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EFFECTS OF SPINAL MOBILIZATION TECHNIQUES IN THE MANAGEMENT OF COBB ANGLE AMONG ADOLESCENT IDIOPATHIC SCOLIOSIS PATIENTS

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Abstract:

Background

Idiopathic scoliosis is considered as the most common type of spinal deformity having insidious onset and relentless progression that may even lead to death. The global prevalence of the disease is 0.47 to 5.2% with the approximate prevalence rate of 2 to 3% in Pakistan. The deformity progresses with the age and approximately 90% of all the cases are being diagnosed during the age of adolescence (10-19 years). Multiple studies have provided evidences that physical therapy intervention strategies are beneficial in improving the Cobb angle but none of these studies have provided evidence on the effects of conservative management alone on scoliosis prior to surgery particularly in the perspective of under developed countries. Hence the present study is aimed to determine the impact of conservative management of Scoliosis in improving the Cobb angle of the Adolescent Idiopathic Scoliosis patients.

Methodology

A Quasi Experimental Study was conducted on 106 Adolescent Idiopathic Scoliosis Patients. The patients were given an initial of eight weeks of supervised exercises intervention in Physical Therapy outpatient department followed by a four weeks of home based session.The outcome measures were assessed through Cobb angle measurement using a radiographic X-rays.

Results

The findings revealed a significant difference in the mean 7.59±2.86 of Cobb angle $p<0.0001$ which shows that interventional strategies of 8 weeks as outpatient and 4 additional weeks as home program was found to be effective as a conservative approach of management for Adolescent Idiopathic Scoliosis of 30^0 or less.

Conclusion

In a nut shell, the conservative approach of Adolescent Idiopathic Scoliosis management protocol designed under the guidelines of Society on Scoliosis Orthopedic and Rehabilitation Treatment (SOSORT) was found to be effective in not only decelerating the progression of the thoracic curve but indeed found to be effective in reducing the Cobb angle.

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INTRODUCTION:

Idiopathic scoliosis is considered as the most common type of spinal deformity having insidious onset and relentless progression that may even lead to death [1]. The global prevalence of the disease is 0.47 to 5.2% [2] with the approximate prevalent rate of 2 to 3% in Pakistan [3]. The deformity progresses with the age and approximately 90% of all the cases are being diagnosed during the age of adolescence (10-19 years) [4]. The rate of incidence of disease is high among females, having male to female ratio ranges from 1:1.5 to 1:3.[5] Scoliosis is characterized by presence of one or more lateral curve in spine that measures greater than 10º using Cobb method in the coronal [6] plane and is classified into different types on the basis of its onset, cause and type of curve [7]. Scoliosis is divided into two major groups' idiopathic scoliosis and non-idiopathic scoliosis [8]. Non-idiopathic scoliosis is subgroup into congenital [9], neuromuscular [10], and mesenchymal scoliosis [11] whereas; idiopathic scoliosis is sub grouped with reference to age into infantile [12], juvenile [13], adolescent [14] and adult scoliosis [15]. The scoliosis of thoracic curve is more prevalent among all types of scoliosis, approximately 48% followed by thoracolumbar/lumbar curve 40%. About 80% of all adolescents presenting with scoliosis have thoracic curve scoliosis [16].Scoliosis causes deformity that not only has cosmetic effects but it can also have compressive effects on internal organs, disability, pain and restriction on patients' capacity to work and in case of severity it may lead to cardio respiratory compromise in the form of cor-pulmonale [17]. Management of Scoliosis is based on the magnitude of spinal curve [18] which can be best determined by measuring cob's angle [19] using a standard posterio-anterior standing radiograph of the spine. Management strategies include observation, physical therapy, bracing and surgical intervention. Cobb angle of < 15º requires observation [20], angle between 15-20º requires physical therapy in outpatient clinics with treatment free interval of 6-12 weeks [21], angle between 20-25º requires intensive rehabilitation program with the indication of brace if required [22] , the cob angle in between 25º -40ºrequires brace intervention [23] and an angle > 40º undergo surgical intervention [24]. The Physical Therapy techniques are primarily designed for the conservative management of scoliosis and to limits the progression of the curve [25]. The conservative management aims to improve pulmonary function (vital capacity), decrease severity of pain and to improve the balance and cardio respiratory fitness [26]. Multiple studies have provided evidences that physical therapy intervention strategies are beneficial in improving the coordination, equilibrium, range of motion and muscular endurance in scoliosis patients [27]. A study conducted Białek M et al in 2011 provided evidences that cobb angle has significantly reduces in patient who has under gone a conservative treatment for scoliosis [28]. Previous researches have provided significant evidences that passive grade-1 mobilization of thoracic spine vertebra helps in relieving pain and improving the functional mobility of the spine [29]. A study conducted by Bennell KL et al in 2010 also provided evidences that spinal mobilization techniques play a vital role in the management of pain and improving the health related quality of life in patient with osteoporotic vertebral fractures [30]. S. Negrini et al a result of his systematic review on "Exercises reduce the progression rate of adolescent idiopathic scoliosis" concluded that an exercise reduces the progression rate of disease [31] . Though the prevalence of scoliosis in Pakistan is approximately 2 to 3% no study regarding the effects of spinal mobilization and conservative management for the treatment of adolescent idiopathic scoliosis has been documented till date. A study conducted in the tertiary care hospital of Pakistan is exclusively specific to estimates the effects of different spinal instrumentation and surgical interventions in reducing the cobb angle although all such studies acknowledges the role of Physical Therapy intervention in a post-operative case in improving spinal mobility, relieving pain and improving lung functional capacity. Hence the purpose of the present study is to evaluate the effects of thoracic spine mobilization strategies in improving the cobb's angle, in adolescent idiopathic scoliosis patients before opting to other options like bracing and surgical interventions.

