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ORIGINAL RESEARCH

Functional Evaluation of Adolescent Idiopathic Scoliosis Patients in Relation to Sagittal Profile

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ABSTRACT

Background: Scoliosis is a complex three-dimensional deformity of the spine that involves the coronal, sagittal, and axial planes with fixed rotation of vertebrae. Adolescent idiopathic scoliosis is the most common type of scoliosis accounting for about 80% of idiopathic scoliosis involving healthy individuals. Aim: To assess the functional outcome of the patient treated surgically with a Scoliosis Research Society questionnaire administered to the patient pre operatively and post operatively.

Materials and Methods: Study Design: A prospective observational study. Study area: Out-Patient and In-Patient wing of the Department of Orthopaedics in Malabar Institute of Medical Sciences Hospital, Calicut. Study Period: The study was conducted from June 2017 to May 2018 for a period of 1 year. Study population: Patients coming to the outpatient wing and patients admitted in the inpatient wing of Department of Orthopaedics in Malabar Institute of Medical Sciences Hospital, Calicut. Sample size: 25. Sampling method: Simple Random sampling method. Inclusion Criteria: All patients diagnosed with adolescent idiopathic scoliosis and who are treated by any method of surgical correction. Study tools and Data collection procedure: SRS questionnaire will assess the patient in five different domains of functional outcome namely pain, mental status, function, self-image and satisfaction with treatment. The mean scores obtained in these five domains and total score are statistically analyzed to find any significant difference preoperatively and post operatively. An improvement in the total SRS score by 0.4 at the latest assessment is considered as Minimum Clinically Important Difference (MCID). Statistical Methods: Data will be analyzed using SPSS V 21.0 (IBM SPSS Inc. Chicago, IL). Continuous data will be summarized as Mean with SD or Median with Inter Quartile range. Categorical data will be summarized as frequency with percentage. Categorized data will be analyzed using Chi-Square test, Fischer's exact test or McNemar test. Paired T test will be used for preoperative and post-operative changes.

Results: A total of 25 patients were studied of which 02(8%) were males and 23(92%) were females. The pre-operative mean SRS score for function and post-operative mean SRS score for function was found to have a significant change (p value=0.01). SRS function score showed a definite increasing trend from 3.37 at first assessment to 3.72 at last assessment. A slight dip in the score was seen at 6 week post op assessment.

Conclusion: There is a significant association between the post-operative sagittal imbalance and a considerable change in the functional outcome of adolescent idiopathic

scoliosis patients treated surgically. Recreating a good sagittal balance postoperatively is of utmost importance. Hence the poor functional outcome in adolescent idiopathic scoliosis patients treated surgically could possibly be because of the attainment of inadequate sagittal profile also.

Keywords: Sagittal Imbalance, Adolescent Idiopathic Scoliosis, Scoliosis Research Society Score.

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INTRODUCTION

Scoliosis is a complex three dimensional deformity of the spine that involves the coronal, sagittal, and axial planes with fixed rotation of vertebrae.[1] Adolescent idiopathic scoliosis is the most common type of scoliosis accounting for about 80% of idiopathic scoliosis involving healthy individuals.[2] Adolescent idiopathic scoliosis, as the name suggests is scoliosis of unknown etiology seen in adolescents between age 10 and skeletal maturity. The prevalence of adolescent idiopathic scoliosis has been estimated to be 5%.[3] A female preponderance is noted and thoracic curves are more common than lumbar curves. Most commonly used surgical correction method for adolescent idiopathic scoliosis is posterior instrumentation and fusion.

It is shown that scoliosis causes mental dysfunction and psychological problems involving both the patient and the family.[4,5] Surgical correction definitely improves the cosmetic appearance. But the improvement in functional outcome is still being weighed with the complications involved in surgical correction.

A satisfactory treatment of adolescent idiopathic scoliosis means a maximum possible correction in the coronal plane, in addition to adequate restoration of the sagittal spinal alignment and vertebral rotation. The need for a coronal plane correction was long known. The importance of sagittal plane changes that need to be corrected for a satisfactory outcome is a recent event in scoliosis correction.

