



EFFECT OF POSTOPERATIVE SHOULDER IMBALANCE ON PATIENT SATISFACTION WITH SURGICAL TREATMENT OF ADOLESCENT IDIOPATHIC SCOLIOSIS

ADÖLESAN İDİYOPATİK SKOLYOZDA CERRAHİ SONRASI OMUZ DENGESİZLİĞİNİN HASTANIN TEDAVİDEN MEMNUNİYETİ ÜZERİNE ETKİSİ

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SUMMARY:

Objective: We aimed to evaluate whether there is a relation between the level of shoulder imbalance after scoliosis surgery and patients' satisfaction with treatment.

Materials and methods: Twenty-three patients with adolescent idiopathic scoliosis (18 females, 5 males; mean age, 15.9 years; age range, 13-24 years), who were treated by posterior instrumentation and fusion and followed up for an average of 35.4 months (range, 24-67 months) postoperatively, were included in this retrospective clinical study. In order to evaluate shoulder balance on coronal plane, three parameters were measured on postoperative radiography: first rib angle, radiographical shoulder height, and clavicle angle. For the assessment of patients' satisfaction with scoliosis surgery, Scoliosis Research Society (SRS)-22r Patient Questionnaire was used.

Results: Fusion was obtained in all patients. On radiography, mean first rib angle was $2.5^{\circ} \pm 2.8^{\circ}$, shoulder height was 6.0 ± 5.4 mm, and clavicle angle was $1.7^{\circ} \pm 1.5^{\circ}$. The mean values for SRS-22r domain scores were between 3.3 and 3.8, being lowest for mental health and highest for pain and self-image. There was no significant correlation between radiographic parameters and total or domain scores of SRS-22r.

Conclusions: Shoulder imbalance is a common undesirable effect of correcting thoracic curve in surgical treatment of adolescent idiopathic scoliosis. However, unless it is severe, shoulder imbalance does not cause patient dissatisfaction.

Keywords: adolescent idiopathic scoliosis; shoulder imbalance; SRS-22r; thoracic curve

Level of evidence: Retrospective clinical study, Level III

ÖZET:

Amaç: Bu çalışmada skolyoz cerrahisi sonrası oluşan omuz dengesizliğinin düzeyi ile hastaların tedaviden memnuniyeti arasında bir ilişki olup olmadığını değerlendirmeyi amaçladık.

Materyal-Metod: Bu retrospektif klinik çalışmaya, posterior enstrümantasyon ve füzyon ile tedavi edilen ve cerrahi sonrası ortalama 35.4 ay (aralık, 24-67 ay) izlenen 23 adölesan idiyopatik skolyoz hastası (18 kadın, 5 erkek; ortalama yaş, 15.9 yıl; yaş aralığı, 13-24 yıl) dahil edildi. Koronal düzlemde omuz dengesini değerlendirmek için, postoperatif radyografide üç parametre ölçüldü: ilk kaburga açısı, radyografik omuz yüksekliği ve klavikula açısı. Hastaların skolyoz cerrahisinden memnuniyetlerini değerlendirmek için, Skolyoz Araştırma Derneği (SRS)-22r Hasta Anketi kullanıldı.

Bulgular: Tüm hastalarda füzyon sağlanmıştır. Radyografide ortalama ilk kaburga açısı $2.5^{\circ} \pm 2.8^{\circ}$, omuz yüksekliği 6.0 ± 5.4 mm ve klavikula açısı $1.7^{\circ} \pm 1.5^{\circ}$ ölçülmüştür. Ortalama SRS-22r domain skorları 3.3 ile 3.8, arasında değişirken, en düşük skor mental sağlık, en yüksek skor ise ağrı ve kendi imaj/görüşü için kaydedilmiştir. Radyografik parametreler ile SRS-22r toplam ve domain skorları arasında anlamlı korelasyon bulunamamıştır.

Sonuç: Adölesan idiyopatik skolyozda cerrahisinde torasik eğriliğin düzeltilmesinin sıkça rastlanan istenmeyen etkisi omuz dengesizliğidir. Ancak bu dengesizlik şiddetli olmadığı sürece, hastalarda tedaviden memnuniyetsizliğe neden olmaz.