METHODOLOGY:

A Quasi Experimental Study was conducted on 106 Adolescent Idiopathic Scoliosis Patients. The patients were given an initial of eight week of supervised based exercises intervention in Physical Therapy outpatient department followed by a four week of home based session to be based on exercises taught to the patient during initial eight so that the patient performed those exercises at home on their own. Subjects recruited in the study were physically examined through Adam forward bend test to detect that either the scoliosis was structural or functional. In functional scoliosis, the deformity of spine become more apparent when the patient bends forward while in structural scoliosis the characteristics of deformity will remain same as in standing posture. To conduct the test the patients were asked to take off their shirts so that spine become visible to physical therapist, the patient was then asked to bend forward to 90 degrees with arms to be hanging on side and feet together, therapist observed the spine

of patient to search for any abnormality in the spinal curve, like increased or decreased in spinal curve and an asymmetry of the trunk. After physical examination every participant were given interventions based on following protocol:

- **Thoracic Spine Mobilization**

Passive oscillatory movements were performed at varying speed and amplitude anywhere along the total range of movement; they may be applied slowly with duration of one in 2 second, or quickly i.e. 3 per second, that may be smooth or interval, with varied amplitude. The joint surfaces was distracted or compressed during the performance of movement. Sustained passive stretching movements was performed that may or may not be combined with tiny amplitude oscillations at the limit of the range.

- **Exercise on Swiss Ball**:

The Exercise protocol progressed as follow:

A. Warm-up,
B. Chest and waist stretching was performed on the concave side for 5 minutes each in both side lying positions (left and right) Then the patient drop to his knees while holding a Swiss ball, bent waist and turned in the opposite direction from the convex side, maintaining the position for 10 second and repeat 10 times each
C. Main exercise was performed for 15 minutes. Patient lying on Swiss ball on the opposite side of convexity place both hands on their head and twist their trunk in opposite direction. Then patient bounce while sitting on a ball with their hands placed on pelvis and feet on the ground. Next, Patient places their hands on ground to support, put both their legs on the ball moving legs and ball side to side. Patient stretch their trunk by pushing ball with one hand while other hand used to support patient on ground in side-lying elbow rested position.
D. Cool-down

- **Dobomed approach:**

It includes the Kyphotization exercises for the thoracic spine and the lordotization exercises for the lumbar spine (ten repetitions for each exercise)

- **Hitch and Hitch Shift Exercise:**

Patients were instructed to lift his heel of the same side of curvature by keeping hip and knee in neutral position and holding the position for fifteen second while repeating the exercise for ten-minute duration.

