Meta-Analysis

Effects of spinal mobilization techniques in the management of adolescent idiopathic scoliosis - A meta-analysis

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ABSTRACT

Objectives: The aim of this study is to examine the effectiveness of diverse exercise regimes used in multiple Randomized Control Trials as the only conservative management strategy for increased Cobb angle among Adolescent Idiopathic Scoliosis.

Methods: Database such as Google Scholar, Medline, and BioMed Central was reconnoitered for the purpose of research articles of interest. Studies in which the effects of conservative management of scoliosis on the magnitude of Cobb angle were calculated were scrutinized procedurally, studies fulfilling the inclusion criteria were retrieved and encompassed in the present study.

Result: A total of 698 cases of AIS that were included in 17 controlled trials are part of this meta-analysis. The pool effects were measured using a standardized mean difference between the experimental and control group at 95% of confidence interval using Hedges'g statistics. Outcomes analyzed, reveals favorable for exercises based experimental group in term of standardized mean difference with an impact of 0.42° on random effect model, according to a Cohen's rule of thumb that depicts a near to moderate effects of exercises based interventions on Cobb angle.

Conclusion: The present study concludes that therapeutic exercise regimes alone have a pivotal role in both decelerating the progression of the curve and reducing the already increased magnitude of the curve.

Keywords: Scoliosis, exercise therapy, cobb ang

Introduction

The conservative, evidence-based medicine in the management of scoliosis has received tremendous input under the term "physiotherapy scoliosis specific exercises" (PSSE) coined by "the society of scoliosis orthopedic rehabilitation and treatment" (SOSORT).[1] During the past decade a call for a change in the management protocol of scoliosis from the different stakeholders including the parents of the children who are not a good candidate for surgery has challenged the previously existed protocol of "wait and see" that far too many doctors use while evaluating candidates having spinal curve in between 10 and 25°.[2] Since then a number of approaches have been developed under PSSE that claims the effectiveness of newly developed exercise regimes in the management of Cobb's angle, functional capacity and pain among patients with idiopathic scoliosis[3] midst them the most prominent and widely used protocol are the Schroth approach developed by Katharina Schroth in 1920[2,4] besides that there are six other schools that also claims the effectiveness of conservative exercise regimes for the management of the scoliosis curves.

Idiopathic scoliosis is characterized by the lateral deviation of the spine measuring to be >10° using Cobb's angle in an otherwise healthy individual for which no known etiology has been recognized.[5-8] The deformity progresses with age, and approximately 90% of all the cases are being diagnosed during the age of adolescence (10–19 years).[9] According to Labelle *et al*. the prevalence of idiopathic scoliosis among adolescence is 2–4% in 2013,[10] while having a 50% higher rate of incidence is found among females than males.[11] Scoliosis causes deformity that not only has cosmetic effects but it can also have compressive effects on internal organs that effect on the patient capacity to work, and in severe cases, it may even lead to cardiorespiratory compromise in the form of cor pulmonale.[12]

While surgical management is specific for the patients having a Cobb's angle >40°[13] conservative management would be a treatment of choice for patients having Cobb's angle <25° with a primary aim to curb the progression of the curve and to reduce the magnitude of the lateral deviation of spine (SOSORT guideline committee),[14-17] number of studies conducted globally on effectiveness of conservative management have indicated variance in results based on reduction in Cobb angle and even few studies have exhibited increase in Cobb angle after following recommended treatment protocol. However, it has been noticed by the researcher that sample size is a primary constraint factor

Table 1: Represents the detail list of all the studies with author name, year of publication, sample size, and interventional strategies