Anahtar Sözcükler: adölesan idiyopatik skolyozda; omuz dengesizliği; SRS-22r; torasik eğrilik

Kanıt Düzeyi: Retrospektif klinik çalışma, Düzey III

INTRODUCTION:

Adolescent idiopathic scoliosis (AIS) is a common abnormality of the spinal curve with an overall prevalence of 0.47-5.2 %⁸. Although recent advances in surgical techniques allow good correction of the main thoracic curve and provides sagittal balance in AIS, curve correction may cause one shoulder to elevate leading to shoulder imbalance^{12,13}. Postoperative shoulder imbalance is even more common with better correction of the main thoracic curve¹².

Although frequency and extent of shoulder imbalance following surgical correction of AIS were well reported^{10,13}, studies in literature on the relation between shoulder imbalance and clinical outcome and patient's perception of spine deformity are limited. Matamalas et al. recently claimed that shoulder balance is not a key factor in patients' perception of spinal deformity in non-operated, moderate AIS cases and that this perception is not correlated with clinical balance¹¹. However, studies on the role of shoulder balance in clinical outcome and patients' satisfaction need to be increased to conclude on the clinical importance of shoulder balance and to further investigate necessary measures to prevent this undesirable effect of surgical correction of AIS.

Therefore, in this study we aimed to evaluate whether there is a relation between the level of shoulder imbalance after scoliosis surgery and patients' satisfaction with treatment.

MATERIALS AND METHODS:

Patients and study design:

Twenty-three patients with AIS (18 females, 5 males; mean age, 15.9 years; age range, 13-24 years), who were treated by posterior instrumentation and fusion and followed postoperatively at a single center between 2009-2012, were included in this retrospective clinical study. The inclusion criteria were T2 (thoracic vertebra 2) proximal fusion level, stable vertebrae with C7 plumb line at 10 mm on frontal plane, patients who are able to stand on foot for radiography, and ensuring fusion in instrumentation region. The exclusion criteria were inability to measure on posteroanterior radiography, mental retardation, history of revision surgery, and neuromuscular scoliosis. The etiology of scoliosis was AIS in 21 patients and congenital scoliosis in 2 patients. According to Lenke classification for idiopathic scoliosis⁹, curve types of patients were listed in Table-1.

Table-1. Demographic and clinical characteristics of scoliosis patients included in the study

Characteristics	Result	
Number of patients	23	
Follow-up duration (months)	35.4±13.7 (range, 24-67)	
Age (years)	16.00±3.680 (range, 16-30)	
Gender	Male	5 (21.7%)
	Female	18 (78.3%)
Lenke's curve type of scoliosis	1	5 (21.7%)
	2	5 (21.7%)
	3	4 (17.4%)
	4	1 (4.3%)
	5	3 (13.0%)
	6	3 (13.0%)
	Congenital	2 (8.7%)
Surgical operation	T2-L3 fusion	9 (39.1%)
	T2-L1 fusion	6 (20.7%)
	T2-L4 fusion	5 (17.2%)
	T2-T12 fusion	2 (6.8%)
	T2-L2 fusion	1 (3.4%)

All patients or legal representatives signed the informed consent form. The study was approved by the Institutional Ethics Committee and conducted in accordance to the latest version of Helsinki Declaration.

Surgical procedure:

All the surgical operations were performed by a single surgeon (A.A.U.).The surgical technique was posterior instrumentation by using polyaxial pedicle screw through posterior approach. The posterior fusion was performed with auto and allogenic cancellous bone after decortication of the lamina.

Radiographic parameters:

All the patients had preoperative standing posteroanterior radiography in a relaxed standing position with hands supported in front and with elbows bended to accommodate shoulder flexion to approximately 30°. In order to evaluated shoulder balance on coronal plane, three parameters were measured on postoperative radiography: first rib angle, radiographical shoulder height, and clavicle angle.

First rib angle is the tilt of a tangential line that connects both the superior borders of first ribs. A positive first rib angle value indicates an inclination to the right of this reference line (Figure-1).