- **Active Thoracic Shift Exercises:**

It includes two methods:

- Using dowel:

The patient was seated in front of the mirror holding a dowel and was instructed to maintain the correct alignment of the body and not allowing the dowel to fall on any side.

- Using Swiss ball:

The patient was side lying on a Swiss ball with the support of the physiotherapist.
Equipment like balance a board in front of mirror was used to help the patient achieve more effective active self-correction.
The duration of intervention strategy was of 50-60 minutes/day, six days/ week for eight continuous weeks followed by four weeks of home base exercises after wards a follow up was done to evaluate the effects of exercise interventions on the basis of assessment parameters.
The exercise protocols were prematurely terminated on the basis of one of the following condition:

1. Respiratory Distress
2. Pain > 6 on Visual Analog Scale
3. Oxygen Saturation level < 90

Home based program:

Home based program includes active spinal mobilization techniques taught to the patient during initial eight-week session. The exercises include kyphotiization and lordotization exercises, hitch and hitch shift exercises and active thoracic spine mobilization exercises using dowel and Swiss ball. The patient was instructed to perform these exercises for at least of 20 minutes for 6 days/week for four straight weeks afterwards the assessment was done to find out the follow up /residual effects.

Assessment Parameters:

Cobb's angle:

Cobb's angle of the participants' thoracic spine was measured through radiographic X-ray (anteroposterior and lateral views) performed at the beginning and at 12 weeks of treatment sessions.

Scoliometry:

The scoliometry was done to identify the effects of exercise protocol on thoracic scoliotic curve. The measurement using scoliometer were taken on day 1 at week 8 (on the completion of supervised exercises based program) and on week 12 (on a follow up session after four weeks to observe follow up/ residual changes).

Inclusion/ Exclusion Criteria

Inclusion Criteria

- Idiopathic Scoliosis at the level of thoracic spine
- Adolescent of age between 10-19 years
- Both genders
- Scoliometer value greater than Zero
- Cobb angle > 20°[18]

Exclusion criteria:

- Respiratory Type II failure
- Red flags e.g. Tumor, Vertebral and Radicular syndrome
- Loss and compression of spinal cord
- Thoracic insufficiency syndrome

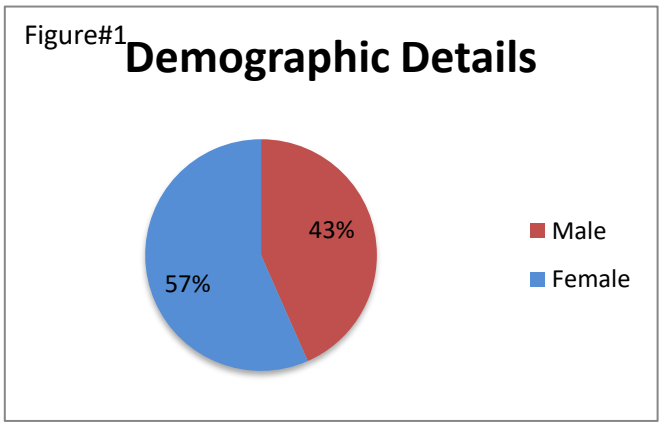
Ethical Consideration

Ethical considerations were made according to guidelines provided under Belmont report for human subjects. The data provided by the participants were kept confidential; consent was taken prior to the recruitment of the participants and was given opportunity to ask any question before, during and after the completion of the study

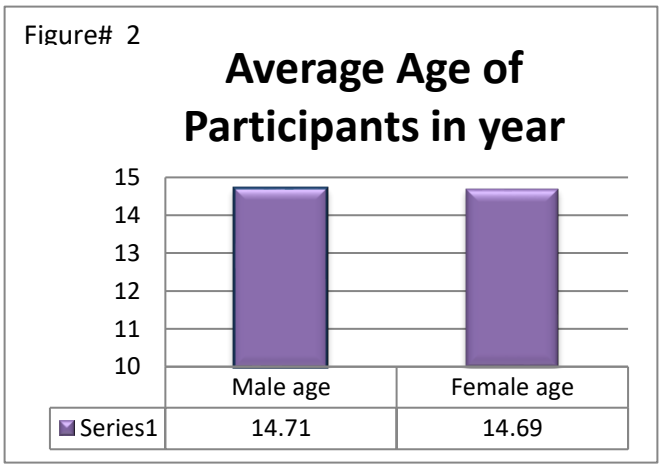
RESULTS:

