Effectiveness of Acupuncture for Scoliosis: A Systematic Review

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ABSTRACT

Scoliosis is a 3-dimensional change of the spine, presenting 10° above Cobb angle. Various acupuncture methods are being increasingly performed to correct scoliosis. However, no systematic review has been published. Therefore, we report on the effectiveness of acupuncture on mild scoliosis in this systematic review. We searched various databases for acupuncture treatment for scoliosis published before June 2021. The primary outcome was Cobb angle, and the secondary outcomes were patient-centered scores. Six studies were identified. RCTs that compared combination therapy with acupuncture, and other treatment methods and showed significant improvement in the Cobb angle, and effective rate, but, with low quality evidence. Acupuncture monotherapy resulted in significant improvement in the Cobb angle and had high heterogeneity compared with other treatment methods, but no significant improvement in the effective rate was observed, and the quality of evidence was low. Regardless of the type of scoliosis, acupuncture monotherapy or combination therapy with acupuncture showed significant improvement in the Cobb angle, and the quality of evidence was moderate. No serious adverse events were observed in the 6 studies reviewed. Acupuncture is considered safe, and it is more effective when performed with other conventional treatments.

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Introduction

Scoliosis is a 3-dimensional spinal deformity with an uncertain etiology. There are 3 main categories of scoliosis: idiopathic, congenital, and neuromuscular. The deformation can be seen in all parts of the spine and at all ages [1-3]. When the Cobb angle is above 10°, a diagnosis of scoliosis is diagnosed [1].

Scoliosis is not rare. The prevalence of adolescent idiopathic scoliosis (AIS) has been reported as between 0.47-10.4% of the adolescent population [4-9], and degenerative scoliosis occurs in 6-68% of adults [10-13]. As life expectancy increases, the proportion of individuals aged > 65 years will increase, and the prevalence of degenerative scoliosis may increase worldwide, especially in developed countries [14]. Tetsuya et al [10] conducted a 12-year community-based cohort study in Japan and determined that among 60 adults who were aged 50-84 years and had no scoliosis or history of spine pathologies, 22 adults were diagnosed with degenerative scoliosis within 12 years.

Treatment for scoliosis is dependent on age, severity of the curve, and whether it’s likely to worsen, and it is divided into surgical and conservative treatments. Surgical treatment is needed when patients have a high Cobb angle (> 45-50°) or multiple , in AIS,

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were no limits on age, and type of scoliosis. There were no language restrictions imposed. However, both surgical and conservative treatments have limitations. Although surgery can modify the curved spine, it is associated with some risk factors and complications [23,24], including neuro-deficit, wound infection, and pseudoarthrosis [25,26]. Regarding conservative treatments, although bracing is known to be most effective in AIS, it has been reported to cause curvature, and is associated with lack of compliance [27,28], and being psychologically detrimental (in the school environment, exercising, and inhibiting socializing) [29]. In degenerative scoliosis, Silva and Lenke [13] reported that treatments such as bracing, physical therapy, exercise therapy, chiropractic manipulation, and injections have low evidence of effectiveness.

Recently, some reports suggested that acupuncture could benefit patients with scoliosis [30,31]. Several randomized controlled trials (RCTs) have been performed to determine the effect of acupuncture treatment for scoliosis. While some systematic reviews (SRs) have evaluated the effects of other therapy’s (bracing, exercise, physical therapy, and injections), a SR evaluating the effectiveness and safety of acupuncture for scoliosis has not been published to date. Therefore, in this SR, we aimed to investigate the benefits and adverse effects of acupuncture on scoliosis compared with other treatments.

Materials and Methods

Protocol and registration

The protocol registration number was assigned upon registration with the Research Registry (no.: 977, https://www.researchregistry.com/) and PROSPERO (2020 CRD42020209805, available from: https://www.crd.york.ac.uk/prospero/display_record.php?ID=CRD42020209805). This review was conducted in accordance with the Preferred Reporting Items for Systemic reviews and Meta-Analyses Protocols (PRISMA-P) 2015 Statement [32].

