

Role of conservative management in the reduction of Cobb angle among adolescent idiopathic scoliosis. A systematic review

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Abstract

Introduction. Physiotherapy Scoliosis Specific Exercises (PSSE) is a conservative approach for the management of adolescent idiopathic scoliosis (AIS) designed according to the guidelines of the International Society on Scoliosis Orthopaedic and Rehabilitation Treatment (SOSORT). Hence the aim of the study is to evaluate the effectiveness of PSSE and conservative management strategies for patients with AIS.

Methods. A systematic review was conducted and searches were carried out on a virtual database. The primary outcome measure analysed in this paper was Cobb angle and angle of trunk rotation, while the secondary outcome included functional capacity. A total of twelve studies were included in the review, which was analysed to determine the effects of conservative management of spinal scoliosis among adolescent aged children.

Results. The study was conducted on patients who had developed idiopathic scoliosis and had a Cobb angle of greater than 10°. The significance of the conservative management protocol was estimated based on the reduction of Cobb angle by > 5° post-intervention.

Conclusions. This review concluded that therapeutic exercises alone have added to the noninvasive standard of care in reducing magnitude of Cobb angle among AIS patients. The studies reviewed in this paper provide significant evidence that a minimum of sixteen weeks of the exercise-based protocol has been able to produce a statistically and clinically significant result in Cobb angle reduction by almost 5° to 8°.

Key words: scoliosis, exercise, Cobb angle

Introduction

Physiotherapy Scoliosis Specific Exercises (PSSE) is a conservative approach for the management of adolescent idiopathic scoliosis (AIS) designed according to the guidelines of the International Society on Scoliosis Orthopaedic and Rehabilitation Treatment (SOSORT). This approach can be used alone and also in combination with bracing for patients with a lateral curve of less than 45° [1]. The approach has gained the special interest of researchers and clinicians in searching the evidence on PSSE effectiveness among the adolescent scoliosis population having a Cobb angle between 10 and 25 degrees. This brings a change in the previously used approach of “wait and see” as used by the clinicians in the management of AIS having a Cobb angle magnitude ≤ 25° [2].

AIS is a multidimensional torsional deformity of the spine that is due to an unknown cause with an estimated prevalence of 0.35% to 5.2% [3]. It is characterized by a lateral spinal curvature of more than 10° in the frontal plane, thoracic lordosis in the sagittal plane (this is a vertical plane that divides the body into right and left halves), and a vertebral rotation in the transverse plane causing changes in the shape of the back represented by a posterior rib hump, plummeting off the rib cage on the concave side and the elevation on the convex side of the curve [4]. The deformity has a global prevalence of between 0.47 and 5.2% in the adolescent population, with a high predominance among girls as compared to boys, especially in higher severity of the curve that progresses with age [5].

Ninety percent of these patients are diagnosed during adolescence [5] and if are not properly treated develop into a deformity that causes altered mechanics of the spine leading to pain, compromised trunk mobility, balance alterations, psychogenic disorders and, in more severe cases, to cardiac and respiratory dysfunction [6].

Scoliosis Research Society (SRS) has developed guidelines for the treatment of growing patients with AIS, where elective surgery is recommended for patients with a lateral curve of more than 45° and conservative treatment for lesser curves. The main objective of PSSE is to limit the magnitude of Cobb angle and progression of the curve [3]. The efficacy of PSSE following SOSORT guidelines has been studied through several randomized controlled trials for managing the spinal deviation with varying degrees of Cobb angle, respiratory dysfunction, spinal pain, and for reducing the need for surgical intervention [7–9].

Many reviews on the role of exercises for AIS have reported positive results on Cobb angle, pulmonary functions, muscle strength, and cosmetic appearance. However, most of these reviews carry a risk of bias by reviewers as they were published by authors who have included their studies in those reviews. There is insufficient evidence available to support the use of conservative approaches of treatments including exercise for the management of AIS and recommended more concrete studies for the collection of valid evidence [10–13]. Hence the paper aims to evaluate multiple approaches used in different trials to determine the effectiveness of PSSE and conservative management strategies for patients with adolescent idiopathic scoliosis.