Demographic Details

A total of 106 Adolescent idiopathic scoliosis patients were recruited in the study, the demographic information shows that out of the total number of the participants 46 were male constituting 43% of the total sample size and 60 were females comprising of 57% of the total sample size. (Figure#1)

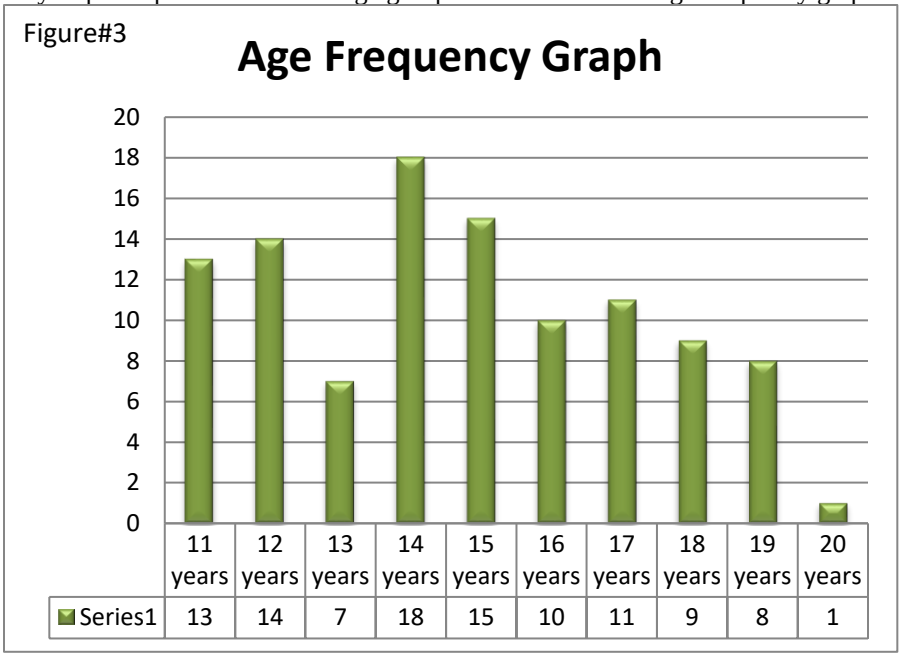


The mean age of the participants included in the study was 14.7± 2.5 years. The average age of the male participants was 14.71±2.5 and the average age of the female participants was 14.69±2.53 years. Figure 2 shows the graphical representation of the mean age of participant's



The frequency of participants in different age group is demonstrated in age-frequency graph Figure#3

Figure#3



The data shows that out of 106 participants included in the study the maximum numbers of the participants were found in the age group 14 years (n=18) followed by 15 years (n=15), 12 years (n=14), 11years (n=13), 17 years (n=11),16years (n=10), 18years (n=9) , 19years (n=8) , 13 years (n=7) and 20 years (n=1).

EFFECTS OF INTERVENTIONAL STRATEGIES ON THE OUTCOME MEASURES:

Adolescent Idiopathic Scoliosis is characterized by the lateral deviation of spine, the primary approach for its management mainly involves protocols that not only decelerates its progression but indeed reduces its magnitude. To determine the impact of management protocols on the Cobb angle two tailed probability test was applied using MEDCALC statistical software. The result of descriptive statistics after applying the test was illustrated in table.1