Author	Year	*n*	Group	Intervention
Zheng *et al*.[18]	2018	53	Experimental	SEAS, 1.5 h session every 2–3 months+Daily exercise at home for 10–15 min.
			Control	TLSO prescribed for 23 h/day.
Lee *et al*.[19]	2017	58	Experimental	Side shift exercises.
			Control	Trunk stabilization exercises.
Langensiepen *et al*.[20]	2017	38	Experimental	Home based, SSE program on a SWBV platform-5 times/week.
			Control	Regular SSE treatment.
Kumar *et al*.[21]	2017	36	Experimental	Task-oriented exercises based on ergonomics, in addition to ex's for conventional group for 1 year.
			Control	Spinal strengthening exercises, self-correction, and breathing exercises.
Ko and Kang[22]	2017	29	Experimental	Spine stabilization exercise program-3 times session/week for 12 weeks.
			Control	Observation-12 weeks.
Kim and Park[23]	2017	15	Experimental	5 min warm up+RME using the Spiro tiger for 10 min+SE for 40 min.
			Control	5 min warm up+Fixed bicycle for 10 min+SE for 40 min.
Alayat *et al*.[24]	2017	50	Experimental	Direction sensitive exercise therapy+Custom position+Exercise program-3 times/week for 12 weeks.
			Control	Traditional exercise therapy protocol-3 times/week for 12 weeks.
Kim *et al*.[25]	2016	24	Experimental	Schroth Exercises Group-3 times/week for 60 min up to 12 weeks.
			Control	Pilates Exercises Group-3 times/week for 60 min up to 12 weeks.
Schreiber *et al*.[26]	2016	44	Experimental	6 months supervised Schroth PSSE intervention.
			Control	Standard of care, observation, or bracing by SRS recommendation.
HwangBo *et al*.[27]	2016	16	Experimental	Schroth Exercises Group-12 weeks, 3 sessions/week.
			Control	Pilates Exercises Group-12 weeks, 3 sessions/week.
Gür *et al*.[28]	2016	25	Experimental	Core stabilization exercises-2 times/week for 10 weeks.
			Control	Traditional exercises+bracing-2 times/week for 10 weeks.
Kuru *et al.et al*.[29]	2015	30	Experimental	The Schroth clinical exercise program under physiotherapist supervision-6 weeks.
			Control	Observational-6 weeks.
Monticone *et al*.[30]	2014	110	Experimental	Active self-correction, task-oriented spinal exercises, and education.
			Control	General exercises aimed at spinal mobilization.
Veizaj[31]	2013	38	Experimental	Mezieres method, 45–60 min session/week for 6 months to 1 year.
			Control	Back school exercises, 2 sessions/week for 6 months to 1 year.
Cheon[32]	2013	16	Experimental	Chiropractic+Lumbar exercises program for 12 weeks.
			Control	Chiropractic only for 12 weeks.
Diab[33]	2012	76	Experimental	Stretching+Strengthening exercises+Corrective exercise program, 3 times/week for 10 weeks.
			Control	Stretching+Strengthening exercises, 3 times/week for 10 weeks.
Zakaria *et al*.[34]	2012	40	Experimental	Stretching exercises followed by a physical therapy program for 3 months.
			Control	Mechanical traction+physical therapy program consists of stretching/strengthening for 3 months.
	Total	698		

of all these studies. Hence, a meta-analysis has been performed to elucidate the inconsistencies found in the previous researches as it provides a strong statistical mechanism for examining the pool effects of independent researches where discrete population sizes are inadequate to provide a strong statistical significance.

Materials and Methods

Identification and eligibility of relevant studies

Database such as Google Scholar, Medline, and BioMed Central was explored for the purpose of research article of interest using the following keywords: Adolescent idiopathic scoliosis and Cobb angle, Adolescent idiopathic scoliosis and SOSORT guidelines, and Cobb angle and Exercise therapy. All those studies in which the effect of conservative management of scoliosis on the magnitude of Cobb angle was calculated were scrutinized procedurally and those studies are fulfilling the inclusion criteria were retrieved and encompassed in the present study.

Inclusion and exclusion criteria

Inclusion criteria embrace all those studies that included only exercise therapy for the conservative management of Adolescent Idiopathic Scoliosis based on different regimes and protocols. All those researches in which surgical interventions were implemented for the correction of the spinal curve or who have taken into account non-idiopathic scoliosis or were conducted before 2005 were excluded from this review.

Data extraction and quality assessment

Data extraction and quality assessment were done on the basis of inclusion and exclusion criteria as per already developed standardized protocols. An assessment form was designed to validate data accuracy by including information from the studies as the first name of the author, year of publication, sample size, and the type of exercise therapy implemented as shown in Table 1.

Data analysis

Analysis was done using MedCalc statistical software. A continuous measure tool (comparing a mean difference between an experimental group and control group) was obtained on a forest plot, and its pooled effects were determined at 95% of confidence interval (CI) using a Hedges'g statistics for the formulation of a standardized mean. For the purpose of interpreting the values obtained on fixed/random model, Cohen's rule of thumb was applied that states a value of 0.2 reflects small effects, of 0.5 indicates a medium and value >0.8 indicates a large effect. For determining the level of heterogeneity supposition, Cochrane Q was determined. The I^2 statistic was applied to quantify inter-study variability having a range of 0–100%, 0% indicating no heterogeneity whereas the increased values indicate a higher level of heterogeneity.

