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THE RELATIONSHIP BETWEEN TRUNK ASSESSMENTS AND QUALITY OF LIFE IN ADOLESCENT IDIOPATHIC SCOLIOSIS FOLLOWING SURGERY

ORIGINAL ARTICLE

ABSTRACT

Purpose: There is a lack of evidence about trunk muscle endurance, range of motion (ROM), flexibility and quality of life (QoL) in subjects with adolescent idiopathic scoliosis (AIS) following posterior instrumentation and fusion (PIF) surgery. The study aimed to compare trunk muscle endurance, ROM, flexibility, and QoL of the AIS subjects with lumbar or thoracic level after surgery. It also investigated the relationship between trunk muscle endurance, ROM, flexibility, and QoL in subjects with AIS.

Methods: Twenty subjects aged between 10-18 years (mean age=15.55±1.46 years) who underwent PIF surgery before 1-3 years were included. The subjects were divided into two groups as a thoracic (n=10) and lumbar group (n=10) according to the PIF surgery level. The ROM was assessed using a universal goniometer, flexibility with sit and reach test and lateral bending, trunk extensor muscle endurance assessed with Biering-Sorensen test, trunk flexor muscle endurance with the Kraus-Weber test, and the QoL through the Scoliosis Research Society-22 revised (SRS-22r) scale.

Results: There was significant difference between the two groups in lateral flexion ROM and lateral bending results ($p<0.05$). Thoracic group showed better results in the lateral flexion ROM and lateral bending test. Trunk flexor muscle endurance was found correlated with extension ROM ($r=0.718$, $p=0.001$), flexion ROM ($r=0.414$, $p=0.007$), right lateral flexion ROM ($r=0.721$, $p=0.001$), and left lateral flexion ROM ($r=0.581$, $p=0.007$). Trunk extensor muscle endurance was found correlated with right rotation ROM ($r=0.511$, $p=0.021$), left rotation ROM ($r=0.410$, $p=0.073$), SRS-22r total score ($r=0.677$, $p=0.001$) and SRS-22r pain score ($r=0.554$, $p=0.011$).

Conclusion: Trunk muscle endurance is essential for body posture and QoL after surgery. These subject's physiotherapy and rehabilitation programs should focus on developing trunk muscle endurance and flexibility to increase QoL following PIF surgery.

Key Words: Adolescent; Scoliosis; Quality of Life.

ADÖLESAN İDİOPATİK SKOLYOZ'DA CERRAHİ SONRASI GÖVDE DEĞERLENDİRMELERİ VE YAŞAM KALİTESİ ARASINDAKİ İLİŞKİ

ARAŞTIRMA MAKALESİ

ÖZ

Amaç: Posteriyor enstrümentasyon ve füzyon (PEF) cerrahisi sonrası adölesan idiyopatik skolyozu (AİS) olan bireylerde gövde kas enduransı, eklem hareket açıklığı (EHA), esneklik ve yaşam kalitesi hakkındaki kanıtlar yetersizdir. Bu çalışmanın amacı, lumbal veya torakal seviyeden cerrahi geçiren AİS'li bireylerin gövde kas enduransı, EHA, esneklik ve yaşam kalitesini torakal veya lumbal seviyeye göre karşılaştırmaktı. Bununla birlikte gövde kas enduransı ile EHA, esneklik ve yaşam kalitesi arasındaki ilişki araştırıldı.

Yöntem: Çalışmaya 10-18 yaşları arasında (yaş=15,55±1,46 yıl) cerrahiden sonra 1-3 yıl süre geçmiş 20 AİS'li birey dahil edildi. Bireyler PEF cerrahisine göre torakal ve lumbal grup olarak ikiye ayrıldı. Bireylerin EHA'sı gonyometre ile, esneklik ölçümleri otur-uzan testi ve lateral eğilme ile, gövde ekstansör kas enduransı Biering Sorensen testi ile, gövde fleksör kas enduransı Kraus Weber Testi ile yaşam kalitesi ise "Scoliosis Research Society-22 revised (SRS-22r)" ile değerlendirildi.