Type of studies

This review included only RCTs, case reports, observational studies, cross-sectional studies, and pilot studies, and SR protocols were excluded. There was no language restriction imposed.

Type of participants

Patients diagnosed with scoliosis and a Cobb angle of at least 10° in the included type of study were included in this review. There were no limits on age, and type of scoliosis.

Types of interventions

Various types of acupuncture were included such as manual acupuncture (MA), electro-acupuncture (EA), thread-embedding acupuncture (TEA), fire acupuncture (FA), and acupotomy for improving symptoms of scoliosis. Combination therapy including acupuncture was also accepted if the only distinction between the groups was acupuncture. Studies that compared between acupuncture according to the duration and acupuncture points were excluded from this review.

Types of outcome measures

The primary outcome used in this review was the Cobb angle. Secondary outcome measures were patient-centered scores, including the visual analog scale (VAS) and adverse events (AEs). Depending on the RCTs identified for review, we also included the Scoliosis Research Society-22 questionnaire (SRS-22) score, Oswestry Disability Index (ODI) score, effective rate, the angle measured using the scoliometer, maximum lung capacity, and height.

Data sources and search methods

National and international databases were searched (MEDLINE, EMBASE, Cochrane Library, China National Knowledge Infrastructure, Citation Information by NII, J-STAGE (Japanese database), Korean Medical Database, Korean Studies Information Service System, ScienceON, and Oriental medicine Advanced Searching Integrated System) until June 2021. The terms for diagnoses (scoliosis, spine curvatures, idiopathic scoliosis, degenerative scoliosis, neuromuscular scoliosis, secondary scoliosis) and treatments (MA, EA, TEA, FA, and acupotomy) were used. Reports and dissertations were also included in the literature search.

Data extraction and quality assessment

Two researchers independently screened the titles and abstracts of the retrieved articles to exclude duplicates and irrelevant reports, and then reviewed the studies by reading the full text for eligibility using predetermined criteria. Disagreement between the 2 reviewers was generally resolved through discussion, and the final decision was made by a 3rd reviewer. The data from the studies were assessed by participant’s characteristics, interventions, outcome measures, results of both the control and experimental groups, and AEs. If data reported in RCTs were ambiguous or missing, the author was contacted via e-mail. If there was no reply, those data were excluded and only the available data was analyzed.

Measures of treatment effect

Information on the participants, interventions, outcomes, results, and AEs was analyzed using Review Manager software (Version 5.4.1; Copenhagen: The Nordic Cochrane Center, The Cochrane Collaboration, 2020). Results are presented as the mean difference (MD) according to the characteristics of the study with a 95%
confidence interval. Statistical heterogeneity between the studies was evaluated using the chi-square test and I-squared ($I^2$) statistics as recommended in the Cochrane Handbook [35]. The $I^2$ statistics were interpreted as: unimportant heterogeneity (0-40%); moderate heterogeneity (30-60%); substantial heterogeneity (50-90%); and considerable heterogeneity (75-100%).

**Publication bias**

The Cochrane Collaboration “risk of bias” criteria (random sequence generation, allocation concealment, blinding of participants, blinding of outcome assessors, incomplete outcome data, selective outcome reporting, and other bias [33]) were used to access the risk of bias. Two reviewers independently assessed the RCTs results as having a high/low/unclear level of evidence. Disagreements between the researchers were solved by discussion; if an agreement was not reached, a 3rd party arbitrated. Reporting bias using funnel plots and visual assessment was not possible because there were < 10 studies included in this review.

**Quality of evidence**

The Grading of Recommendations Assessment, and the Development and Evaluation (GRADE) method were used in the GRADE Pro tool (https://gradepro.org/) to rate the quality of evidence. The quality of evidence from RCTs begin as high quality evidence, but they could be downrated to moderate, low, or very low based on: (1) limitations in design and implementation (risk of bias); (2) inconsistency (unexplained heterogeneity); (3) indirectness; (4) imprecision (spare data); and (5) publication bias.