Results

Characteristics of the included studies

A total of 17 randomized control trials were included comprising 698 cases of AIS as a part of this meta-analysis from Google Scholar, Medline, and BioMed Central database. The studies were strictly scrutinized, and only those RCTs were included in which the Cobb angle was measured as a primary outcome in response to exercises. Reference list of all the selected articles was also studied to extract out other relevant articles, through this exercise five more articles were recruited. PRISMA guidelines for the selection of study were followed which was given in Figure 1.

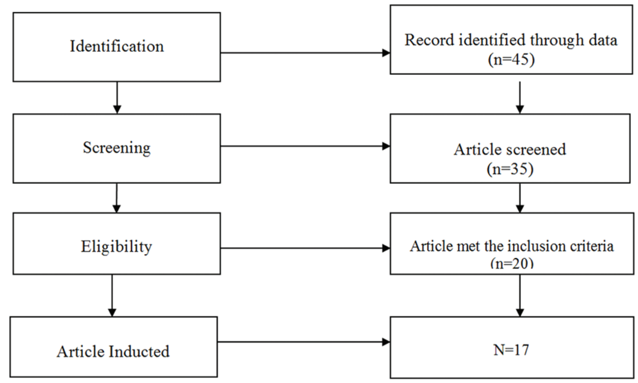

Figure 1: Flow diagram according to PRISMA guidelines

Test for heterogeneity

The Q test and I^2 test were calculated to identify the level of heterogeneity, as the values of level of inconsistency were within 95% of CI random effect model was used for assessing the pool effects.

Synthesized findings

Overall synthesized finding of 17 studies included were found to be in favor of the experimental group. The pool effects of Cobb angle in term of standardized mean difference as obtained in a random effects models showed an impact of 0.42° in favor of exercises based intervention that according to a Cohen rule of thumb depicts a near to moderate effects of exercises based interventions on Cobb angle as shown in Table 2.

Effect of exercise on Cobb angle is also plotted on the forest plot to determine the pooled effects in random and fixed effect model at 95% of CI as shown in Figure 2.

Risk of bias

Risk of bias of studies included in this review was assessed on the basis of Cochrane Collaboration tools for assessing the risk of bias as shown in Table 3.

Allocation

Random sequence generation

The randomization sequence was generated by the 16 studies[18-34] which illustrates the unknown risk of bias.

Allocation concealment

The concealed allocation in the randomized controlled trials was considered by the 15 studies (Zheng *et al*.[18] 2018, Lee *et al*.[19] 2017, Langensiepen *et al*.[20] 2017, Kumar *et al*.[21] 2017, Ko *et al*.[22] 2017, Kim and Park[23] 2017, Alayat *et al*.[24] 2017, Kim *et al*.[25] 2016, Schreiber *et al*.[26] 2016, HwangBo *et al*.[27] 2016, Gür *et al*.[28] 2016, Monticone *et al*.[30] 2014, Veizaj[31] 2013, Diab *et al*.[33] 2012, and Zakaria *et al*.[34] 2012). On the contrary, two studies (Kuru *et al*.[29] 2016 and Cheon *et al*.[32] 2013) illustrated the unknown allocation approach.

Blinding

Blinding of participants and personnel

Nine out of 17 studies (Zheng *et al*.[18] 2018, Lee *et al*.[19] 2017, Langensiepen *et al*.[20] 2017, Kumar *et al*.[21] 2017, Alayat *et al*.[24] 2017, Schreiber *et al*.[26] 2016, Gür *et al*.[28] 2016, Kuru *et al*.[29] 2016, and Monticone *et al*.[30] 2014) considered the participants and personnel blinding whereas two of the studies (Kim and Park[23] 2017, and Veizaj[31] 2013) showed unknown blinding approach. Six studies (Ko *et al*.[22] 2017, Kim *et al*.[25] 2016, HwangBo *et al*.[27] 2016, Cheon *et al*.[32]