Sonuçlar: Çalışmamızda iki grup arasında lateral fleksiyon EHA ve lateral eğilme sonuçları açısından iki grup arasında fark bulundu ($p<0.05$). Torakal grup lateral fleksiyon EHA ve lateral eğilme sonuçları açısından daha yüksek değerlere sahipti. Gövde fleksor kas enduransı, ekstansiyon EHA ile ($r=0,718$, $p=0,001$), fleksiyon EHA ile ($r=0,414$, $p=0,007$), sağ lateral fleksiyon EHA ile ($r=0,721$, $p=0,001$) ve sol lateral fleksiyon EHA ($r=0,581$, $p=0,007$) ile ilişkili bulundu. Gövde ekstansor kas enduransı, sağ rotasyon EHA ($r=0,511$, $p=0,021$), sol rotasyon EHA ($r=0,410$, $p=0,073$), SRS-22r toplam skoru ($r=0,677$, $p=0,001$) ve SRS-22r ağrı skoru ($r=0,554$, $p=0,011$) ile ilişkili bulundu.

Tartışma: Gövde kas enduransı cerrahi sonrasında vücut postürü ve yaşam kalitesi için önemlidir. Bu hastaların fizyoterapi ve rehabilitasyon programları, PEF cerrahisini takiben yaşam kalitesini artırmak için gövde kas enduransı ve esnekliğini geliştirmeye odaklanmalıdır.

Anahtar Kelimeler: Adölesan; Skolyoz; Yaşam Kalitesi.

INTRODUCTION

Adolescent idiopathic scoliosis (AIS) is defined as a three-dimensional spine deformity with the spine rotation in the transverse plane and lateral spine in the frontal plane more than 10° and generally in the right thoracic direction (1). The AIS is a generally progressive disease that is seen in adolescents aged 10-18 years and is the most common of all cases of scoliosis (2). The decision of the best treatment depends on the age of the subject (menarche, iliac apophysis, Risser stage, Tanner stage, location of the curvature, and progression risks). Generally, surgery is recommended for subjects who have curvatures more than 45° (3). Surgery can adversely affect the quality of life (QoL) and physical performance in the daily life of the subjects in the early postoperative period (4,5).

The surgery affects the strength and endurance of the trunk muscles. The trunk flexor and extensor muscles are affected to accommodate postural changes after surgery (4). In subjects with AIS, trunk muscle endurance is critical from an early stage for appropriate posture. Therefore, the endurance of the trunk muscles should be monitored and evaluated pre and postoperatively. In literature, few studies focused on trunk muscle endurance of AIS subjects (4,6-8). While some of these studies were performed with non-surgical subjects, some of them only investigated the long-term results after surgery. There is a lack of study concerning early trunk muscle endurance results after surgery.

Studies have shown that subjects with AIS who have undergone surgery have less overall spine mobility than healthy group (9,10). Previous studies have reported limitations in the vertebral joint range of motion (ROM) due to surgical fusion in subjects with AIS (10,11). The loss of spinal mobility before surgery may further affect the functional activity of subjects in daily life with further restriction of movement after surgery (10).

The QoL represents satisfaction with the general well-being associated with the goals, interests, and expectations of the subject within the environment and cultural values (12). In addition to clinical outcomes, assessing the QoL is essential to investigate the efficacy of surgery. In recent years, studies on QoL in scoliosis have increased considerably. Studies are showing QoL improvements after surgery (5,13,14). Therefore, this study was aimed to examine trunk muscle endurance, ROM, flexibility, and QoL of the AIS subjects after surgery. We divided the subjects with AIS into two groups and wanted to see how the patients with lumbar and thoracic curvature were affected after surgery. We also investigated the relationship between the trunk assessment and QoL in subjects with AIS. We hypothesized that trunk muscle endurance, ROM, and QoL would relate to each other.

METHODS

Subjects

At the beginning of the study, the G* Power (G*Power Ver. 3.0.10, Franz Faul, Universität Kiel, Germany) program was used for determining the number of subjects. When the trunk extensor muscle endurance was considered as the primer outcome measure, it was predicted to include at least 20 subjects at a level of $p<0.05$ with a power ratio of 83%. This study was designed as a cross-sectional, case-control study. Subjects who had undergone with posterior instrumentation and fusion (PIF) surgery, aged between 10 and 18 years and time after surgery in 1-3 years were included in the study. Subjects who had contraindications to exercise, had mental problems, neuromuscular or neurological problems, congenital malformation or trauma-related comorbidity and had non-idiopathic scoliosis were excluded from the study. Twenty-nine subjects were recruited for this study. Among the 29 AIS subjects, five subjects with AIS failed to complete the tests, and four subjects with AIS who did not comply with the inclusion criteria were excluded. Sixteen females and four males were included in the study. None of the subjects had received physiotherapy after surgery. An informed consent form was obtained from all subjects and their parents. This study was approved by the Hacettepe University Non-Interventional Research Ethics Committee Approval Date: 26.07.2017 and Approval Number: GO 17/548.