Sagittal balance reflects a shape of the spine that allows it to keep the stable standing position with minimum expenditure of muscle effort.[6] Normal sagittal spinal balance is a result of mutual articulation of the pelvis and the spine in the sagittal plane. A normal thoracic spine should exhibit kyphosis while the lumbar spine should be in lordosis, although the degrees may vary significantly in the healthy population. The main purpose of these lordotic and kyphotic spine segments is to balance the head, and maintain a horizontal gaze, over the pelvis in an energy-efficient position allowing the C7 plumb line, a vertical line drawn from the centre of the C7 vertebral body, to pass within a few millimetres of the posterior-superior corner of S1.[7]

It depends on the interaction of several factors like bone, discs, ligaments, mechanical factors, muscle strength and resistance, and compensatory ability, the alteration of any of these leading to sagittal imbalance. Recent research has recognized the importance of sagittal balance in normal and pathological states. Sagittal balance is shown to be the most important and reliable radiographic predictor of clinical health status in the adult patient presenting with spinal deformity. The pelvic state may be altered after posterior fusion of curves in idiopathic scoliosis.[8]

Aim:

To assess the functional outcome of the patient treated surgically with a Scoliosis Research Society questionnaire administered to the patient pre operatively and post operatively.

MATERIALS & METHODS

Study Design: A prospective observational study.

Study area: Out-Patient and In-Patient wing of the Department of Orthopaedics in Malabar Institute of Medical Sciences Hospital, Calicut.

Study Period: The study was conducted from June 2017 to May 2018 for a period of 1 year.

Study population: Patients coming to the outpatient wing and patients admitted in the inpatient wing of Department of Orthopaedics in Malabar Institute of Medical Sciences Hospital, Calicut.

Sample size: 25

Sample size calculations: Sample size is calculated using the formula, n = 4PQ/L2. Where P is the prevalence of adolescent idiopathic scoliosis. Q = 100-P. And L is allowable error. A previous study has shown that the overall prevalence of adolescent idiopathic scoliosis is 5%. (Konieczny MR, Senyurt H, Krauspe R. Epidemiology of adolescent idiopathic scoliosis. Journal of children's orthopaedics. 2013 Feb 1;7(1):3-9.(3))Taking this into consideration we expect the P value to be 5. Hence a sample size of 19 is required at L=10%. Considering a lost to follow up of 30% a sample size of 25 is required.

Sampling method: Simple Random sampling method.

Inclusion Criteria:

All patients diagnosed with adolescent idiopathic scoliosis and who are treated by any method of surgical correction.

Exclusion Criteria:

1. Patients with any congenital bony anomalies or mass lesions of the spine
2. Patients who had undergone any previous spine surgeries
3. Patients with history of fractures in the spine
4. Patients with listhesis in the x-ray
5. Patients with neuromuscular, syndromic, or metabolic diseases
6. Patients with any other spinal disorder along with adolescent idiopathic scoliosis
7. Patients who are not willing to be part of the study.

Ethical consideration: Institutional Ethical committee permission was taken prior to the commencement of the study.

Study tools and Data collection procedure: A patient who is diagnosed to have adolescent idiopathic scoliosis and is being planned for surgical correction will be requested to fill the Scoliosis Research Society version 30 Questionnaire (SRS 30) after explaining in detail and obtaining proper consent. Post operatively when patient is reviewed on OP basis also the questionnaire will be administered at 6weeks, 3months and 6 months. The questionnaire has got 30 questions, each of which are assigned a score ranging from 1-5 where 1 is worst and 5 is best as per the scoring guide recommended by SRS.