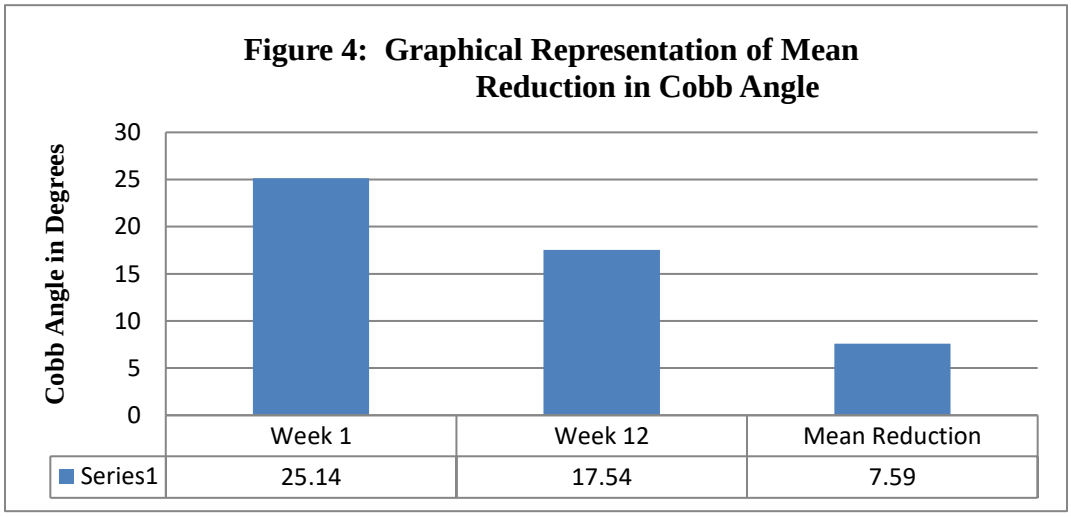
Table 1 Mean Representation of Cobb Angle		
	Week 1(Pre)	Week 12(Post)
Sample size	106	106
Arithmetic mean (Cobb Angle)	25.14	17.54
95% CI for the mean	24.54 to 25.74	16.99 to 18.09
Variance	9.74	8.21
Standard deviation	3.12	2.86
Standard error of the mean	0.3	0.27

The findings showed that the pre-interventional mean of the Cobb angle of the subjects was 25.14±3.12 which was reduced to 17.54±2.86 after the twelve weeks of intervention (initial eight week and a follow up of four weeks of home based exercises session). The inferential statistics of the findings was illustrated in table.2

Paired samples t-test

Table 2: Mean Difference observed after 12 weeks of intervention	
Mean difference	7.59
Standard deviation of differences	2.86
Standard error of mean difference	0.27
95% CI	-8.14 to -7.04
Test statistic t	-27.29
Degrees of Freedom (DF)	105
Two-tailed probability	P < 0.0001

The findings revealed a significance difference in the mean 7.59±2.86 of Cobb angle p<0.0001 which shows that interventional strategies of 8 weeks as outpatient and 4 additional weeks as home program, under the prescribed protocol of present study was found to be effective as a conservative approach of management for Adolescent Idiopathic Scoliosis of 30^0 or less. Figure 4 shows the graphical representation of the pre-post effect on the mean difference of the Cobb angle.



Bar chart shows that the Cobb angle of the participants before the start of the intervention was 25.14^0 which reduced to 17.54^0; a mean reduction in the Cobb angle of the participants was calculated to be around 7.59^0.

DISCUSSION:

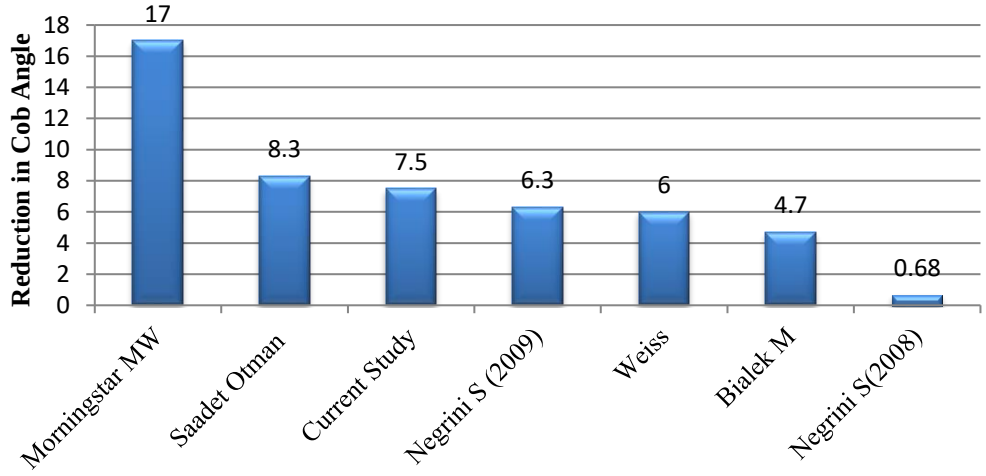
The result obtained from the study shows that greater number of female (57%) were effected from scoliotic deformity in comparison to male (43%); a female to male ratio of 4:3 was calculated, the result was according to the study conducted by Konieczny, M.R et al in 2013[4] in which it was concluded that the prevalence of spinal deformity was more common in female than male with an estimated ratio of 3:1 and 5:3 respectively. According to the study conducted by Grivas, T.B. et al 2006 an interesting pattern was observed regarding the prevalence of Adolescent Idiopathic Scoliosis patient in which it was concluded that Geographical latitude significantly alter the prevalence of AIS among the females whereas no direct observation of geographical latitude on the prevalence of AIS was found among male population [32]. However, the observable pattern was that in every degree change in the geographical latitude the prevalence of female with AIS was greater than male. According to the results of present study the greater number of patient with AIS were found in the age group of 14 years (a total of 18 participants out of which 10 were females and 8 were males) which generally regarded as an age of skeletal maturity, similarly according to the findings of Scoliosis research society, Australia, 2014 the greater risk of progression of the scoliosis curve was noticed in between the age group of 11-16 years where the