Table 2: Pooled effects of exercise intervention on Cobb angle in term of SMD

Study	Experimental group	Control group	Total	SMD	SE	95% CI	T	P	Weight (%)	
									Fixed	Random
Zheng *et al*. 2018	29	24	53	0.054	0.27	−0.49 to 0.60			8.86	6.17
Lee *et al*. 2017	28	30	58	−0.014	0.25	−0.53 to 0.50			9.75	6.21
Langensiepen *et al*., 2017	20	18	38	−0.22	0.31	−0.86 to 0.42			6.44	6.05
Kumar *et al*., 2017	18	18	36	−1.81	0.39	−2.60 to −1.01			4.32	5.83
Ko *et al*., 2017	14	15	29	0.24	0.36	−0.50 to 0.98			4.98	5.92
Kim and Park, 2017	8	7	15	−0.39	0.49	−1.45 to 0.66			2.70	5.47
Alayat *et al*., 2017	25	25	50	−0.81	0.29	−1.39 to −0.23			7.79	6.13
Kim *et al*., 2016	12	12	24	0.65	0.40	−0.18 to 1.49			3.99	5.78
Schreiber *et al*., 2016	21	23	44	−0.15	0.29	−0.75 to 0.44			7.44	6.11
HwangBo *et al*., 2016	8	8	16	−0.74	0.49	−1.79 to 0.31			2.72	5.48
Gür *et al*., 2016	12	13	25	−0.53	0.39	−1.35 to 0.27			4.21	5.81
Kuru *et al*., 2015	15	15	30	0.49	0.36	−0.24 to 1.23			5.03	5.92
Monticone *et al*., 2014	55	55	110	−2.62	0.25	−3.14 to −2.11			9.75	6.21
Veizaj, 2013	19	19	38	2.73	0.44	1.83 to 3.64			3.28	5.63
Cheon *et al*., 2013	8	8	16	−1.60	0.55	−2.78 to −0.42			2.16	5.25
Diab, 2012	38	38	76	−0.09	0.22	−0.55 to 0.35			12.69	6.28
Zakaria *et al*., 2012	20	20	40	−2.40	0.41	−3.23 to −1.57			3.89	5.76
Total (fixed effects)	350	348	698	−0.46	0.08	−0.62 to −0.3	−5.696	<0.001	100	100
Total (random effects)	350	348	698	−0.42	0.28	−0.98 to 0.13	−1.495	0.135	100	100

CI: Confidence interval

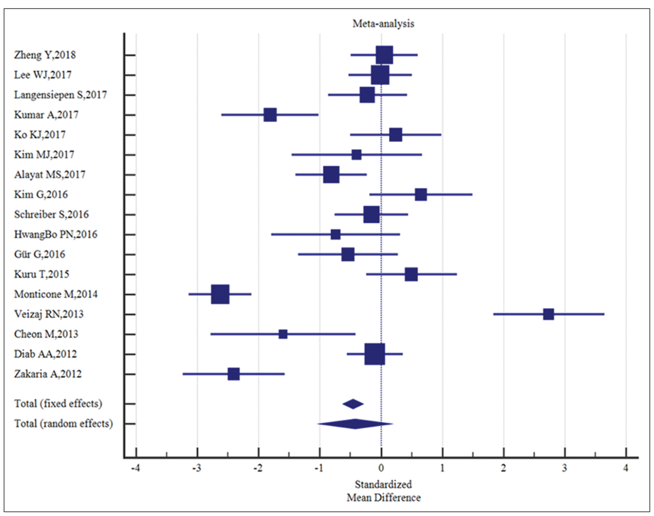

Figure 2: Illustrates the findings of the results of each study and its impact on the pool effects at the given level of confidence interval

2013, Diab[33] 2012, and Zakaria *et al*.[34] 2012) had shown the high risk of bias.

Blinding of outcome assessment

All the 17 studies had considered the blinding of the outcome assessment.

Incomplete outcome data

In the configuration of the risk of bias, all the studies have shown the absolute assessments and analysis of the outcome measures.

Selective reporting

The selective reporting of the outcome measures was also illustrated in all the studies. The author's judgment of risk of assessment was illustrated in Figure 3.