SRS questionnaire will assess the patient in five different domains of functional outcome namely pain, mental status, function, self-image and satisfaction with treatment. The mean scores obtained in these five domains and total score are statistically analyzed to find any significant difference preoperatively and post operatively. An improvement in the total SRS score by 0.4 at the latest assessment is considered as Minimum Clinically Important Difference (MCID).[9,10]

Patients are to be assessed preoperatively and again post operatively at 6 weeks, 3 months and 6 months with Scoliosis Research Society 30 questionnaire. Patient is administered the printed copy of the questionnaire in multiple choice questions format and asked to mark their response. Mean scores for five different domains namely pain, function, self-image, mental status and satisfaction with management and total score is calculated and interpreted.

Statistical Methods:
Data will be analyzed using SPSS V 21.0 (IBM SPSS Inc. Chicago, IL). Continuous data will be summarized as Mean with SD or Median with Inter Quartile range. Categorical data will be summarized as frequency with percentage. Categorized data will be analyzed using Chi-Square test, Fischer's exact test or McNemar test. Paired T test will be used for preoperative and post-operative changes. Continuous data from the same person at different points of time will be tested using one-way repeated measure ANOVA or Kruskall-Wallies test. For all tests p value less than 0.05 will be considered as statistically significant.

RESULTS

Table 1: Sex distribution in the study population

Gender	Frequency	Percentage
Males	02	8%
Females	23	92%
Total	25	100%

A total of 25 patients were studied of which 02(8%) were males and 23(92%) were females.

Table 2: Age distribution in the study population

	Age
Mean	15.12
SD	2.33
Minimum	11
Maximum	19

The average age of the study participants is 15.12±2.33. The ages ranged from 11 to 19.

Scoliosis Research Society Score (SRS 30)

SRS 30 Total Score

Table 3: Descriptive statistics of SRS 30 Total Score

	Pre op	6weeks Post op	3 Month Post op	6 Month Postop
Mean	3.54	3.56	3.76	3.77
Median	3.6	3.54	3.7	3.84
Standard Deviation	0.48	0.23	0.23	0.33
Minimum	2.76	3.1	3.34	3
Maximum	4.46	4.0	4.08	4.46

Table 4: Analysis of SRS 30 Total Score

SRS Total	Mean ± SD	Median	Minimum	Maximum	p value
Pre-operative	3.54±0.49	3.6	2.8	4.5	0.09
6 Mon Postop	3.76±0.34	3.8	3	4.5	

The mean value of total SRS score showed a gradual increase with time from 3.54 at the first assessment to 3.76 at the last assessment. But the change in total score from preoperative to last follow up was not found to be significant (p value=0.09).

SRS 30 Score (Function/Activity)

