching primarily targets the stiff glenohumeral capsule, ligaments, and periaricular muscles. Axial rotation of the joint capsule increases the glenohumeral distance [39] and reduces the concave compression effect [40]—where the humeral head displaces toward the glenoid fossa, encountering resistance from the concave surface that restricts joint mobility. Reducing this effect improves range of motion. This meta-analysis confirms that rotation-inclusive manipulation demonstrates superior efficacy in pain reduction and joint mobility restoration.

Current evidence demonstrates that manipulative therapy effectively reduces pain and shoulder dysfunction while improving range of motion, overall effective rate, and cure rate in frozen shoulder patients. Rotation-inclusive techniques further enhance VAS improvement and passive forward flexion/abduction. No adverse events were reported, suggesting favorable safety. However, only one study [13] evaluated long-term outcomes (16 weeks), limiting conclusions regarding long-term efficacy and safety. Future research should systematically investigate these aspects.

Previous systematic reviews of manipulative therapy for frozen shoulder included traction-based techniques in observation groups compared to physical therapy, acupuncture, or block therapy controls, focusing primarily on overall effective rate, cure rate, and VAS without comprehensive shoulder function analysis [33]. Consequently, their conclusions incompletely demonstrated manipulative therapy's effectiveness. Our meta-analysis extends beyond these metrics to evaluate overall manipulative therapy efficacy and specifically assess shoulder function C-M scores and range of motion improvements, confirming the therapeutic value of manipulation and rotation techniques.

Limitations and Recommendations: (1) No studies reported trauma or fractures from manipulative procedures, but analysis suggests that 10–56 day manipulation interventions exhibit relatively high efficacy and clinical safety. (2) Substantial clinical heterogeneity likely stems from different manipulation schools, non-unified practitioner techniques, and varying single-session durations. (3) Diverse and inconsistent shoulder function scales were used; most Chinese studies failed to specify scale names or measurement methods. Future research should standardize shoulder function assessment tools to improve evaluation specificity.

In summary, meta-analysis of current literature indicates that manipulative therapy, particularly rotation-inclusive techniques, effectively relieves shoulder pain and improves function compared to physical therapy and acupuncture. However, limited sample sizes and methodological quality necessitate additional high-quality evidence.

Author Contributions: Yide Fang and Hao Hu conceived and designed the study. Yide Fang drafted the manuscript. Hao Hu organized tables and generated RevMan plots. Xing Ding, Qingshan Ma, Yayun Zhang, and Yanni Wang conducted literature search and screening. Jinhai Xu and Wen Mo supervised the project and revised the manuscript.

Conflict of Interest: The authors declare no competing interests.

Note: Figure translations are in progress. See original paper for figures.