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Subjects and methods

Databases and literature surveillance

The literature search was conducted through a systematic approach on five electronic databases, including MEDLINE, Google Scholar, PubMed, Cochrane Library, and Web of Science, considering the tenure preceding 2005 due to the scarcity of articles. The relevant search was accompanied using Medical Subject Headings [MeSH] terms i.e. "Scoliosis AIS AND exercise, Cobb angle". The filters on study duration and preferred language were applied.

Inclusion/exclusion criteria

The inclusion criteria embrace studies irrespective of the research design that include the physical therapy management (comprise of sole or combination of exercises and adjunct treatment) for an AIS age between 8 and 18 years, having a Cobb angle between 10 and 45°. Functional outcomes, such as muscle strength, vital capacity, and the quality of life, were also measured as a secondary outcome. Studies in which surgical procedures have been conducted for the management of the scoliosis curve or those that included non-idiopathic scoliosis or were conducted before the year 2005 were excluded from the review. Studies were also excluded if found in other than the English language, and having unavailable full-texts.

Ethical approval

The conducted research is not related to either human or animal use.

Risk of bias

Cochrane collaboration tools were used to analyse the risk of bias of the studies included in this review that include random sequence generation, allocation concealment, blinding of participant and personnel, blinding of outcome assessor, incomplete outcome data and selective reporting.

Results

For this systematic analysis, a literature review of 1123 articles were carried out related to the topic. Searches were conducted on virtual databases such as MEDLINE, Google Scholar, and PubMed by using the keywords: Scoliosis, idiopathic scoliosis, Adolescent idiopathic scoliosis, and conservative management in scoliosis. More than 1100 studies were identified in an initial search that matched the tenure of 2005–2020, out of which 12 studies were inducted for the review, the rest were excluded based on the unmatched title, removal of duplications, irrelevant records, non-availability of the full-text article, and articles published in a language other than English ($n = 997$). Further, 144 full-text papers were extracted to be reviewed, out of which only 12 studies were selected based on inclusion criteria that involved 546 AIS patients, investigating the effects of therapeutic exercises, manual therapy techniques, and patient-related instructions on Cobb angle and functional outcome measures. The selection criteria of studies are depicted in Figure 1.

Synthesized findings

Among the twelve studies, eight studies were randomized controlled trials; two were quasi-experimental, one was a retrospective cross-sectional and the other was a case report.

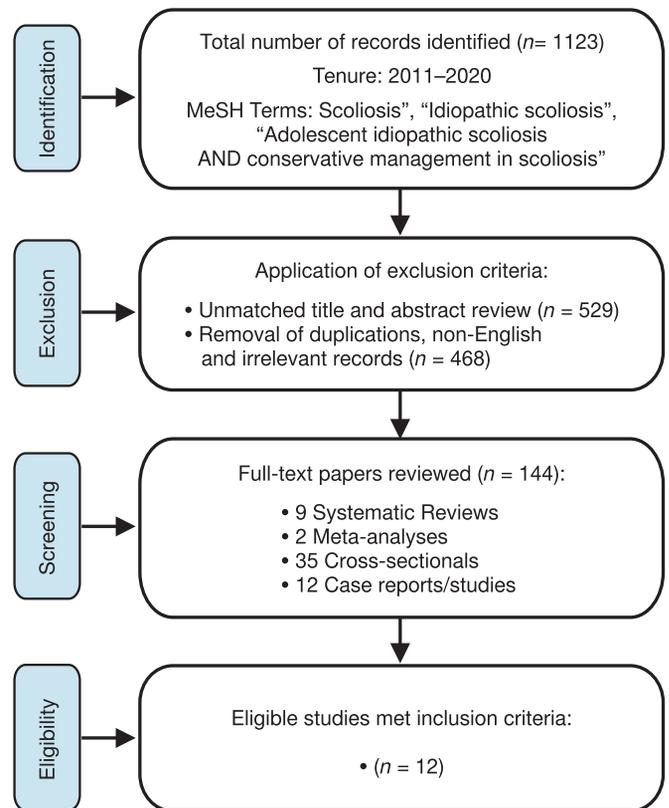


Figure 1. Represents conceptualization of the review process

The synthesized results on Cobb angle and functional outcome measure along with characteristics and description of studies are represented in Table 1.