**Results**

**Study selection**

A total of 234 studies were retrieved during the search. After removing 16 duplicates, 218 studies were screened using the titles and abstracts. There were 200 records excluded using the predefined criteria, and the remaining 18 articles were assessed for eligibility by full text. There were 6 studies included in this review and meta-analysis (Fig. 1).

**Characteristics of included studies**

Characteristics of the 6 studies [34-39] including a total of 489 patients with scoliosis are shown in Table 1. All 6 studies were conducted in China. Four studies were 2-arm parallel trials [34,35,37,39], and 2 studies were 3-arm trials [36,38]. In terms of the type of scoliosis, there were 3 studies on AIS [36-38], and 3 studies on degenerative scoliosis [34,35,39]. The average Cobb angle in the total number of experimental groups was 22.05° in AIS, and 16.53° in degenerative scoliosis. In all studies, acupuncture was used as the experimental intervention. Among them, 3 studies [34,36,38] compared acupuncture monotherapy with other treatments using the Cobb angle. All 6 studies [34-39] compared other treatments and combination therapy, with acupuncture and used the Cobb angle as the primary outcome. Regarding the types of acupuncture, 1 study used MA [38] and 2 used EA [36,39]. The remaining 3 studies each used FA [34], acupotomy [35], and TEA [37]. Acupuncture was compared with manipulation [36,37], exercise [34,38], and traction [35,39]. With respect to acupoints, 3 studies used the Hyeopcheok (EXB2) point [36,38], and 4 studies used acupoints in the surroundings of the affected spinous process [34,35,37,39]. The duration of treatment for most studies was 1-2 months [34,36-39] and only 1 study lasted for 3 months [35]. The total number of times acupuncture treatment was performed varied from 1 to 60 [34-39]. Regarding the gender distribution of participants, there were 208 male participants and 281 female participants. All studies evaluated the Cobb angle [34-39] as the primary outcome measurement, and the secondary measurements varied in each study, including effective rate [34,36-38], height [38], T1 pelvic angle [35], distance between the central sacral vertical line, and C7 plumb line (C7PL) and the centre sacral vertical line (CSVL) distance [38], SRS-22 score [36], VAS score [39], and ODI score [39]. Follow-ups were not performed in any of the studies [34-39].

**Risk of bias assessment**

The quality of the 6 studies [34-39] was assessed using the risk of bias tool. All studies presented a random sequence generation (low risk of selection bias), but only 1 study [35] provided information on allocation concealment (introducing an unclear risk of selection bias). Regarding the interventions, blinding of the participants and personnel during acupuncture treatment was not possible, and
therefore this was assessed as a high risk of performance bias. There was no clear information on detection bias in any of the studies, so it was recorded as an unclear risk of detection bias. Regarding the risk of attrition bias, although 2 studies had dropouts (10% [34] and 4% [37]), the percentage was as low and so the risk of attrition bias was assessed as low. All trials were assessed as being free from reporting bias and therefore the risk of reporting bias was low (Fig. 2).

### Effects of interventions

The interventions were categorized as acupuncture monotherapy [34,36,38], and combination therapy with acupuncture [35-39], and subgroups as per the interventions (Table 1). Analysis was performed according to the type of scoliosis. Effects of intervention results were mainly compared by using the Cobb angle [34-39] and by the study; effective rate [34,36-38], height [38], T1 pelvic angle [35], CVSL-C7PL distance [38], SRS-22 score [36], VAS score [39], and ODI score [39] were also included.

### Acupuncture monotherapy versus other various treatments

The acupuncture monotherapy group in the RCTs used FA [36], EA [36], and MA [38]. Acupuncture was compared with bracing [34], manipulation [36], and exercise [38]. The duration of the studies was 30-60 days. Two studies [36,38] reported on AIS, and 1 [34] study reported on degenerative scoliosis.