chances of developing the scoliotic curve were 10 %, 40%, 70 % and 90% based on the initial magnitude of cobb angle <20, 20-30, 30-60 and >60 respectively which suggest that the risk of progression in the magnitude of the scoliosis curves mainly depends upon the chronological age and the riser sign (age of skeletal maturity) and hence it was on the basis of these two factors the management of Scoliosis was widely designed (Indication of Conservative Management of Scoliosis, SOSORT guidelines 2006) and as per these guidelines the management protocol for this study has been designed keeping on record that significance of any scoliosis management strategies was mainly to be identified on the basis of its effectiveness in the reduction of the Cobb angle (Lateral deviation of Spine).

Cobb Angle

The Cobb angle of Adolescent Idiopathic Scoliosis patients was significantly reduced after twelve week of intervention given to the patients in the outpatient physical therapy department for eight week and home based therapy program for four week, the mean reduction in the Cobb angle as observed was around 7.5^0.The result is according to the study conducted by Saadet Otman et al in which it was concluded that six weeks of supervised exercises session reduces the Cobb angle from 26.1^0 to 17.8^0 [33] a mean difference of around 8.3^0 was observed. Negrini, S (2009). reported a mean reduction of 6.3^0, however according to the same study no fixed duration of intervention was given and it was stated that the duration was determined according to the patient need[34]. Białek, M., in 2011 reported a mean reduction in the Cobb angle of around 4.7^0 in which the interventional strategies was based on according to the protocol of Functional Therapy of Scoliosis Approach (FITS) where the duration of the protocol was of two weeks and was given to the patient twice in a year [28]. In another study conducted by Negrini S et al in 2008, it was observed that a conservative approach based on the guidelines of SOSORT on a designed protocol of Scientific Exercise Approach to Scoliosis (SEAS) a Cobb angle was reduced only by 0.68^0 [31].An interesting findings were concluded by Morningstar MW et al in 2004 in a study titled as "Scoliosis treatment using a combination of Manipulative and rehabilitation therapy" the study reported a reduction in Cobb angle of around 17^0 after 4-6 weeks of interventional strategy. Weiss, H.R reported that Scroth approach for the conservative treatment of Scoliosis was found to be effective even in the worst cases of scoliosis in which the patients with a cob angle $\geq 25^0$ and $\leq 27^0$ were given intervention and a mean reduction in the cob angle of 6^0 was observed in 18% of the cases, however for 25% of the cases the same research had also observed an increase in the 6^0 of the scoliotic curve in those patients having a prognosis risk of 65%, thus concluded that conservative approach was effective only in those having less prognostic risk to be determined through Lonstein and Carlson (L-C) formula as prescribed under the guidelines of SOSORT 2006 [18]. The graphical representation of the reduction in the Cobb angle as observed under this study and the previously conducted studies was given in figure # 5.