Subjects were divided into two groups as thoracic (n=10; T1-T6 at the proximally, T11-L1 at the

distally) and the lumbar group (n=10; T9-T11 at the proximally, L1-L4 at the distally) according to the lower instrumentation level in PIF surgery. Because of the surgical strategy to treat scoliosis, a key factor to determine is that the level at which the instrumentation should end (15). Lumbar mobility can be changed in different fused groups. The average number of fused vertebrae calculated from distally to proximally fused vertebrae. Growth stages were decided according to Tanner stage (16).

Assessments

Range of Motion

The universal goniometer (Baseline Evaluation Instrument®, Fabrication Enterprises, Inc., White Plains, NY, USA) was used to measure the ROM of the lumbar flexion, extension, lateral flexion, and rotation movement (17). Subjects leaned forward, back and sideways in standing position. Measurements were repeated three times and averaged value was recorded.

Flexibility

Sit and Reach Test: The test was applied in the sitting position in order to avoid pelvic tilt and rotation of the spine. The distance between the third finger and the foot was measured with a tape measure and recorded as cm. If the finger did not reach the foot, the result was recorded as negative, if reached and passed the foot, and the result was recorded as positive (18).

Lateral Bending Test: The test performed in the standing position. Lower extremities were positioned parallel and 20 cm away from each other, 10 cm away from the wall. The location of the distal end of the third finger on the thigh was marked. Then, the subjects were asked to tilt their torso to the side by sliding their hands down the thigh. The level was reached again, and the distance between them was measured and recorded. The compensatory movement of the trunk was blocked during the test (18).

Trunk Muscle Endurance

Trunk extensor muscle endurance was assessed using the Biering-Sorensen Test. The subjects were positioned in a prone with a pillow under the lower abdomen. Subjects were asked to maintain their original positions throughout the test as long as possible (Figure 1). The test was finished when subjects could not be maintained in this position or 240 seconds expired (19).

Kraus Weber Test was used to evaluate flexor muscle endurance. The subjects were positioned supine and raised with 90° flexion of the knee and hip joints and 60° flexion of the trunk. Subjects were asked to maintain their original positions throughout the test as long as possible (Figure 2). The test was finished when subjects could not maintain this position or 240 seconds expired (20).

Quality of Life

Scoliosis Research Society-22 revised (SRS-

Table 1: Physical Characteristics of the Subjects.

Physical Characteristics	Thoracic Group (n=10) Mean±SD (Min-Max)	Lumbar Group (n=10) Mean±SD (Min-Max)	p
Age (years)	15.33±1.63 (13-17)	15.64±1.44 (13-18)	0.735
Gender (Females/Males)	8/2	8/2	1.000
Height (cm)	164.66 ±11.66 (149-185)	166.57±10.70 (152-188)	0.869
Weight (kg)	55.50 ±10.01 (43-70)	53.78±8.51 (41-67)	0.868
BMI (kg/m²)	20.38 ±2.36 (18.64-25.07)	19.71±2.72 (16.60-25.39)	0.364
Menarche Age (years)	13.66±0.55 (13-14)	12.69±1.25 (10-15)	0.142
Number of Fusions (n)	8.83±2.04 (6-11)	11.21±4.02 (3-15)	**0.046***

*p<0.05, Student t-test. BMI: Body Mass Index.

22r): The SRS-22r scale, which was developed by Scoliosis Research Society was used to evaluate QoL in subjects with AIS (13). The scale consists of five domains and 22 questions including function, pain, self-image, mental health, and satisfaction from treatment. All domains have separate subscore except for the total score. The scale is based on 5-Likert system (1: Worst, 5: Best). The Turkish version of the SRS-22r was used, and required permission was taken from the authors who translated the scale into Turkish (21).