### Cobb angle

Three studies compared various acupuncture treatment with other treatments and evaluated the Cobb angle from the baseline to the endpoint. Meta-analysis was conducted according to the 3 subgroups. One subgroup compared acupuncture with manipulation, and the pooled results showed no significant difference (MD = -0.50, 95% CI: -2.59-1.59, p = 0.64, and I² was not applicable). Another subgroup compared acupuncture with exercise. There was no significant difference in the pooled results (MD = 0.90, 95% CI: -1.36-3.16, p = 0.43). Another subgroup compared acupuncture with using a brace. There was a significant difference in the pooled results (MD = 3.76, 95% CI: 2.98-4.54, p < 0.0001). The overall pooled results showed a statistically significant difference between acupuncture and other treatments (MD = 3.01, 95% CI: 2.31-3.71, p = 0.0001, and I² = 89%). The substantial heterogeneity resulted from Chen et al’s study, which included exercise for both the treatment and control groups. In addition, the

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**Table 1. Characteristics of Identified Studies.**

<table>
<thead>
<tr>
<th>1st author (y, country)</th>
<th>Type of scoliosis</th>
<th>Acupuncture treatment</th>
<th>N(M/F)</th>
<th>Mean±SD Cobb</th>
<th>Mean Age</th>
<th>Treatment details of acupuncture group</th>
<th>Treatment details of control group</th>
<th>safety profile</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st author (y, country)</td>
<td></td>
<td></td>
<td></td>
<td>Control</td>
<td>Control</td>
<td>Accupuncture</td>
<td>Control</td>
<td>Method</td>
</tr>
<tr>
<td>Liu LY (2020, China)</td>
<td>AIS</td>
<td>Combination</td>
<td>30 (9/21)</td>
<td>27.12±6.24</td>
<td>12.17±2.12</td>
<td>TEA + Ex + Man</td>
<td>56</td>
<td>60 d</td>
</tr>
<tr>
<td>LZY (2019, China)</td>
<td>AIS</td>
<td>Mono</td>
<td>36 (22/14)</td>
<td>20.17±4.72</td>
<td>13.52±0.71</td>
<td>EA</td>
<td>30</td>
<td>60 d</td>
</tr>
<tr>
<td>Tan Z (2021, China)</td>
<td>AIS</td>
<td>Mono</td>
<td>36 (21/13)</td>
<td>21.5±4.6</td>
<td>13±2</td>
<td>MA + Ex</td>
<td>42</td>
<td>60 d</td>
</tr>
<tr>
<td>Chen CX (2018, China)</td>
<td>DS</td>
<td>Mono</td>
<td>45 (23/33)</td>
<td>17.3±2.48</td>
<td>11.6±0.86</td>
<td>FA + Ex</td>
<td>30</td>
<td>30 d</td>
</tr>
<tr>
<td>Jiang CS (2020, China)</td>
<td>DS</td>
<td>Combination</td>
<td>30 (10/20)</td>
<td>24.8±5.00</td>
<td>62.9±7.1</td>
<td>AP + Tr</td>
<td>30 d</td>
<td>60</td>
</tr>
<tr>
<td>Yang R (2017, China)</td>
<td>DS</td>
<td>Combination</td>
<td>30 (10/20)</td>
<td>18.5±3.2</td>
<td>53.0±8.7</td>
<td>EA + Tr</td>
<td>30</td>
<td>45 d</td>
</tr>
</tbody>
</table>
risk of bias of blinding participants and personnel; (2) 1 level for inconsistency of the studies; and (3) 1 level for the imprecision of results due to sparse data (Fig. 3).

Effective rate

Three studies [34,36,38] evaluated the effective rate as the secondary outcome measure and calculated the risk ratio (RR) using the fixed model according to 3 subgroups. One subgroup was a comparison of acupuncture with manipulation, which showed no significant difference (RR = 0.92, 95% CI: 0.66-1.28, \( p = 0.62 \)). Another subgroup compared acupuncture with exercise and showed no significant difference (RR = 1.06, 95% CI: 0.92-1.22, \( p = 0.4 \)). The other subgroup compared acupuncture with use of a brace and showed no significant difference (RR = 1.22, 95% CI: 1.00-1.49, \( p = 0.05 \)). The overall effective rate showed no significant difference (RR = 1.08, 95% CI: 0.95-1.23, \( p = 0.22 \), and \( I^2 = 15\% \)).