Cobb angle

The primary outcome measures analysed in this paper were the Cobb angle and trunk rotation angle. It was observed that postural correction and the active exercises protocol reduced the progression of the spinal deformities, angle of trunk rotation and magnitude of the Cobb angle. Otman et al. [25] reported a significant reduction in the spinal curve ($p < 0.01$) after six weeks of conservative treatment. Kumar et al. [7] concluded that both bracing and exercises reduced the spinal curve and that no significant difference existed between the groups intervened by exercises and braces alone ($p > 0.05$). Stępień et al. [19] reported a significant reduction in the angle of trunk rotation in the thoracic and lumbar spine ($p < 0.001$) after immediate effects of the PNF technique. Schreiber et al. [20] in a randomized controlled trial reported an improvement in the spinal curve of the patient after a six-month intervention based on Schroth.

Monticone et al. [23] reported that active self-correction and task-based exercises had potency over traditional spinal exercises and found a significant reduction in the Cobb angle of a patient that was given intervention based on the task-oriented protocol ($p < 0.05$). Zaina et al. [26] also reported an improvement in the spinal curve and a reduction in the progression of the curve through a conservative approach of intervention.

Functional outcome measure

A functional outcome such as muscle strength, vital capacity, and the quality of life was measured as a secondary outcome. Otman et al. [25] reported that conservative man-

Table 1. Characteristics of the studies included

Author	Sample size	Study design	Target population	Intervention	Duration	Results
Skeggs et al., 2020 [14]	10	Retrospective-cross sectional	AIS patients with age between 8 and 14 years	PA thoracolumbar spine radiographs with the patient standing in the Schroth trained and normal standing position	N/A	Major Cobb angle was a mean of 6° less ($p = 0.02$) and the compensatory curve was 5° less ($p = 0.03$)
Rrecaj-Malaj et al., 2020 [15]	69	Randomized controlled trial	Patients with AIS having Cobb angle of 10°–45° and age between 10 and 17 years	Schroth and Pilates regimens performed daily for 60 minutes for 10 weeks	24 weeks	Significant improvements ($p < 0.05$) were found in both groups.
Yagci and Yakut, 2019 [16]	30	Randomized controlled trial	AIS females with a COG angle of (20°–45°)	Core stabilization exercises along with brace wearing was given to one group for a period of 4 months, on the contrary the other group received a scientific approach exercise regime for scoliosis	16 weeks	The Cobb angle for thoracic and lumbar along with angulation of angle of trunk rotation, symmetry of body, and cosmetic trunk deformity was managed and controlled for both groups
Hedayati et al., 2018 [17]	30	Quasi-experimental study	Patients with progressive scoliosis curves of 15–50 degrees	Patients in an experimental group underwent brace adjustment twice per week and performed group exercise, whereas those in the control group received a routine protocol	11 weeks	
Yagci et al., 2018 [18]	20	Randomized controlled trial		Traditional exercises along with BBAT were given to the experimental group, on the other hand conventional exercises twice a week for the duration of an hour were given to the control group	10 weeks	Cobb angle was found to be improved in the group that underwent BBAT in comparison to the one that received traditional exercises
Stepień et al., 2017 [19]	83	Quasi-experimental study	Girls aged 10 to 17 years with double idiopathic scoliosis	Bilateral lower limb patterns of proprioceptive neuromuscular facilitation were used in combination with the “contract-relax” technique and stimulation of asymmetrical breathing	6 months	Immediate effects of PNF mobilization significantly decreased the angle of trunk rotation in the thoracic ($p < 0.001$) and lumbar spine ($p < 0.001$)
Kumar et al., 2017 [7]	36	Randomized controlled trial	AIS (< 150 for thoracolumbar region and < 200 for thoracic region)	Task oriented exercises based on ergonomics in addition to exercises for conventional group for one year	1 year	FVC was found to be significantly ($p = 0.001$) higher in experimental group
Schreiber et al., 2016 [20]	50	Randomized controlled trial	AIS patients with curves of 10°–45° and Risser grade 0–5 aged between 10 and 18 years	Experimental group received five sessions with a duration of sixty minutes for two weeks followed by 60-minute session performed weekly along with home program with a duration of 30–45 minutes. Standard care and bracing were administered to the control group	24 weeks	Experimental group significantly reduces the largest curve than controls (–3.5°, 95% CI –1.1° to –5.9°, $p = 0.006$)
Kuru et al., 2016 [21]	51	Randomized controlled trial	Patients with adolescent idiopathic scoliosis	The intervention was divided into three groups. The first group underwent a 3D exercise program, home program exercises were performed in the second group, the later was the control group	24 weeks	Cobb (–2.53°; $p = 0.003$) and rotation angles (–4.23°; $p = 0.000$) significantly decreased, which indicated an improvement in the clinic exercise group
Weiss et al., 2016 [22]	1	Case report	Thirty seven year-old woman with AIS	Schroth exercise and computer-aided design bracing	64 weeks	Schroth exercise and bracing reduced the Cobb angle in radiographical examination
Monticone et al., 2014 [23]	110	Randomized controlled trial	AIS patients with Cobb angle of less than 25°	Experimental group received active self-correction exercises along with spinal exercises whereas control group received conventional spinal exercises and education	48 weeks	A greater reduction in Cobb angle of > 5° was observed in the experimental group
Bas et al., 2011 [24]	6	Randomized controlled trial	Patients with Cobb angle $28.1° \pm 2.1°$ and Risser 1.7 ± 1.8 and age between 12 and 15 years	Sports activities for 2 h, twice a week	6 weeks	The maximal power output was significantly increased in experimental group