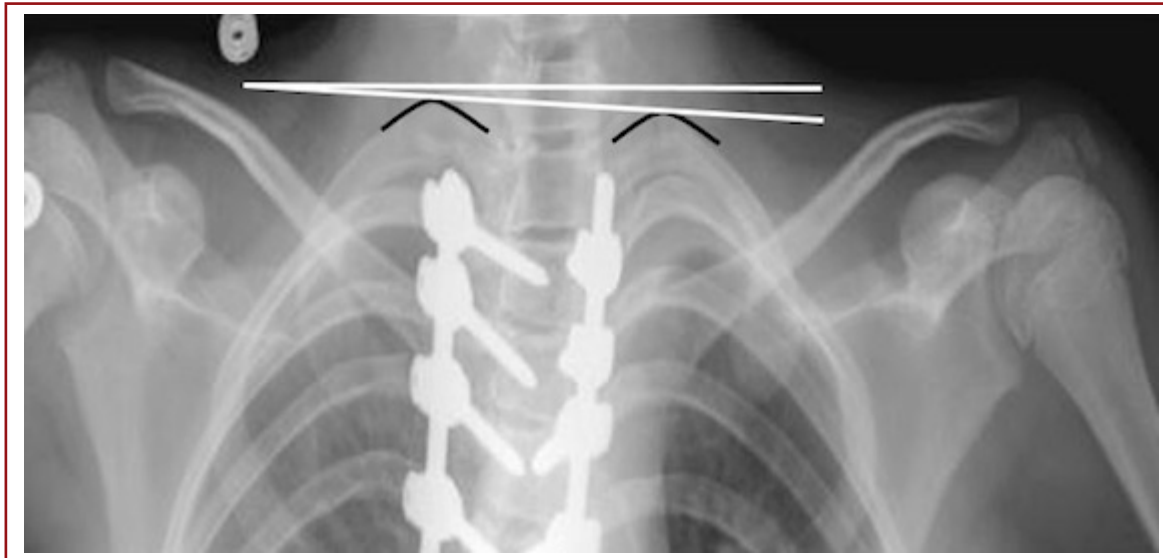


Figure-1. Measurement of first rib angle on posteroanterior radiography. It is the tilt of a tangential line that connects both the superior borders of first ribs.

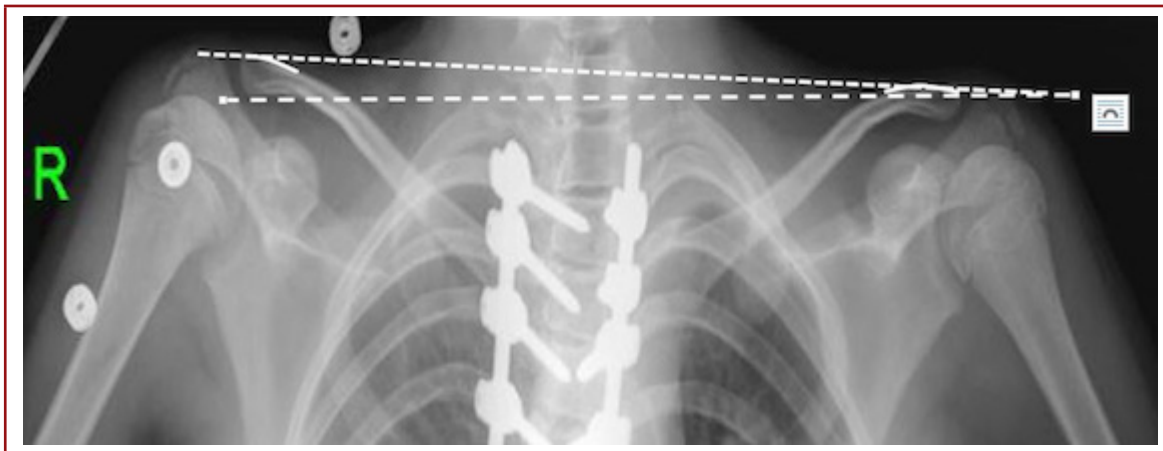


Figure-2. Measurement of clavicle angle on posteroanterior radiography. It is the angle between the horizontal line and the tangential line connecting the highest two points of each clavicle.