The GRADE analysis indicated that the evidence for this outcome was of low quality and the evidence was downgraded by 2 levels: (1) 1 level for risk of bias of blinding participants and personnel; and (2) 1 level for imprecision of results due to sparse data (Fig. 4).

Other treatments (height, CSVL-C7PL distance, angle measured using scoliometer, maximum lung capacity)

Regarding variance in height, the MD was converted to a positive, because the post-treatment outcome was inevitably larger than the pre-treatment outcome. The study by Tan et al [38] compared MA with exercise, from the baseline to the endpoint. The pooled results showed no significant difference (MD = -0.50, 95% CI: -4.72-3.72, \( p = 0.82 \), and \( I^2 \) was not applicable).

In terms of the CSVL-C7PL distance, the study by Tan et al [38] compared MA with exercise, from the baseline to the endpoint. The pooled results showed no significant difference between acupuncture and exercise (MD = 0.50, 95% CI: -1.35-2.35, \( p = 0.60 \)). Evaluation of heterogeneity was not applicable.

In terms of the angle measured using the scoliometer, the study by...
Tan et al [38] compared MA with exercise, and used the scoliometer measurements from the baseline to the endpoint to analyze the overall results. The pooled results showed no significant difference between acupuncture and exercise (MD = 0.20, 95% CI: -1.52-1.92, p = 0.82). Evaluation of heterogeneity was not applicable.

In terms of maximum lung capacity, the study by Tan et al [38] compared MA with exercise, and used maximum lung capacity from the baseline to the endpoint to analyze the overall results. The MD was converted to a positive because the post-treatment outcome was inevitably larger than pre-treatment outcome. The pooled results showed no significant difference between acupuncture and exercise (MD = 30.00, 95% CI: -149.80 -209.80, p = 0.74). Evaluation of heterogeneity was not applicable.

The GRADE analysis indicated that the evidence for these outcomes was of low quality and the evidence was downgraded by 2 levels: 1) 1 level for risk of bias of blinding participants and personnel; and 2) 1 level for the imprecision of results due to sparse data.

**Acupuncture combined with other treatments versus other treatments**

There were 5 studies that were categorized as add-on acupuncture RCTs [35-39]. These studies used traction [35,39], exercise [38], manipulation [36], and combination of exercise and manipulation to compare with acupuncture [37]. In terms of acupuncture treatment, MA [38], EA [36,39], acupotomy [35], and TEA [37] were used. Regarding the types of scoliosis, 3 studies involved AIS [36-38], and 2 studies involved degenerative scoliosis [35,39]. The Cobb angle [35-39], effective rate [36-38], height [38], SRS-22 score [36], VAS score [39], ODI score [39], CSVL-C7PL distance [38], scoliometer measurement [38], and maximum lung capacity [38] were recorded. The study by Jiang et al [35] presented post-treatment results on T1 pelvic angle, VAS scores, and the degree of spinal rotation using the median score and interquartile ranges (rather than means and standard deviations), therefore, analysis could not be performed.

**Cobb angle**

Five studies [35-39] compared other treatments with acupuncture add-on treatment and evaluated the Cobb angle from the baseline to the endpoint. Meta-analysis was conducted according to each method for 3 subgroups. One subgroup compared traction with acupuncture and traction, which showed a significant difference (MD = 2.53, 95% CI: 1.78-3.27, p < 0.0001, and I^2 = 0). Another subgroup compared manipulation with acupuncture and manipulation, and showed a significant difference (MD = 3.4, 95% CI: 1.73-5.07, p < 0.0001, and I^2 = 41). The last subgroup compared exercise with acupuncture and exercise, and showed a significant difference (MD = 4.10, 95% CI: 1.97-6.23, p = 0.0002). The pooled results showed significant differences between the acupuncture add-on treatment and other treatment groups (MD = 2.81, 95% CI: 2.16-3.45, p < 0.0001, and I^2 = 3%). The GRADE analysis indicated that the evidence for this outcome was low quality and the evidence was downgraded by 2 levels: (1) 1 level for risk of bias of blinding participants and personnel; and (2) 1 level for imprecision of results due to sparse data (Fig. 5).