Statistical Analysis

The SPSS 22.0 program (IBM SPSS Statistics version 22.0, IBM Corp. Armonk, New York, USA) was used for statistical analysis. The Shapiro-Wilk test was used for assessing normality of the distribution of the data. Demographic data, the forward reach test, and the lateral bending test results were distributed normally. Independent sample t-test was used to compare the data between thoracic and lumbar groups. The lumbar ROM and the muscle endurance test results did not show normal distribution; therefore, the Mann Whitney-U test was used to compare the differences between groups. The significance level was chosen as $p<0.05$. Spearman Rank Correlation Coefficient was used to analyze the relationship between muscle endurance, flexibility, QoL, and ROM results. Correlation coefficients were considered to be low correlation (r=0.30-0.39), moderate correlation (r=0.40-0.59), strong correlation (r=0.60-0.74), and perfect correlation (r=0.75-1.00) (22).

RESULTS

There was no statistically significant difference in physical characteristics of the subjects in both thoracic and lumbar groups except in the fusions number ($p<0.05$) (Table 1). All the female subjects completed the age of menarche, and over two years had passed. The mean time after surgery was 22.5±8.09 months. There was a significant difference between the two groups in lateral flexion ROM and lateral bending results ($p<0.05$). The thoracic group showed better results in the lateral flexion ROM and lateral bending test results

Table 2: Comparison of Thoracic Group and Lumbar Group Findings.

Variables	Thoracic Group (n=10)		Lumbar Group (n=10)		p
	Mean±SD	Median (IQR)	Mean±SD	Median (IQR)	
Flexor Muscle Endurance (s)	37.51±23.59	36.92 (32.02)	20.12±8.31	17.03 (8.85)	0.701
Extensor Muscle Endurance (s)	36.66±26.95	26.10 (50.07)	35.86±20.65	30.46 (34.34)	0.869
Trunk Flexion ROM (°)	76.66±13.44	82.33 (23.68)	70.50±9.32	72.65 (12.77)	0.137
Trunk Extension ROM (°)	28.75±7.75	31.46 (12.80)	23.78±6.29	24.10 (5.90)	0.090
Lateral Flexion ROM (°)					
Right	34.75±5.93	34.65 (8.40)	22.57±7.03	23.60 (3.70)	**0.003***
Left	33.82±6.75	34.83 (12.77)	23.70±5.40	24.00 (5.17)	**0.015***
Rotation ROM (°)					
Right	36.15±10.23	39.15 (12.10)	29.55±7.34	27.81 (10.25)	0.280
Left	37.16±9.47	39 (6.50)	29.42±8.18	30 (12.50)	0.560
Forward Reach (cm)	-16.22±11.06	-18.16 (18.07)	-19.11±9.56	-21.46 (9.71)	0.458
Lateral Bending (cm)					
Right	15.66±1.95	16.41 (2.68)	11.05±3.35	10.80 (4.87)	**0.009***
Left	15.93±2.11	16.73 (3.04)	11.50±2.08	10.91 (3.37)	**0.003***
SRS-22r					
Pain	4.15±0.93	4.30 (1.52)	4.37±0.46	4.50 (0.85)	0.934
Self-Image	3.5±0.37	3.50 (0.70)	3.87±0.43	3.80 (0.70)	0.105
Functional Activity	4.36±0.40	4.30 (0.60)	4.24±0.47	4.20 (0.70)	0.504
Mental Health	3.83±0.82	4.20 (1.55)	3.45±0.61	3.60 (0.80)	0.184
Satisfaction	4.58±0.49	4.75 (1.00)	4.53±0.53	4.75 (1.00)	0.893
Total	3.95±0.41	4.09 (1.28)	4.01±0.30	3.99 (0.62)	0.934

*p<0.05; Mann Whitney U test. IQR: Interquartile Range, ROM: Range of Motion.

Table 3: Relationship between Muscle Endurance, Range of Motion, and Quality of Life in Subjects with Adolescent Idiopathic Scoliosis.