AIS – adolescent idiopathic scoliosis, PA – physical activity, BBAT – basic body awareness therapy, PNF –proprioceptive neuromuscular facilitation, FVC – forced vital capacity, SSE – scoliosis-specific exercise

agement protocol also turned out to be effective in strengthening the back muscle, improving vital capacity, and postural correctness. Schreiber et al. [20] reported improvement in the self-efficacy questionnaire score of the patient which serves as a measure to quantify the self-efficacy of the patients in overcoming the barriers to physical activity.

Risk of bias

The risk of bias based on the author’s judgment for each included trial was performed using Cochrane’s Risk of Bias Tool, as shown in Table 2 and Figure 2.

Random sequence generation

Nine studies [7, 14–16, 18, 20, 21, 23, 24] demonstrated a low risk of bias, two studies [17, 19] represented high risk whereas in one study [22] randomization was not applicable.

Allocation concealment

In six studies [7, 14, 16, 18, 21, 23] allocation was concealed indicating low risk of bias, four [15, 17, 19, 24] studies indicate high risk, one [20] represents unknown risk and in one study [22] concealment was not applicable.

Blinding of participants and personnel

Five studies [15, 17, 19, 22, 24] out of 12 showed a high risk of bias.

Blinding of outcome assessment

Six studies [7, 15, 16, 18, 23, 24] reported low risk of bias. However, five studies [14, 17, 19–21] showed high risk while in one study [22] it was not applicable.

Table 2. Cochrane summary for risk of bias (n = 12)

Studies	Random sequence generation	Allocation concealment	Participants blinding	Outcome assessment blinding	Incomplete outcome data	Selective reporting
Kumar et al., 2017 [7]	✓	✓	✓	✓	✓	✓
Rrecaj-Malaj et al., 2020 [15]	✓	×	×	✓	✓	✓
Yagci and Yakut, 2019 [16]	✓	✓	✓	✓	×	✓
Hedayati et al., 2018 [17]	×	×	×	×	×	✓
Yagci et al., 2018 [18]	✓	✓	✓	✓	×	✓
Stępień et al., 2017 [19]	×	×	×	×	✓	✓
Skaggs et al., 2020 [14]	✓	✓	✓	×	✓	✓
Kuru et al., 2016 [21]	✓	?	✓	×	✓	✓
Schreiber et al., 2016 [20]	✓	✓	✓	×	✓	✓
Weiss et al., 2016 [22]	N/A	N/A	×	N/A	✓	✓
Monticone et al., 2014 [23]	✓	✓	✓	✓	✓	✓
Bas et al., 2011 [24]	✓	×	×	✓	✓	✓

✓ – indicates low risk of bias, × – indicates high risk of bias, ? – indicates that cannot ensure risk of bias
 N/A – not applicable