**Effective rate**

Three studies [36-38] evaluated the effective rate as the secondary outcome measure and calculated the risk ratio (RR) using a fixed model according to methods by 2 subgroups. One subgroup

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![Fig. 4. Effective rate: Acupuncture monotherapy versus other various treatments.](image-url)
compared manipulation with acupuncture and manipulation, and showed significant difference (RR = 1.24, 95% CI: 1.06-1.46, \( p = 0.006 \), and \( I^2 = 0\% \)). The other subgroup compared exercise with acupuncture exercise and showed no significant difference (RR = 1.09, 95% CI: 0.96-1.24, \( p = 0.17 \)). The pooled results showed a significant difference (RR = 1.19, 95% CI: 1.06-1.32, \( p = 0.002 \), and \( I^2 = 0\% \)). The GRADE analysis indicated that the evidence for this outcome was low quality and the evidence was downgraded by 2 levels: (1) 1 level for risk of bias of blinding participants and personnel; and (2) 1 level for imprecision of results due to sparse data (Fig. 6).

Patient-centered outcome scores (SRS-22, VAS, ODI)

In terms of the SRS-22, the study by Li et al [36] compared manipulation with EA and manipulation, and used the SRS-22 scores to analyze the overall results. The MD was converted to a positive because the higher the score, the better the quality of life. The pooled results showed a significant difference (MD = 1.50, 95% CI: 0.54-2.46, \( p = 0.002 \)). Evaluation of heterogeneity was not applicable. The graph is shown in Fig. 7A.

In terms of VAS, the study by Yang et al [39] compared traction with EA and traction, and used the VAS scores from the baseline to the endpoint to analyze the overall results. The pooled result showed a significant difference (MD = 2.00, 95% CI: 1.58-2.42, \( p < 0.0001 \)).
Evaluation of heterogeneity was not applicable. The graph is shown in Fig. 7B.

In terms of ODI, the study by Yang et al. [39] compared traction with EA and traction, and used the ODI scores from the baseline to the endpoint to analyze the overall results. The pooled result showed a significant difference (MD = 7.30, 95% CI: 5.61-8.99, \( p < 0.0001 \)). Evaluation of heterogeneity was not applicable. The graph is shown in Fig. 7C.

The GRADE analysis of 3 outcomes indicated that the evidence for this outcome was low quality and the evidence was downgraded by 2 levels; (1) 1 level for risk of bias of blinding participants and personnel; and (2) 1 level for the imprecision of results due to sparse data.

Others (height, CSVL-C7PL distance, scoliometer measurement, maximum lung capacity)

With respect to height outcomes, the subgroups compared exercise with MA and exercise [38]. Regarding height variance, the MD was converted to a positive because the post-treatment outcome was inevitably larger than the pre-treatment outcome. The pooled results showed no significant difference (MD = 1.90, 95% CI: -2.13-5.93, \( p = 0.35 \), and \( I^2 \) was not applicable).

In terms of CSVL-C7PL outcomes, the study by Tan et al. [38] compared exercise with MA and exercise, and used the CSVL-C7PL from the baseline to the endpoint to analyze the overall results. The pooled results showed no significant difference between acupuncture and exercise, and exercise (MD = 0.70, 95% CI: -1.21-2.61, \( p = 0.47 \)). Evaluation of heterogeneity was not applicable.

In terms of the angle determined with the scoliometer, the study by Tan et al. [38] compared exercise with MA and exercise, and used the scoliometer to measure the angles from the baseline to the endpoint to analyze the overall results. The pooled results showed no significant difference between acupuncture and exercise, and exercise (MD = 0.90, 95% CI: -0.74-2.54, \( p = 0.28 \)). Evaluation of heterogeneity was not applicable.