Measurements		Flexor Muscle Endurance	Extensor Muscle Endurance
Range of Motion (°)			
Trunk Flexion	**r**	0.414	0.105
	p	0.070	0.661
Trunk Extension	**r**	**0.718**	0.297
	p	**0.001***	0.203
Right Lateral Flexion	**r**	**0.721**	-0.450
	p	**0.001***	0.850
Left Lateral Flexion	**r**	**0.581***	0.850
	p	**0.001***	0.726
Right Thoracolumbar Rotation	**r**	0.398	**0.511**
	p	0.082	**0.021***
Left Thoracolumbar Rotation	**r**	0.345	0.410
	p	0.136	0.073
Flexibility			
Forward Reach	**r**	-0.086	0.117
	p	0.689	0.622
Right Lateral Bending	**r**	**0.502**	-0.070
	p	**0.024***	0.769
Left Lateral Bending	**r**	0.343	0.020
	p	0.139	0.935
Instrumented Vertebrae			
Lower (Distally) Instrumented Vertebrae	**r**	-0.035	**-0.462**
	p	0.088	**0.040***
Proximally Instrumented Vertebrae	**r**	0.221	-0.364
	p	0.348	0.114
SRS-22r			
Pain	**r**	0.303	**0.554**
	p	0.194	**0.011***
Self-image	**r**	0.186	**0.482**
	p	0.433	**0.031***
Functional Activity	**r**	0.391	0.280
	p	0.088	0.231
Mental Health	**r**	0.032	**0.554**
	p	0.894	**0.011***
Satisfied with Treatment	**r**	0.044	0.176
	p	0.853	0.459
Total	**r**	0.063	**0.677**
	p	0.791	**0.001***

*p<0.05. Spearman correlation analysis. SRS-22r: Scoliosis Research Society.

(p<0.05) (Table 2). There was no difference for trunk muscle endurance and rotation ROM in two groups (p>0.05) (Table 2).

In general, subjects with AIS, in the SRS-22r, the mean pain score was found at 4.30 points, the self-image score was found to be 3.70, the functional activity score was 4.20 points, the mental health parameter score was 3.50 points, the satisfaction with the treatment score was 4.50 in the study. The SRS-22r sub-scores were not different between the thoracic and lumbar group (p>0.05) (Table 2).

There was a strong correlation between flexor trunk muscle endurance and extension ROM (r=0.721, p<0.05), right rotation ROM (r=0.718, p<0.05), there was a moderate correlation with trunk flexion ROM (r=0.414, p<0.05), left lateral flexion ROM (r=0.581, p<0.05). There was a moderate correlation between extensor endurance

Figure 1: Biering Sorensen Test.

Figure 2: Kraus Weber Test.

and right rotation ROM (r=0.511, p<0.05) and left rotation ROM (r=0.410, p<0.05) (Table 3). There was a moderate correlation between flexor muscle endurance and right lateral bending (r=0.502, p=0.024), low correlation with left lateral bending (r=0.343, p=0.139). Extensor muscle endurance had no relationship with flexibility.

The lower instrumented vertebrae had a moderate relationship with extensor muscle endurance (r=-0.462, p=0.040) but there was no relationship with flexor muscle endurance (r=-0.035, p=0.084). There was a strong correlation between trunk extensor muscle endurance and SRS-22r total score (r=0.677, p=0.001), moderate correlation with self-image (r=0.482, p=0.031), and mental health (r=0.554, p=0.011). Flexor muscle endurance was not related to SRS-22r total score (r=0.063, p=0.791) and sub scores.

DISCUSSION

This study investigated trunk muscle endurance, ROM, flexibility, and QoL in subjects with AIS following PIF surgery. It was found that there was no difference between trunk muscle endurance for thoracic and lumbar group, but lateral flexion movement and lateral flexibility was higher thoracic group than lumbar group.

In our study, all females completed the age of menarche and over two years had passed. This shows that no growth period would affect the curvature of the spine and that the females almost completed the maturation stage. In both groups, one male subject was in the rapid growth phase of growth. Muscle strength of males reaches high levels at about 14-16 years of age (16). Considering that muscle strength may also affect muscle endurance of these individuals, this study may not give the best results. We thought that effects of immaturity in terms of muscle strength might be negligible since the lower number subjects from each group.