Figure 5: Mean Reduction in Cobb Angle as Observed in Different Studies



Whereas the usefulness of interventional strategies in term of its cost effectiveness was determined on the basis of its duration and it was observed that the study of Mormingstar et al and Saadet Itman et al claimed that a reduction in Cobb angle of around 17^0 and 8.3^0 was attained after giving the intervention for only six weeks [33,35] whereas according to the present study a reduction in the Cobb angle of around 7.5^0 was observed after giving the intervention for 12 weeks. Negrini et al in a two previously conducted studies concluded that no fixed duration of intervention was recommended to the patients and the duration was based on depending the condition of patient whereas Weiss et al and Bialek M et al claimed the reduction in the Cobb angle after twelve months of interventional strategies

CONCLUSION:

In a nut shell, the conservative approach of Adolescent Idiopathic Scoliosis management protocol designed under the guidelines of Society on Scoliosis Orthopedic and Rehabilitation Treatment (SOSORT) was found to be effective in not only decelerating the progression of the thoracic curve but indeed found to be effective in reducing the Cobb angle. The intervention protocol was comprised of eight week of outpatient physical therapy rehabilitation program along with additional four weeks of home-based approach based on exercises taught to the patients during initial eight weeks of rehabilitation program. The exercise based rehabilitation protocol of this research were also compared with the protocol used in the previously conducted studies and on the basis of its finding on outcome measures and duration it was concluded that the exercise protocol used in this research was not only effective in term of its management but was also found to be cost effective and potent in term of its lasting residual outcome. However, there had some limitations in the study like the interventions were only given in a single tertiary care hospital of Karachi, Pakistan which may effect on the generalization of the result.

REFERENCES:

1. Fazal A, Lakdawala RHJIjogm. Fourth-generation spinal instrumentation: experience with adolescent idiopathic scoliosis at a tertiary care hospital in Pakistan. 2012;5:151.
2. Labelle H, Richards SB, De Kleuver M, et al. Screening for adolescent idiopathic scoliosis: an information statement by the scoliosis research society international task force. 2013;8(1):17.
3. Arif M, Inam M, Hassan WJJoSP. Radiographic outcome of Adolescent idiopathic scoliosis surgical correction with posterior spinal fusion using pedicle screw and rods fixation. 2011;16(3):118.
4. Konieczny MR, Senyurt H, Krauspe RJJocso. Epidemiology of adolescent idiopathic scoliosis. 2012;7(1):3-9.
5. Kamtsiuris P, Atzpodien K, Ellert U, Schlack R, Schlaud MJB, Gesundheitsforschung, Gesundheitsschutz. Prevalence of somatic diseases in German children and adolescents. Results of the German Health Interview and Examination Survey for Children and Adolescents (KiGGS). 2007;50(5-6):686-700.
6. Negrini S, Aulisa AG, Aulisa L, et al. 2011 SOSORT guidelines: orthopaedic and rehabilitation treatment of idiopathic scoliosis during growth. 2012;7(1):3.
7. Romano M, Minozzi S, Bettany-Saltikov J, et al. Exercises for adolescent idiopathic scoliosis. 2012(8).
8. Akazawa T, Minami S, Kotani T, Nemoto T, Koshi T, Takahashi KJS. Health-related quality of life and low back pain of patients surgically treated for scoliosis after 21 years or more of follow-up: comparison among nonidiopathic scoliosis, idiopathic scoliosis, and healthy subjects. 2012;37(22):1899-1903.
9. Sparrow DB, Chapman G, Smith AJ, et al. A mechanism for gene-environment interaction in the etiology of congenital scoliosis. 2012;149(2):295-306.
10. Mattila M, Jalanko T, Puisto V, Pajulo O, Helenius IJTJob, volume jsB. Hybrid versus total pedicle screw instrumentation in patients undergoing surgery for neuromuscular scoliosis: a comparative study with matched cohorts. 2012;94(10):1393-1398.
11. Eckalbar WL, Fisher RE, Rawls A, Kusumi KJWIRDB. Scoliosis and segmentation defects of the vertebrae. 2012;1(3):401-423.
12. Tsiligiannis T, Grivas TJS. Pulmonary function in children with idiopathic scoliosis. 2012;7(1):7.
13. Coillard C, Circo AB, Rivard CHJS. SpineCor treatment for Juvenile Idiopathic Scoliosis: SOSORT award 2010 winner. 2010;5(1):25.
14. Tao F, Wang Z, Li M, et al. A comparison of anterior and posterior instrumentation for restoring and retaining sagittal balance in patients with idiopathic adolescent scoliosis. 2012;25(6):303-308.
15. Charosky S, Guigui P, Blamoutier A, Roussouly P, Chopin DJS. Complications and risk factors of primary adult scoliosis surgery: a multicenter study of 306 patients. 2012;37(8):693-700.
16. Suh S-W, Modi HN, Yang J-H, Hong J-YJEsj. Idiopathic scoliosis in Korean schoolchildren: a

