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Original Article

A New Radiologic Parameter for Optimizing the Cosmetic Perception and Postoperative Satisfaction of Scoliosis: Preoperative Skin Curve Length/Bone Curve Length Ratio

Skolyoz Hastalarında Kozmetik Algısı ve Postoperatif Hasta Memnuniyetini Optimize Etmede Yeni Bir Radyolojik Parametre: Cilt Eğriliği Uzunluğunun Kemik Eğriliği Uzunluğuna Oranı

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ABSTRACT

Objective: Sometimes, curvatures with higher Cobb angles may not affect the cosmetic appearance as much as some lower Cobb angle scoliosis. Mostly, admissions to hospitals in adolescent idiopathic scoliosis are for subjective cosmetic reasons. Postoperative satisfaction may be insufficient despite high radiographic correction. Converting perception to objective numerical values may be useful. We evaluated the skin curve length/bone curve length ratio on preoperative and postoperative second-year Scoliosis Research Society questionnaire-22 revised (SRS-22r) scores to present an objective assessment of perception and guide satisfaction concerns.

Methods: Forty female, posteriorly instrumented Lenke type 1 adolescent idiopathic scoliosis patients were grouped according to change in SRS-22r total scores compared to preoperative total scores as group 1 (lower postoperative second-year scores), group 2 (0-4 points higher), and group 3 (≥5 points higher postoperative second-year scores) and also in the second step according to change in SRS-22r self-image scores compared to preoperative scores: group self-image-minus (lower postoperative second-year scores), group self-image-0 (same scores), and group self-image-plus (higher postoperative second-year scores). The relationships between postoperative satisfaction and preoperati ve/postoperative second-year Cobb angle, apical vertebral translation, coronal balance, thoracic truncal shift, thoracic kyphosis, lumbar lordosis, sagittal balance, skin curve length/bone curve length, and preoperative SRS-22r domains were evaluated.

Results: No significant difference between groups in preoperative skin curve length, preoperative bone curve length, age, Risser

ÖZ

Amaç: Bazen, daha yüksek Cobb açılarına (CA) sahip eğrilikler; kozmetik görünümü, bazı düşük dereceli skolyozlar kadar etkilemeyebilir. Çoğunlukla, Adölesan İdyopatik Skolyoz (AIS)' de hastaneye başvurular subjektif kozmetik nedenlerdendir. Yüksek radyografik düzeltmeye rağmen ameliyat sonrası memnuniyet yetersiz kalabilir. Kozmetik algısını objektif sayısal değerlere dönüştürmek faydalı olabilir. Kozmetik algı ve memnuniyetin objektif değerlendirmesini sunmak için ameliyat öncesi ve sonrası 2. yıl (po2y) Cilt Eğrisi Uzunluğu (SCL)/Kemik Eğrisi Uzunluğu (BCL) değerlerinin SRS-22r skorlarına etkisini değerlendirdik.

Gereç ve Yöntemler: Posterior enstrümantasyon ve füzyon cerrahisi uygulanmış 40 kadın Lenke tip 1 AIS hastası po2y toplam SRS-22r puanının preoperatif puana kıyasla değişimine göre Grup 1 (puanı düşen), Grup 2 (0-4 puan artan), Grup 3 (toplam SRS-22r puanı ≥5 artan) olarak gruplandırıldı. Çalışmanın ikinci basamağında GroupSI-Minus (Öz-İmaj puanları po2y'de azalan), GroupSI-0 (Öz-İmaj puanları po2y'de aynı kalan) ve GroupSI-Plus (Öz-İmaj puanları po2y'de artan) olarak gruplandı. Preoperatif ve po2y CA, Apikal vertebral translasyon (AVT), koronal denge (CB), torasik trunkal shift (TTS), torasik kifoz (TK), lomber lordoz (LL), sagital denge (SB), SCL/BCL ve preoperatif SRS-22r altbaşlıklarından hangilerinin postoperatif memnuniyeti etkilediği değerlendirildi.