There were two groups of subjects undergoing surgery (thoracic and lumbar level). Previous studies have shown that the ROM of the subjects with AIS in the lumbar group was lower than in the thoracic group (10,11). Surprisingly, the ROM except for lateral flexion was similar in both groups in this study could show that lumbar mobility after surgery is conditioned by other factors apart from the number of mobile segments. One of these could be the patient's level of mobility before surgery. Neither did the design of this study allow for the evaluation of the importance of this factor, nor did we know the degree of movement that was lost with fusion or its effect on the clinical variables. Further study is needed to clarify the effects of pre-surgical mobility level on post-surgical outcomes.

For lateral flexion, the thoracic group had a higher ROM than a lumbar group probably due to the difference in fused vertebrae and the fact that a 22.5-month period was sufficient for the fusions to be fused and adapted.

A study examining flexibility showed no difference in trunk flexibility between thoracic and lumbar groups. The reason for this could be because of

Sanchez-Raya et al. measured perceived flexibility, which contains three questions and score a 3-15 point (23). The difference in method does not allow for a comparison of these results.

Muscle endurance is an ability of muscle group to perform repeated contraction with different type against a load. Several studies evaluated trunk muscle endurance in subjects with AIS in the literature (4,6,8). While some of these studies were performed with non-surgical subjects, some of them examined the long-term results after surgery. However, there was no study about relationship muscle endurance and lower instrumentation vertebra. This study showed that, as fusion is distal, extensor muscle endurance could be adversely affected.

Smith et al. reported that there was a relationship between extensor muscle endurance and QoL in adolescents (8). Findings of our study were similar to Smith et al. The study showed that extensor trunk muscle endurance is vital for the QoL in subjects with AIS. Flexor muscle endurance has been related to ROM in this study, as a consequence of this result flexor muscle endurance may be an essential physical function in AIS. Further study is needed to understand whether improving trunk muscle endurance may improve the ROM and QoL from this study.

For the relationship between trunk muscle endurance and ROM, there were several correlations. While flexor muscle endurance had a relationship with trunk flexion, extension, and lateral flexion, extensor muscle endurance had a relationship with thoracolumbar rotation. The role of trunk muscle endurance in postural adaptation is still unknown due to the lack of adequate study of trunk muscle endurance (24). This study may show that trunk muscle endurance has an important role in ROM after surgery. One reason for this correlation might be that many fusions of the spine make the spine so immobile that it causes the subject a problem to fulfill the daily life as wished.

The AIS causes postural deformities in the spine, and these deformities affect physical performance and body image, as a consequence of these problems can have a negative impact in QoL (25). In our study, we evaluated the QoL using the SRS-22r questionnaire after 1-3 years of surgery. Several studies emphasize that increase in QoL due to the decrease in pain after surgery in subjects with AIS (26,27). The mean pain score was found at 4.30 points (thoracic group=4.15, lumbar group=4.37). According to pain score subjects did not feel pain probably due to the fact that they developed postural adaptation after 22.50 months of surgery.

The most important goals of surgery are to correct the deformity and improve the QoL, which depends on positive self-image and functional activity (28). Weinstein et al. stated that the desire to go to surgery most of the AIS subjects is due to aesthetic concerns (29). The self-image score of subjects with AIS was found to be 3.70 points (thoracic group=3.50, lumbar group=3.87). This score indicates that AIS subjects are satisfied with their body appearance after surgery, but many of them are unstable. The functional activity score of subjects with AIS was 4.20 points (thoracic group=4.36, lumbar group=4.27). This result indicated that functional activity is useful in subjects with AIS after surgery, subjects are approaching normal activity levels, and indirectly, QoL is high. The mental health parameter score of the subjects with AIS was 3.50 points (thoracic group=3.83, lumbar group=3.45). This score indicates moderate psychological wellbeing of subjects after surgery. We believe that a decrease in the aesthetic concerns of subjects with AIS causes this result after surgery. The satisfaction with the treatment score of the subjects with AIS was 4.50 (thoracic group=4.58, lumbar group=4.53) in this study. This score shows that AIS subjects are satisfied with the treatment and surgical intervention after receiving the diagnosis, and this may affect QoL.

These results showed that muscle endurance was correlated with ROM, flexibility, and QoL in AIS following surgery. In addition, trunk muscle endurance did not change significantly after fusion according to fusion level. When planning a physiotherapy program for AIS after surgery, endurance, flexibility, and QoL should be considered together.