prospective screening study of over 1 million children. 2011;20(7):1087-1094.
17. Wong H-K, Tan K-JJIjoo. The natural history of adolescent idiopathic scoliosis. 2010;44(1):9.
18. Weiss H-R, Negrini S, Rigo M, et al. Indications for conservative management of scoliosis (guidelines). 2006;1(1):5.
19. Sangole AP, Aubin C-E, Labelle H, et al. Three-dimensional classification of thoracic scoliotic curves. 2009;34(1):91-99.
20. Galvis S. *Biomechanical Assessment of Adolescent Idiopathic Scoliosis Deformity and Treatment*, University of Kansas; 2016.
21. REPAS PJh. 69006 LYON. 2002;27:1843.
22. Dolan LA, Wright JG, Weinstein SLJTNEjom. Effects of bracing in adolescents with idiopathic scoliosis. 2014;370(7):681.
23. Richards BS, Bernstein RM, D'amato CR, Thompson GHJS. Standardization of criteria for adolescent idiopathic scoliosis brace studies: SRS Committee on Bracing and Nonoperative Management. 2005;30(18):2068-2075.
24. Peelle MW, Boachie-Adjei O, Charles G, Kanazawa Y, Mesfin AJTSJ. Lumbar curve response to selective thoracic fusion in adult idiopathic scoliosis. 2008;8(6):897-903.
25. Landauer F, Wimmer CJMOT. Therapieziel der Korsettbehandlung bei idiopathischer Adoleszentenskoliose. 2003;123(3):33-38.
26. Koumbourlis ACJPrr. Scoliosis and the respiratory system. 2006;7(2):152-160.
27. Fusco C, Zaina F, Atanasio S, et al. Physical exercises in the treatment of adolescent idiopathic scoliosis: an updated systematic review. 2011;27(1):80-114.
28. Białek MJS. Conservative treatment of idiopathic scoliosis according to FITS concept: presentation of the method and preliminary, short term radiological and clinical results based on SOSORT and SRS criteria. 2011;6(1):25.
29. Shum GL, Tsung BY, Lee RYJAopm, rehabilitation. The immediate effect of posteroanterior mobilization on reducing back pain and the stiffness of the lumbar spine. 2013;94(4):673-679.
30. Bennell KL, Matthews B, Greig A, et al. Effects of an exercise and manual therapy program on physical impairments, function and quality-of-life in people with osteoporotic vertebral fracture: a randomised, single-blind controlled pilot trial. 2010;11(1):36.
31. Negrini S, Fusco C, Minozzi S, et al. Exercises reduce the progression rate of adolescent idiopathic scoliosis: results of a comprehensive systematic review of the literature. 2008;30(10):772-785.
32. Grivas TB, Vasiliadis E, Mouzakis V, Mihas C, Koufopoulos GJS. Association between adolescent idiopathic scoliosis prevalence and age at menarche in different geographic latitudes. 2006;1(1):9.
33. Otman S, Kose N, Yakut YJSmj. The efficacy of Schroth s 3-dimensional exercise therapy in the treatment of adolescent idiopathic scoliosis in Turkey. 2005;26(9):1429-1435.
34. Negrini S, Atanasio S, Fusco C, Zaina FJS. Effectiveness of complete conservative treatment for adolescent idiopathic scoliosis (bracing and exercises) based on SOSORT management criteria: results according to the SRS criteria for bracing studies-SOSORT Award 2009 Winner. 2009;4(1):19.
35. Morningstar MW, Joy TJC, osteopathy. Scoliosis treatment using spinal manipulation and the Pettibon Weighting System™: a summary of 3 atypical presentations. 2006;14(1):1.