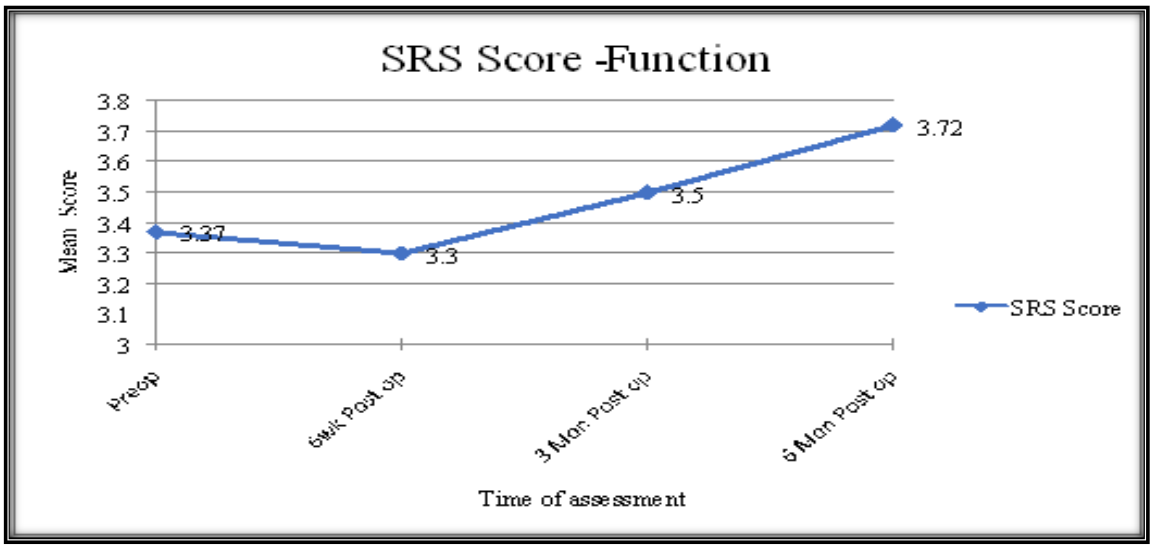

Figure 1: Change in SRS – Function/Activity score over time

Table 5: Analysis of SRS – Function/Activity score over time

SRS function	Mean ± SD	Median	Minimum	Maximum	p value
Pre-operative	3.37±0.52	3.4	2.8	4.8	0.01
6 Mon Postop	3.72±0.35	3.7	3	4.2	

The pre-operative mean SRS score for function and post-operative mean SRS score for function was found to have a significant change (p value=0.01). SRS function score showed a definite increasing trend from 3.37 at first assessment to 3.72 at last assessment. A slight dip in the score was seen at 6 week post op assessment.

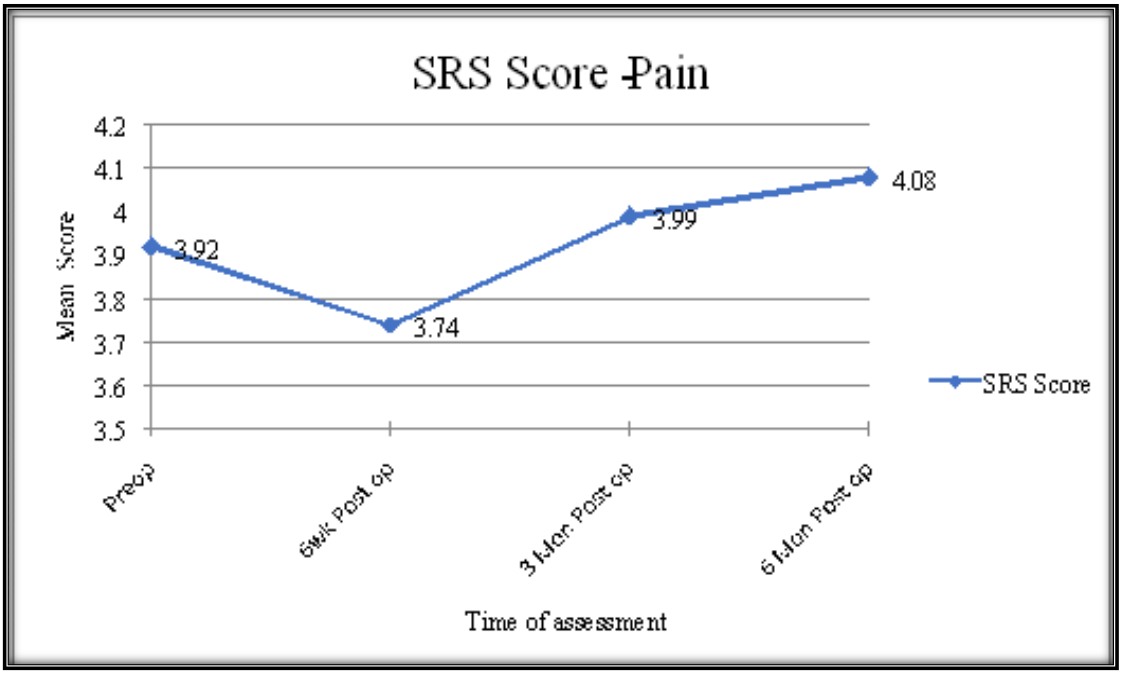

Figure 2: Change in SRS – Pain score over time

Table 6: Analysis of SRS – Pain score over time

SRS Pain	Mean ± SD	Median	Minimum	Maximum	p value
Pre-operative	3.92±0.64	4	2.8	5	0.32
6 Mon Postop	4.08±0.49	4.2	3	5	

The pre-operative mean SRS score for pain and post-operative mean SRS score for pain was found to have no significant association (p value=0.32). The pre-operative SRS pain score (3.92±0.64) was found to be only slightly lesser compared to the last postoperative SRS pain score (4.08±0.49) value. Early post op period showed a decrease in the score which gradually increased with time.