The most important limitation of our study was that we did not assess trunk muscle endurance, flexibility, ROM, and QoL before the surgery. The

other limitation of the study was that the functional performance was not investigated in subjects with AIS after surgery. In order to better understand the effect of muscle endurance assessment, it would be better to perform a test that measures functional performance like shuttle test. The study lacks a follow-up period because of its cross-sectional nature. In addition, the inclusion period was between 1 and 3 years, and two years of difference in this age may be a significant period of growth.

In conclusion, we showed that trunk muscle endurance was related to ROM and QoL in subjects with AIS. There was a difference between thoracic and lumbar group for right-left side ROM and flexibility. These results reveal the necessity of trunk muscle endurance, flexibility, and ROM parameters in the post-surgical exercise program. Initial pre-operative evaluation and late post-operative outcomes based on an appropriate follow-up period may also contribute significantly to the importance of rehabilitation. In addition, trunk extensor muscle endurance and QoL may affect lower instrumented vertebra level in subjects with AIS. We recommended that future studies can be done to increase trunk muscle endurance in the postoperative period. For example, the effects of core stabilization exercises on trunk muscle endurance, flexibility, and ROM can be investigated.

Sources of Support: None.

Conflict of Interest: None.

Ethical Approval: This study was approved by the Ethics Committee of Hacettepe University Non-Interventional Research Ethics Committee Approval Date: 26.07.2017 and Approval Number: GO 17/548.

Informed Consent: A written informed consent was obtained from all study participants.

Peer-Review: Externally peer-reviewed.

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REFERENCES

1. Ghandehari H, Mahabadi MA, Mahdavi SM, Shahsavaripour A, Seyed Tari HV, Safdari F. Evaluation of patient outcome and satisfaction after surgical treatment of adolescent idiopathic scoliosis using scoliosis research society-30. Arch Bone Jt Surg. 2015;3(2):109-13.
2. Weinstein SL, Dolan LA, Cheng JC, Danielsson A, Morcuende JA. Adolescent idiopathic scoliosis. Lancet. 2008;371(9623):1527-37.
3. Fusco C, Donzelli S, Lusini M, Salvatore M, Zaina F, Negrini S. Low rate of surgery in juvenile idiopathic scoliosis treated with a complete and tailored conservative approach: end-growth results from a retrospective cohort. Scoliosis. 2014;9(1):9-12.
4. Danielsson AJ, Romberg K, Nachemson AL. Spinal range of motion, muscle endurance, and back pain and function at least 20 years after fusion or brace treatment for adolescent idiopathic scoliosis: a case-control study. Spine. 2006;31(3):275-83.
5. Danielsson AJ, Wiklund I, Pehrsson K, Nachemson AL. Health-related quality of life in patients with adolescent idiopathic scoliosis: a matched follow-up at least 20 years after treatment with brace or surgery. Eur Spine J. 2001;10(4):278-88.
6. Schreiber S, Parent EC, Moez EK, Hedden DM, Hill D, Moreau MJ, et al. The effect of Schroth exercises added to the standard of care on the quality of life and muscle endurance in adolescents with idiopathic scoliosis: an assessor and statistician blinded randomized controlled trial. Scoliosis. 2015;10(1):10-24.
7. Shin SS, Woo YK. Characteristics of sitting balance and trunk muscle endurance in patients with adolescent idiopathic scoliosis. Phys Ther Korea. 2007;14(4):35-43.
8. Smith AJ, O'Sullivan PB, Campbell AC, Straker LM. The relationship between back muscle endurance and physical, lifestyle, and psychological factors in adolescents. J Orthop Sports Phys. 2010;40(8):517-23.
9. Wilk B, Karol LA, Johnston CE, Colby S, Haideri N. The effect of scoliosis fusion on spinal motion: a comparison of fused and nonfused patients with idiopathic scoliosis. Spine. 2006;31(3):309-14.
10. Engsberg JR, Lenke LG, Reitenbach AK, Hollander KW, Bridwell KH, Blanke K. Prospective evaluation of trunk range of motion in adolescents with idiopathic scoliosis undergoing spinal fusion surgery. Spine. 2002;27(12):1346-54.
11. Wong-Chung DA, Schimmel JJ, de Kleuver M, Keijsers NL. Asymmetrical trunk movement during walking improved to normal range at 3 months after corrective posterior spinal fusion in adolescent idiopathic scoliosis. Eur Spine J. 2018;27(2):388-96.
12. Carr AJ, Gibson B, Robinson PG. Is quality of life determined by expectations or experience? BMJ. 2001;322(7296):1240-3.
13. Asher MA, Lai SM, Glattes RC, Burton DC, Alanay A, Bago J. Refinement of the SRS-22 health-related quality of life questionnaire function domain. Spine. 2006;31(5):593-7.
14. Bunge EM, Juttmann RE, de Kleuver M, van Biezen FC, de Koning HJ. Health-related quality of life in patients with adolescent idiopathic scoliosis after treatment: short-term effects after brace or surgical treatment. Eur Spine J. 2007;16(1):83-9.
15. Bridwell KH, Glassman S, Horton W, Shaffrey C, Schwab F, Zebala LP, et al. Does treatment (nonoperative and operative) improve