In terms of the maximum lung capacity, Tan et al. [38] compared exercise with acupuncture and exercise, and evaluated the maximum lung capacity from the baseline to the endpoint. The MD was converted to a positive because the post-treatment outcome was inevitably larger than the pre-treatment outcome. The pooled results showed a significant difference between exercise and acupuncture, and exercise (MD = 238.00, 95% CI: 55.63-420.37, \( p = 0.01 \)). Evaluation of heterogeneity was not applicable.

The GRADE analysis of the outcomes indicated that the evidence for these outcomes were low quality and the evidence was downgraded by 2 levels; (1) 1 level for risk of bias of blinding participants and personnel; and (2) 1 level for the imprecision of results due to sparse data.

![Fig. 7. Acupuncture combined with other treatment versus other treatments. (A) SRS-22 scores. (B) VAS scores. (C) ODI scores. ODI, Oswestry disability index; SRS-22, Scoliosis research society patient questionnaire; VAS, visual analog scale.](image-url)
According to the type of scoliosis

Cobb angle

Among 6 studies [34-39], 8 models were used to evaluate the Cobb angle from the baseline to the endpoint. The meta-analysis was conducted according to the type of scoliosis. In the subgroup AIS [38-40] there were 5 models included, the pooled result showed a significant difference (MD = 2.14, 95% CI: 0.81-3.47, \( p = 0.002 \), and \( I^2 = 45\% \)). In the subgroup degenerative scoliosis, 3 studies [34,35,39] were included, and the pooled result showed a significant difference (MD = 3.11, 95% CI: 2.57-3.65, \( p < 0.0001 \), and \( I^2 = 60\% \)). The overall Cobb angle of the studies showed significant improvement (MD = 3.11, 95% CI: 2.57-3.65, \( p < 0.0001 \), and \( I^2 = 60\% \)). The reason for the high heterogeneity for each subgroup was the mix of interventions (acupuncture monotherapy, acupuncture combination). The GRADE analysis indicated that the evidence for this outcome was low quality and the evidence was downgraded by 2 levels: (1) 1 level for risk of bias of blinding participants and personnel; and (2) 1 level for inconsistency of the studies (Fig. 8).

AEs

Information on safety was reported in 3 RCTs [34,35,38]. No RCTs reported serious AEs attributed to acupuncture.

Discussion

Patients with scoliosis suffer from body imbalance, pain, exercise limitation [40], and fear of the curved angle increasing. There are various conservative treatments available such as bracing, exercise, manipulation, and injection. However, these conventional treatments have low evidence of efficacy and other shortcomings. In this review, 6 studies were included with a total of 489 patients, 57 days of treatment duration, and no restriction on the type of scoliosis.

In the 6 studies, there were 5 types of acupuncture performed: MA, EA, FA, TEA, and acupotomy. The comparators included 5 types of conventional treatments: bracing, traction, exercise, traction plus exercise, and manipulation. The primary outcome measure was the Cobb angle, and the secondary outcome measures were the effective rate, height, SRS-22 score, VAS score, ODI score, CSVL-C7PL distance, scoliometer measurement, and maximum lung capacity. With various types of acupuncture, comparator, and outcome measures, acupuncture and other treatments were compared in this review.

Acupuncture treatment reduced the Cobb angle, regardless of the type of scoliosis and whether the acupuncture treatment was conducted alone or in combination with other conventional treatments. Other studies have also reported that acupuncture reduced symptoms as well as the Cobb angle in patients with scoliosis [41-43]. Acupuncture treatment may have the potential to reduce the chances of requiring surgery, and improve the quality of life of patients with scoliosis.

Comparing acupuncture monotherapy with combination treatments, which is a difficult comparison to make, indicated that acupuncture combination treatment had the tendency to better improve symptoms of scoliosis compared with acupuncture.
monotherapy. Acupuncture monotherapy improved the Cobb angle but showed little or no significant difference in the effective rate, height, CSVL-C7PL, scoliometer measurement, and maximum lung capacity. In contrast, combination treatment reduced the Cobb angle and showed significant differences in the effective rate, VAS score, SRS-22 score, ODI score, and maximum lung capacity.