Bulgular: Preoperatif SCL, preoperatif BCL, yaş, Risser, takip süresi, enstrümantasyon seviyeleri, preoperative/po2y CA, CB, AVT, TTS, TK, LL, SB açısından gruplar arasında anlamlı fark

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stage, follow-up time, instrumentation levels, preoperative and postoperative second-year Cobb angle, coronal balance, apical vertebral translation, thoracic truncal shift, thoracic kyphosis, lumbar lordosis, and sagittal balance ($P > .05$) was detected. Significant difference between group 1 and group 2 ($P = .014$) and group 1 and group 3 in preoperative skin curve length/bone curve length was detected ($P = .009$). Significant difference in preoperative skin curve length/bone curve length between group SI-Minus and Group SI-Plus was detected. A negative correlation between satisfaction and postoperative second-year thoracic truncal shift (r: –0.244, $P = .016$) and preoperative skin curve length/bone curve length (r: –0.263, $P = .035$) and a positive correlation between postoperative second-year satisfaction and postoperative second-year skin curve length/bone curve length (r: 0.201, $P = .047$) were detected. A negative correlation between preoperative total score and preoperative Cobb angle (r: –0.218, $P = .031$) was detected.

Conclusions: Using preoperative skin curve length/bone curve length is a simple, inexpensive method that allows predicting changes in satisfaction and SI scores. So, expectations of patients and surgeons can be rationalized; future concerns or disagreements between patients and doctors can be avoided.

Keywords: Scoliosis, satisfaction, self-image, SRS-22, x-rays, correlation

saptanmadı ($P > ,05$). Preoperatif SCL/BCL'de Grup 1 ve 2 ($P = ,014$) ve Grup 1 ve 3 arasında anlamlı fark saptandı ($P = ,009$). Grup SI-Minus ve Grup SI-Plus arasında preoperatif SCL/BCL'de anlamlı fark saptandı; diğer parametrelerde anlamlı fark saptanmadı. Memnuniyet ile po2y TTS arasında (r: –0,244, $P = ,016$) ve preoperatif SCL/BCL (r: –0,263, $P = ,035$) arasında negatif korelasyon saptandı. Po2y memnuniyet ile po2y SCL/BCL arasında pozitif korelasyon saptandı (r: 0,201, $P = ,047$). Preoperatif toplam skor ile preoperatif CA arasında negatif korelasyon saptandı (r: –0,218, $P = ,031$).

Sonuçlar: Preoperatif SCL/BCL, memnuniyet ve Öz-İmaj puanlarındaki değişimi tahmin etmeye izin veren basit, ucuz bir yöntemdir. Böylece hastaların ve cerrahların beklentileri rasyonelle ştirilebilir; hastalar ve doktorlar arasında gelecekteki endişeler veya anlaşmazlıklar önlenebilir.

Anahtar Kelimeler: skolyoz, memnuniyet, öz-imaj, SRS-22, x-ışınları, korelasyon

INTRODUCTION

Adolescent idiopathic scoliosis (AIS) is a 3-dimensional deformity. Clinical and radiographic deformity determines fusion levels together. It may be difficult to predict how surgery will affect the clinical deformity. Adolescent idiopathic scoliosis may manifest itself in the thoracic region as rib asymmetry, truncal shift, shoulder imbalance, and thoracic prominence[1]; pelvic asymmetry and lumbar prominence can be seen in lumbar major scoliosis.[1] Ribs' rotation causes rib hump asymmetry. Deformity is more prominent, especially in thin patients.[2]

Lenke type 1 scoliosis depicts that the structural major curve is in the main thoracic region.[3] Subcutaneous fat may prevent reflection of deformity.[2] Most common reasons for admission to hospital in AIS are for cosmetic reasons and anxiety of progression; especially cosmetic concerns are subjective.[4,5]

MAIN POINTS

- Radiographic evaluation of adolescent idiopathic scoliosis is made on bony curvature of the spine; however, reflection of scoliosis on skin tissue constitutes body perception.
- The weight of the patient and distribution of adipose tissue are effective in prominence of the deformity.
- Preoperative cosmetic condition affects ultimate satisfaction level.
- The relationship between skin curve length and bone curve length should be evaluated preoperatively.