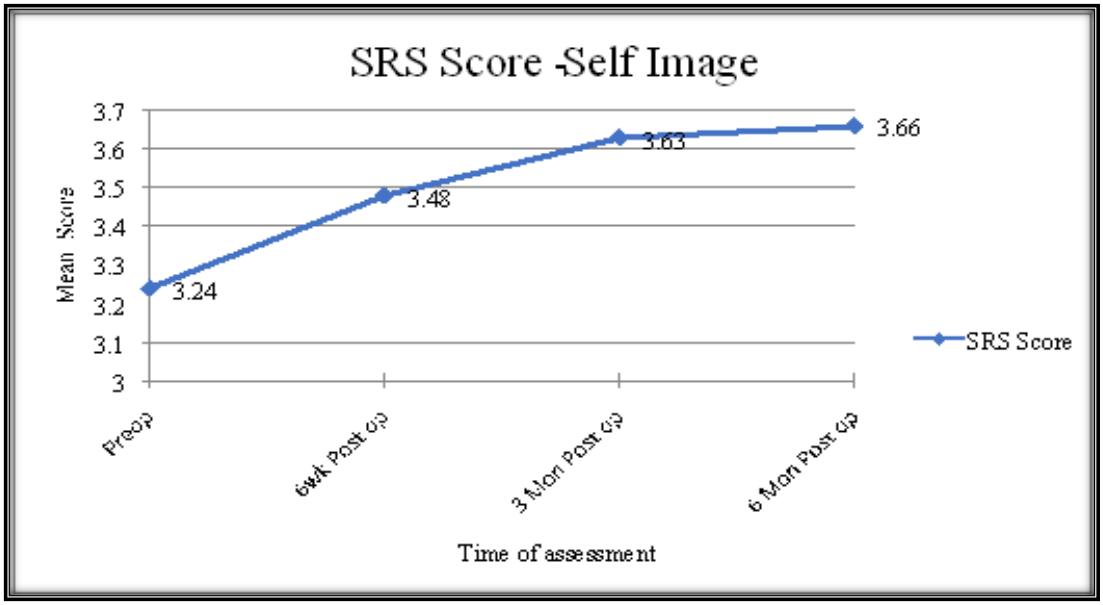

Figure 3: Change in SRS Self Image / Appearance score over time

Table 7: Analysis of SRS – Self Image / Appearance score over time

SRS self-image	Mean ± SD	Median	Minimum	Maximum	p value
Pre-operative	3.24±0.66	3.2	2	4.8	0.029
6 Mon Postop	3.66±0.41	3.6	2.9	4.3	