It is interesting to note that acupuncture combination treatment had superior effects in various outcomes compared with conventional monotherapy, whereas acupuncture monotherapy showed little effect. This implies that acupuncture monotherapy should be supplemented with other therapies.

The etiology of spinal deformity is multifactorial mostly of an idiopathic nature, involving the bony structures, muscles, and ligaments, it may be neurological, and metabolic, and chemical factors may increase the rate of progression [44]. The mechanism of conservative treatment for scoliosis needs to be further investigated. Traction force allows the spine and surrounding structures to rearranged to realign the coronal and sagittal imbalance [45]. Braces apply force to correct spinal deformity on the convex and longitudinal sides [46]. Core muscle training while exercising improves stability and flexibility [47,48]. Manipulation enhances joint mobility [49] and decreases muscle tension and pain [50]. Each treatment is considered to improve scoliosis by benefiting the structural deformities in many ways. In contrast, MA, FA, TEA, and acupotomy, which were included as interventions in the studies reviewed, have a different mechanism. Acupuncture increases blood flow [51,52], causes micro environmental changes [52], and strengthens the muscles [53]. FA relieves structural impairment and reduces inflammation [54,55]. Acupotomy releases conglutination, thereby regulating the dynamic equilibrium of the tissue surrounding the spine, and reducing the induction of harmful signals [56]. It also relieves muscle tone and fatigue, and improves the balance in extensor muscles [57]. TEA provides both physical and chemical action [58], enables tissue regeneration [59] within relatively long periods of treatment [60]. Considering these characteristics, acupuncture mono therapy may impart physical limitations to cause structural changes. Regarding combination treatment, while the trait of each method helps the spine to recover from deformations and imbalance, combination treatment with acupuncture may work as an “uplift.” Moreover, combination therapy with acupuncture could provide patients comfort psychologically [61] and relief from parasympathetic- and neurotransmitter-related actions [62] compared with other conventional treatments.

These results are consistent with those reported in clinical practice. In South Korea, Korean medicine doctors use not only acupuncture but manipulation, traction, exercise, cupping, and physical treatment, similar to the practice in China [63-67]. Acupuncture is safe [68] and does not interrupt patients’ daily life like a brace does [29]. Thus, it is a good conservative treatment option. For patients with scoliosis who are already being treated with other treatments, such as the brace, exercise, traction, and manipulation, the addition of acupuncture to the routine care could have synergistic effects to prevent deterioration in symptoms of scoliosis.

This is the first SR that has evaluated the effectiveness and safety of acupuncture for scoliosis. However, there are some limitations to this review. Firstly, the number of patients and studies included in this SR was insufficient. Secondly, there was a high risk of bias, especially for the criteria of blinding of participants and personnel, in all the included studies. Thirdly, all studies were conducted in China, and the studies included various types of acupuncture and comparators. Fourthly, in terms of the primary outcome measure, the Cobb angle measurement could be erroneous and depends on the handler [69]. The studies did not consider this potential error in measurement. Furthermore, the outcome measures were so diverse that some analysis sections (especially in patient- centered index) only contained 1 or 2 studies. Fifthly, the follow-up periods were not long enough to determine whether the changes in scoliosis symptoms would be maintained. Lastly, the average Cobb angle of the experimental group was 20°, which was classified as mild scoliosis, therefore, a different interpretation would be needed in the case of severe scoliosis requiring surgery. This review only reported on patients who required conservative treatment. Therefore, based on the aforementioned limitations, future research should be conducted to validate these findings.

Conclusion

This SR and meta-analysis indicated that the addition of acupuncture to the other routine care could be effective in mild cases of scoliosis, especially in reducing the Cobb angle, and was a safe treatment for AIS and degenerative scoliosis.

Conflicts of Interest

The authors have no conflicts of interest to declare.

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Ethical Statement

This research did not involve any human or animal experiment.

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