Discussion

Multiple AIS management approaches based on different exercises regimes are advocated to be effective in reducing the lateral curve of the spine, over the past decade number of researches have been conducted to quantify the impact of exercises on the Cobb angle providing confronting results. Moreover, with the development of the conservative management guidelines for scoliosis multiple exercise approaches has been identified by practitioners claiming their effectiveness in reducing the progression and decelerating the magnitude of the scoliosis curve, but most of such studies provide low-quality evidence as the protocols applied were on small sample size; further, the researcher has been unable to extract any meta-analysis to filtered the claim of all these randomized controlled trials. This meta-analysis contributes uniquely to increase the statistical strength and to acquire a more comprehensive and reliable interpretation of the findings. The guidelines given until date for the conservative management of AIS are highly dependent on the age of onset and the magnitude of the spinal curve[1] but not so focused on the pooled effects of the specific exercises regimes and their protocols. Hence, most of the studies conducted have utilized different regimes of exercises with varied protocols thus this

Table 3: Author judgment regarding risk of bias assessment

Domains	Random sequence generation	Allocation concealment	Blinding of participants and personnel	Blinding of outcome assessment	Incomplete outcome data	Selective reporting
Zheng *et al*., 2018[18]	√	√	√	√	√	√
Lee *et al*., 2017[19]	√	√	√	√	√	√
Langensiepen *et al*., 2017[20]	√	√	√	√	√	√
Kumar *et al*., 2017[21]	√	√	√	√	√	√
Ko and Kang, 2017[22]	√	√	×	√	√	√
Kim and Park, 2017[23]	√	√	?	√	√	√
Alayat *et al*., 2017[24]	√	√	√	√	√	√
Kim and HwangBo, 2016[25]	√	√	×	√	√	√
Schreiber *et al*., 2016[26]	√	√	√	√	√	√
HwangBo *et al*., 2016[27]	√	√	×	√	√	√
Gür *et al*., 2016[28]	√	√	√	√	√	√
Kuru *et al*., 2015[29]	√	?	√	√	√	√
Monticone *et al*., 2014[30]	√	√	√	√	√	√
Veizaj, 2013[31]	√	√	?	√	√	√
Cheon *et al*., 2013[32]	?	?	×	√	√	√
Diab *et al*., 2012[33]	√	√	×	√	√	√
Zakaria *et al*., 2012[34]	√	√	×	√	√	√

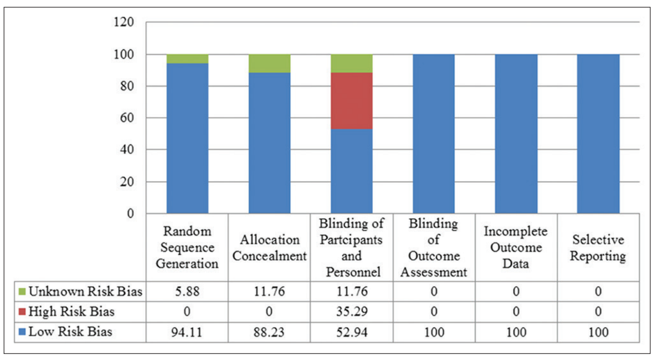

Figure 3: Risk of bias assessment in percentage

meta-analysis addresses the need to determine the collective impact of exercises as a management strategy for the lateral spinal curve.

Different studies have provided evidence that conservative management with or without bracing significantly reduces the Cobb's angle along with the improvement in the functional capacity of the patient.[21,26,29-30] However, Alexi reported the use of bracing alone reduces the Cobb angle by 5°, whereas according to the same study specific exercises strategies were essential only to increase the postural correctness and muscle strength among the patients.[35] On the other hand, a retrospective study conducted in 2009 on the effectiveness of complete conservative treatment for adolescent idiopathic scoliosis based on the guidelines of SOSORT reported a significant reduction in the scoliosis curvature by overall 7.1°, thoracic 7.3°, thoracolumbar 8.4°, and lumbar 7.8°. Moreover, a statistically significant result had also been reported in esthetics index and angle of trunk rotation.[36]

The result of this meta-analysis revealed that exercises based conservative management on the guidelines of SOSORT is effective in the management of Cobb angle with a near to moderate effect size as measured using random effect model.

While deducing the result researcher, acknowledges some limitations as non-availability of satisfactory number of studies as most of the studies available on topic were based on the outcome measures other than Cobb angle which makes the availability of literature on this parameter difficult and in certain cases despite efforts the availability of full-text articles of some literatures were not possible to extract.

The study has combined the impact of exercises regimes on Cobb angle as noted in different RCTs into a single analysis and with a watchful selection of data based on the stringent policy the researcher believes that current meta-analysis would be a knowledgeable tool for the clinicians and would open a door for future researches.

Conclusion

The present study indicates that therapeutic exercises regimes had a pivotal role not only in decelerating the progression of the curve but also indeed effective in reducing the magnitude of the curve.

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