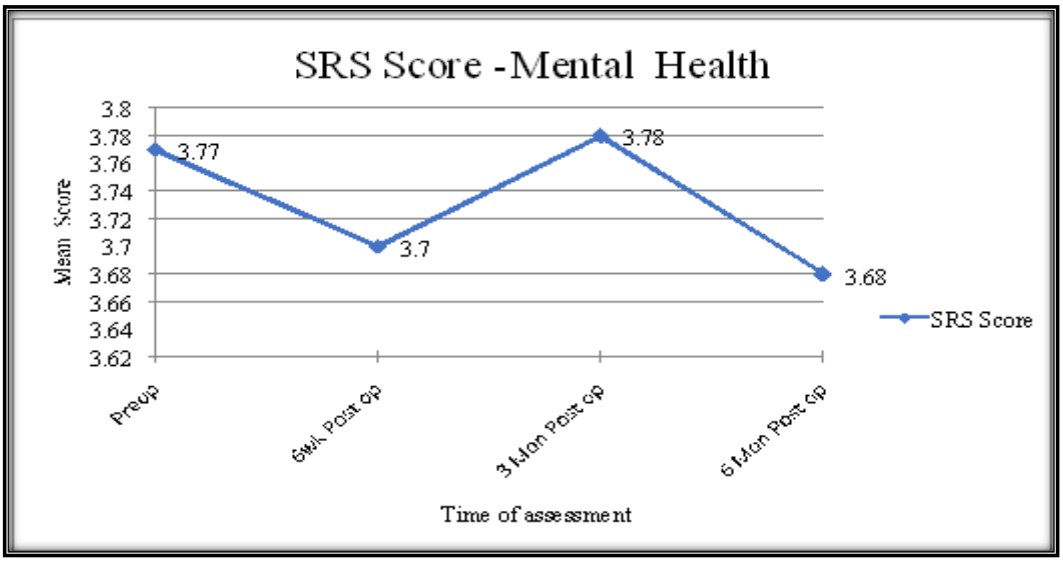

Figure 4: Change in SRS - Mental Health

The pre-operative SRS self-image score and 6 month post-operative SRS self-image score is found significant (p value=0.029). The pre-operative SRS self-image score (3.24±0.66) is found much lesser compared to the post-operative SRS self-image score (3.66±0.41) value. Self-image scores showed a rising trend throughout the post op assessment.

Table 8: Analysis of SRS – - Mental Health

SRS mental health	Mean ± SD	Median	Minimum	Maximum	p value
Pre-operative	3.77±0.62	3.8	2.5	4.8	0.526
6 Mon Postop	3.68±0.53	3.6	2.4	4.8	

The pre-operative SRS mental health score and post-operative last follow up SRS mental health score is not significantly associated (p value=0.526). The pre-operative SRS mental health score (3.77±0.62) is found slightly higher compared to the 6 months postoperative SRS mental health score (3.68±0.53) value. Mental health scores showed fluctuating levels at different times of assessment.

Table 9: Analysis of SRS – satisfaction score

SRS satisfaction	Mean ± SD	Median	Minimum	Maximum	p value
Pre-operative	3.37±0.70	3.5	2	4.5	0.101
6 Mon Postop	3.72±0.58	4	2.7	5	

The pre-operative SRS satisfaction with management score and 6-month postoperative SRS satisfaction score is not significant (p value=0.101). The pre-operative SRS satisfaction score (3.37±0.70) is found slightly lesser compared to the post-operative SRS satisfaction score (3.72±0.58) value. The satisfaction levels showed a decline in value towards the later stages of assessment.

Table 10: Analysis of MCID and Sagittal Balance

MCID	Sagittal imbalance		Total
	Present	Absent	
Absent	11	01	12
Present	06	07	13
Total	17	08	25

Relative Risk = 0.4034 with 95% CI 0.2013 to 0.8081 (p value = 0.01)

There is a significant association between sagittal imbalance and minimum clinically important difference as p value is 0.03. The probability of having a minimum clinically important difference reduces with the presence of sagittal imbalance as evidenced by a relative risk of 0.40.

Percentage of people with sagittal imbalance having minimum clinically important difference in SRS score is 35.3% while percentage of those who had a sagittal balance post operatively and had MCID is 87.5%.

DISCUSSION

Scoliosis is a three-dimensional spinal deformity with lateral curvature and fixed vertebral rotation. Adolescent idiopathic scoliosis is the most common form of idiopathic scoliosis where in the age of onset is beyond 10years and before the attainment of skeletal maturity.[4] Earlier treatment modalities especially surgical correction was more focused on the coronal plane deformity correction while recent studies have thrown light on the importance of sagittal plane correction.

A mutual articulation between the pelvis and spine in order to balance the head, maintain a horizontal gaze and keep a stable standing position with minimum expenditure of energy is what is called as sagittal balance.[5]

On assessing the clinical outcome with the scoliosis research society scoring we noted significant improvement in the function (activity) and self-image (appearance) modalities of the score while the total score, mental health, pain and satisfaction modalities did not show a significant change. Post-operative sagittal imbalance showed a significant association with minimum clinically important difference in total score. It was seen that sagittal imbalance is a risk factor for not attaining a minimum clinically important difference in total score there by proving the hypothesis that inadequate sagittal profile obtained post operatively is a cause for the poor function outcome in adolescent idiopathic scoliosis patients treated surgically.