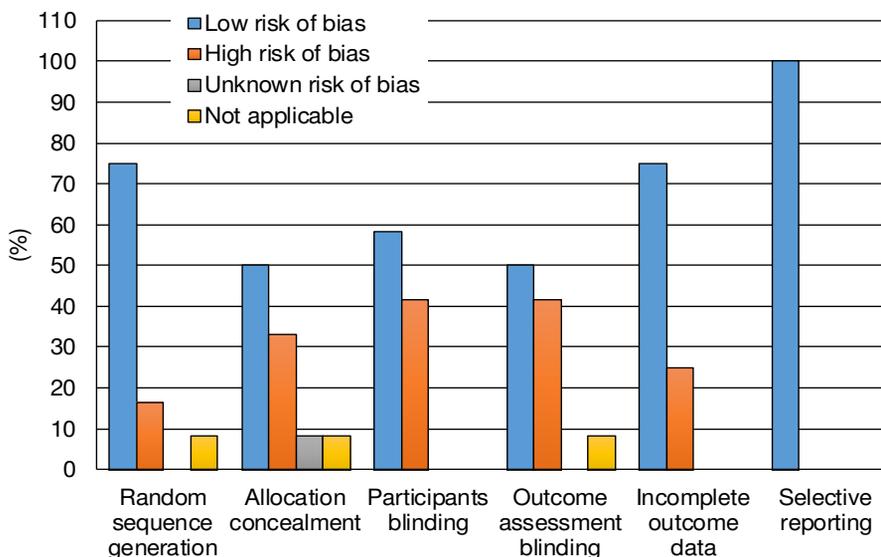


Figure 2. Cochrane risk of bias assessment

Incomplete outcome data

Three [16–18] out of 12 studies reported the loss to follow-up data and incomplete outcome data while remaining showed a low risk of bias.

Selective reporting

All the included studies [7, 14–24] showed low risk of bias.

Discussion

A total of twelve studies were analysed to determine the effects of conservative management of idiopathic scoliosis among the adolescent population with an angle of more than 10°. The significance of the conservative management was estimated based on the reduction of Cobb angle by > 5° post-intervention. The studies reviewed in this paper provided significant evidence that a minimum of sixteen weeks of the conservative management strategies was found to be statistically and clinically significant results in Cobb angle reduction by almost 5° to 8°. As reported in the studies of Kumar et al. [7], Schreiber et al. [20], Kuru et al. [21] and Zaina et al. [26] therapeutic exercise protocols alone and combined with braces have been able to reduce Cobb angle and pain significantly along with the overall in patient. Stepien et al. [19] reported the significance of the PNF technique in improving the angle of angle of trunk rotation of patients in both the thoracic and lumbar regions. A study conducted in Turkey on 45 AIS patients using Schroth exercise-based intervention concluded that Schroth exercises were found to be effective in reducing Cobb angle by -2.53° after 24 weeks of intervention [21]. The results were consistent with the findings of the study of Negrini et al. [27] in which significant reduction of scoliosis curvature i.e. -7.3° at thoracic spine with 90% median compliance during the treatment of 4.2 ± 1.4 years was reported that remained true for 85% of patients after two-year follow-up. A randomized control trial conducted in 2014 suggested that a structured active self-correction exercise plan and task-oriented exercises are significantly effective as compared to traditional exercises in reducing a Cobb angle of > 5° and enhancing the health-related quality of life in AIS patients with a Cobb angle < 25° [23]. Besides improvement in the spinal curve, the review also provided significant evidence in favour of secondary outcomes that were important for clinical perspectives and prevent the recurrence in developing the curve again. The secondary outcome as measured by Schreiber et al. [20] and Otman et al. [25] in their respective studies revealed that not only exercises regimes were effective in achieving the primary outcomes but in fact, these therapeutic exercises regimes were crucial in achieving secondary outcomes like muscle strengthening, postural control, and functional capacity as all these outcomes were turned out to be beneficial in the long run to maintain the residual effects of the exercises. The study highlights the emergence of diverse exercise interventions in the management of AIS before any surgical intervention to prevent the progression of the curve conservatively. However, due to the scarcity of researches the efficacy of the standard intervention is still unclear. Therefore multicentre trials should be conducted considering the effective exercises for AIS patients to document profound evidence-based conclusions.

Conclusions

The review of different studies conducted in this paper provided evidence that both PSSE and conservative man-

agement approaches that included different therapeutic exercises had a significant role in the reduction of the magnitude of Cobb angle of a patient who had developed idiopathic scoliosis.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

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