Radiographical shoulder height is the difference in millimeters in the soft tissue shadow directly superior to the acromioclavicular joint⁶. Clavicle angle is the angle between the horizontal line and the tangential line connecting the highest two points of each clavicle (Figure-2). When the left clavicle up and the right clavicle down, clavicle angle show positive values¹⁴.

Assessment of patient satisfaction:

For the assessment of patients' satisfaction with scoliosis surgery, Scoliosis Research Society (SRS)-22r Patient Questionnaire was used. The SRS-22r is a valid instrument for the assessment of the health related quality of life of patients with scoliosis². It has five domains, each scoring between 1 (worst) and 5 (best): function, pain, self-image, mental health, and satisfaction with management. Turkish version of SRS-22r has been shown to be valid and reliable¹.

Statistical analysis:

Study data were summarized by descriptive statistics (mean, standard deviation, range, frequency, and percentage). The correlations between SRS-22r domain scores and radiographic

parameters were analyzed by Spearman correlation coefficient (r). Statistical level of significance was set to $p < 0.05$. All analyses were performed by using MedCalc Statistical Software (MedCalc Software bvba, version 12.7.7, Ostend, Belgium).

RESULTS:

The mean C7 plumb line value on frontal plane was 4.8 mm (range, 0-9 mm). The level of proximal instrumentation and fusion ended at T2 for all patients, while distal instrumentation and fusion level was L3 (lumbar vertebra 3) in 9 patients, L1 in 6 patients, L4 in 5 patients, T12 in 2 patients, and L2 in 1 patient (Table-1). Fusion was obtained in all patients. Patients were followed up for an average of 35.4 months (range, 24-67 months) postoperatively.

On radiography, mean first rib angle was $2.5 \pm 2.8^\circ$, shoulder height was 6.0 ± 5.4 mm, and clavicle angle was $1.7 \pm 1.5^\circ$ (Table-2). The mean values for SRS-22r domain scores were between 3.3 and 3.8, being lowest for mental health and highest for pain and self-image (Table 2). There was no significant correlation between radiographic parameters and total or domain scores of SRS-22r ($p > 0.05$ for all, Table-3).

Table-2. Radiographic parameters and SRS-22 scores of study patients

	Results [Mean±standard deviation (median, min-max)]	
Radiographic parameters		
First rib angle (°)	2.5±2.8	(2, 0-10)
Shoulder height (mm)	6.0±5.4	(4, 0-14)
Clavicle angle (°)	1.7±1.5	(1, 0-5)
SRS-22r scores		
Pain	3.8±0.8	(4.0, 1.8-5.0)
Self-image	3.8±0.6	(3.8, 2.6-4.8)
Function	3.7±0.7	(4.0, 2.2-4.8)
Mental health	3.3±0.9	(3.4, 1.0-4.8)
Satisfaction with management	3.7±1.1	(4.0, 2.0-5.0)
Total	3.6±0.7	(3.8, 1.9-4.8)

Table-3. Correlation between radiographic parameters and SRS-22r scores as correlation coefficient (r) and corresponding p value

Radiographic parameters	SRS-22r score					
	Pain	Self image	Function	Mental health	Satisfaction with management	Total
First rib angle	r=0.306 p=0.156	r=0.058 p=0.791	r=0.299 p=0.165	r=-0.033 p=0.882	r=-0.239 p=0.271	r=0.046 p=0.834
Shoulder height	r=-0.050 p=0.821	r=0.037 p=0.867	r=-0.113 p=0.165	r=-0.251 p=0.248	r=-0.243 p=0.265	r=-0.184 p=0.400
Clavicle angle	r=-0.078 p=0.725	r=0.109 p=0.620	r=-0.081 p=0.714	r=-0.126 p=0.567	r=-0.196 p=0.370	r=-0.105 p=0.634

DISCUSSION:

As biomechanical understanding of curve patterns in AIS and surgical techniques improve over time, scoliosis surgery has provided satisfying outcome⁵. In particular, the development of instrumentation with pedicle screw provided optimal correction of thoracic curve, but also led to hypercorrection in some cases resulting in coronal imbalance, trunk shift, and shoulder imbalance⁷. Ideally, the optimal level of curve correction should provide coronal and sagittal alignment without causing undesirable effects of hypercorrection. In order to determine this optimal level of correction, the clinical and cosmetic impacts of hypercorrection, like shoulder imbalance should be known.