the two-year quality of life in patients with adult symptomatic lumbar scoliosis: a prospective multicenter evidence-based medicine study. Spine. 2009;34(20):2171-8.
16. Tanner JM, Whitehouse RH. Clinical longitudinal standards for height, weight, height velocity, weight velocity, and stages of puberty. Arch Dis Child. 1976;51(3):170-9.
17. Helenius I, Remes V, Yrjönen T, Ylikoski M, Schlenzka D, Helenius M, et al. Does gender affect outcome of surgery in adolescent idiopathic scoliosis? Spine. 2005;30(4):462-7.
18. Eider J. Callanetics as one of the factors in motor abilities development in women. J Hum Kin. 2003;10(2):93-8.
19. Biering-Sørensen F. Physical measurements as risk indicators for low-back trouble over a one-year period. Spine. 1984;9(2):106-19.
20. Ito T, Shirado O, Suzuki H, Takahashi M, Kaneda K, Strax TE. Lumbar trunk muscle endurance testing: an inexpensive alternative to a machine for evaluation. Arch Phys Med Rehabil. 1996;77(1):75-9.
21. Alanay A, Cil A, Berk H, Acaroglu RE, Yazici M, Akcali O, et al. Reliability and validity of adapted Turkish Version of Scoliosis Research Society-22 (SRS-22) questionnaire. Spine. 2005;30(21):2464-8.
22. Hayran M, Hayran M. Sağlık araştırmaları için temel istatistik. 1st ed. Ankara: Art Ofset Matbaacılık Yayıncılık Organizasyon; 2011.
23. Sanchez-Raya J, Bago J, Pellise F, Cuxart A, Villanueva C. Does the lower instrumented vertebra have an effect on lumbar mobility, subjective perception of trunk flexibility, and quality of life in patients with idiopathic scoliosis treated by spinal fusion? J Spine Disord Tech. 2012;25(8):437-42.
24. Lanzetta D, Cattaneo D, Pellegatta D, Cardini R. Trunk control in unstable sitting posture during functional activities in healthy subjects and patients with multiple sclerosis. Arch Phys Med Rehabil. 2004;85(2):279-83.
25. Freidel K, Petermann F, Reichel D, Steiner A, Warschburger P, Weiss HR. Quality of life in women with idiopathic scoliosis. Spine. 2002;27(4):E87-E91.
26. Carreon LY, Sanders JO, Diab M, Sturm PF, Sucato DJ, Group SDS. Patient satisfaction after surgical correction of adolescent idiopathic scoliosis. Spine. 2011;36(12):965-8.
27. Gum JL, Bridwell KH, Lenke LG, Bumpass DB, Sugrue PA, Karikari IO, et al. SRS22R appearance domain correlates most with patient satisfaction after adult deformity surgery to the sacrum at 5-year follow-up. Spine. 2015;40(16):1297-302.
28. Tones M, Moss N, Polly DW Jr. A review of quality of life and psychosocial issues in scoliosis. Spine. 2006;31(26):3027-38.
29. Weinstein SL, Dolan LA, Spratt KF, Peterson KK, Spoonamore MJ, Ponseti IV. Health and function of patients with untreated idiopathic scoliosis: a 50-year natural history study. JAMA. 2003;289(5):559-67.