25 participants were enrolled in the study who had ages ranging from 11 to 19 with mean age of 15.12. Of this 92% were females and 8% males showing a female to male ratio of 10.2:1. This is in parlance with the established gender ratio of 10:1 when curves more than 30degress as considered as per Sud A et al.[5]

SRS 30 Score

Scoliosis Research Society score version 30 is a systematically designed tool to assess the functional outcome and health related quality of life in adolescent idiopathic scoliosis patients. It assess the functional outcome in five modalities namely function, pain, self-image, mental health and satisfaction.

The total SRS score obtained in preoperative assessment and post-operative assessment at the final follow up at 6 months post op were 3.54±0.49 and 3.76±0.34 respectively, but the change was not statistically significant (p=0.09). It was slightly less than the mean value stated for normal adolescents (4.0 ± 0.4) as per Verma et al.[11] The change in mean value (3.37±0.52 to 3.72±0.35) for function was significant (p=0.01) and was almost near normal value as per Verma et al,[11] (3.9 ± 0.4). Self-image also showed a significant increase (p=0.029) from 3.24±0.66 to 3.66±0.41. Normal value as per Verma et al,[11] is 3.9 ± 0.6. Pain, mental health and satisfaction with management did not show significant changes (p = 0.32, 0.53, 0.10 respectively) when they changed from 3.92±0.64 to 4.08±0.49, 3.77±0.62 to 3.68±0.53 and 3.37±0.70 to 3.72±0.58 respectively. Normal adolescents showed a pain and mental health domain mean scores of 4.3 ± 0.6 and 3.7 ± 0.6 respectively as per Verma et al.[11]

Findings of our study was in agreement with the findings of Chaib et al,[12] where in post operatively a significant change in function (p=0.01) and self-image domains (p=0.04) were seen. But it differed partially from the findings in study by Rushton et al,[13] which was suggestive of change in pain and self-image domains. Study by Elnady et al,[14] showed a significant (p <0.001) change in total SRS score from 2.8 to 3.7. But this could be because they considered only curves more than 70 degrees in their study.

An improvement in the total SRS score to a level of minimum clinically important difference was seen in 52%. This is similar to the study by Liu et al,[15] where an improvement of such level was seen in 43% to 74% in different domains and 58% seen in total score.

Functional outcome and Sagittal Balance:

A statistically significant association has been observed between the functional outcome measured with SRS 30 score (total score was initially assessed for a minimum clinically important difference (MCID) of 0.4) and the presence of a sagittal imbalance. A significant association between those without MCID and those with sagittal imbalance post operatively was seen with p value of 0.03. The relative risk measured was 0.4034 with 95% CI (0.2013 to

0.8081). So it indicates that there is an inverse relation between a significant improvement in SRS score and post-operative sagittal imbalance.

In other words obtaining a sagittal balance post operatively increases the chances of having a better functional outcome. To the best of our knowledge this is the first study that assesses the influence of sagittal balance on the functional outcome measured with a SRS 30 questionnaire in adolescent idiopathic scoliosis patients treated surgically. Studies on the health related quality of life (HRQOL) following surgery in adult spinal deformities also has had similar results with post-operative sagittal alignment influencing the functional outcome. Schwab et al,[15] had shown a significant (p=0.05) relation of SRS score with sagittal alignment in adult spinal deformity.

CONCLUSION

There is a significant association between the post-operative sagittal imbalance and a considerable change in the functional outcome of adolescent idiopathic scoliosis patients treated surgically. Postoperative sagittal balance is of paramount importance. Hence the poor functional outcome in adolescent idiopathic scoliosis patients treated surgically could possibly be because of the attainment of inadequate sagittal profile also.

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