However, it is not clear whether postoperative shoulder imbalance has any significant clinical and functional impact and cause dissatisfaction of patients in long-term. Some studies claim that shoulder imbalance (elevation over 2 cm) is a potential cause of dissatisfaction¹⁵, while some suggested that shoulder imbalance has not a principal role in patients' self-perception¹¹. However, no study focused on the relation between postoperative shoulder imbalance parameters and patients' satisfaction with treatment.

In the present study, we obtained fusion at all spinal levels, which is indicative of a successful scoliosis surgery by posterior instrumentation using polyaxial pedicle screw. The radiographic parameters (first rib angle, shoulder height, and clavicle angle) revealed that patients had mild to moderate postoperative shoulder imbalance at long-term follow-up (24-67 months). In literature, postoperative radiographic parameters for shoulder imbalance showed a range of values depending on preoperative level of shoulders, the surgical technique, and follow-up duration. In a large series on 619 patients with AIS, preoperative T1 tilt increased from -0.10° to 2.42° , clavicle angle from -1.39° to 0.79° , and radiographic shoulder height from -7.04 mm to 1.63 mm¹⁰. In 106 patients with Lenke type 1A curve, Matsumoto et al.¹² reported clavicle angle and T1 tilt angle as $1.8^\circ \pm 2.1^\circ$ and $3.4^\circ \pm 5.5^\circ$ at postoperative follow-up. Namikawa et al.¹³ found that radiographic shoulder height improved from preoperative -12.3 mm to $+5.7$ mm after posterior fusion with segmental pedicle screws in 24 patients with AIS. We determined postoperative first rib angle as $2.5^\circ \pm 2.8^\circ$, shoulder height as 6.0 ± 5.4 mm, and clavicle angle as $1.7^\circ \pm 1.5^\circ$.

In the study by Namikawa et al.¹³, radiographic shoulder height of 20 mm and over was defined as shoulder imbalance, which occurred in 7 out of 24 patients (29%) immediately postoperatively, most of which improved on long-term follow-up. Smyrnis et al.¹⁵ reported postoperative shoulder elevation in 25% of 56 AIS patients, and that half of those with moderate imbalance (≥ 1 cm shoulder elevation) expressed dissatisfaction. In contrary, we found that there was no significant correlation

between shoulder imbalance and patients' satisfaction with treatment, which was evaluated by SRS-22r. The postoperative SRS-22r scores in our population ranged from 3.3 and 3.8, being lowest for mental health and highest for pain and self-image. These scores were similar to postoperative SRS-22r scores reported in the previous studies⁴.

In order to improve surgical balance, additional correction methods, such as direct vertebral rotation, were suggested, but no significant effect has been reported with these techniques³. Currently less correction of the distal thoracic curve seems to be the only effective method to achieve better shoulder balance. However, our finding of insignificant effect of shoulder imbalance on patients' satisfaction may lead to questioning the need for limiting curve correction and taking interventional measures to prevent shoulder imbalance.

The main limitation of the present study was its small sample size, which precludes us from reaching a definitive conclusion on the relation between shoulder imbalance and patients' satisfaction with treatment. Another important limitation need to be noted is the lack of preoperative data, which does not allow the evaluation of the surgery-induced change on both shoulder imbalance and patients' satisfaction. Nevertheless, this is the first study focusing on the role of shoulder imbalance in patients' satisfaction with surgical treatment of AIS.

In conclusion, one of the aims in surgical treatment of scoliosis is achieving shoulder balance. We can say that imbalance in radiographical shoulder height up to 15 mm and at first rib angle up to 10° , and difference between the each shoulder's clavicle angle values up to 5° do not cause patient dissatisfaction in AIS in this relatively small series.

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