Low self-esteem, low self-image (SI), mood disturbances, worry over peer relations, and suicidal ideation have been reported in AIS patients.[6] Body image concerns may cause impairment in daily functioning and in social activities.[7]

Curvatures of ≥40°-50° have progressive potential and constitute surgical indication.[8] However, in clinical practice, it is seen that some patients have more cosmetic defects despite less Cobb angle (CA), and some have fewer cosmetic disorders despite higher CA.[9] Some authors stated that CA is not correlated,[10] and some showed little correlation[11] with SRS-22r scores and reported that CA does not reflect body perception. Subjective perception of cosmesis is due to alteration of patients' lifestyles, sociocultural environments, ages, genders, and maturity levels.[12] In some AIS patients with high-grade CA that can be indicated for surgery, since no cosmetic defect is detected, conservative follow-up of the patient can be continued. Cosmetic perception varies from patient to patient. Patients are more negatively affected in body perception than parents.[13] Also, both patient's and family's perceptions of body appearance may differ from that of surgeons.[2] Moreover, as there is no consensus about cosmetic disorders according to AIS, surgical indication for AIS differs between surgeons.[14] In other words, cosmetic perception is a subjective situation for patients, parents, and surgeons.

Radiographic evaluation of AIS is made on the bony curvature of the spine; however, what constitutes body perception is reflection of scoliosis on skin tissue. Radiographical shape of the bones is not very important for patients as

it is for surgeons.[10] Because patients' concerns about their shape of the body are not related to bone deformity, it is related to appearance of their body from outside.[15] Therefore, evaluating only radiographic angles may not be enough.

Estimating postoperative satisfaction in preoperative period is difficult and can be problematic for patients, parents, and surgeons. Although excellent radiological correction is achieved, patient satisfaction may be low. On the contrary, although some patients do not like their appearance enough, they can be extremely satisfied with treatment as the best surgical correction is achieved.[14] Converting subjective values to objective numerical values may be useful for determining satisfaction; this provides perceptible value for both patients and surgeons.

The line formed by skin fold is not the same as the line formed by the bone structure of spine (Figures 1 and 2). Especially, the lordotic structure of the lumbar region and subcutaneous fat tissue move these 2 lines apart. In this study, we evaluated the effect of the ratio between skin curve length (SCL), which is the line formed by skin tissue, and bone curve length (BCL), which is the line formed by bone tissue, on pre- and postoperative SRS-22r scores and determined the effect of the ratio on the overall satisfaction of patients. We aimed to present an objective assessment of perception.

METHODS

Our study was carried out in a tertiary reference training and research hospital working only on orthopedics and traumatology. Adolescent idiopathic scoliosis patients who underwent posterior segmental instrumentation and fusion between January 2011 and January 2020 with the consensus of committee of hospital's spine surgery team to eliminate subjectivity bias were analyzed.

The study was carried out according to the Declaration of Helsinki. Ethics committee approval was received from local ethics committee of the hospital. Written informed consent was obtained from patients or their next caretakers.

Our study was carried out retrospectively on Lenke type 1 AIS patients with a preoperative body mass index (BMI) of <30, who were followed up for at least 2 years, operated between the ages of 10 and 18, without previous spine surgery history.

Adolescent idiopathic scoliosis patients who completed both preoperative and postoperative second-year (po2y) SRS-22r forms were included in the study. Patients without idiopathic scoliosis, patients with intraoperative or



Figure 1. Preoperative skin curve length (SCL) and preoperative bone curve length (BCL).

postoperative complications including infection, pseudarthrosis, and implant-related insufficiency, patients who underwent surgery more than once, patients who did not complete preoperative and/or po2y SRS-22r form, patients who were exposed to spinal trauma after posterior instrumentation, patients whose preoperative radiographs could not be reached, patients who were out of follow-up, and patients with a previous history of spine surgery before fusion were excluded. Since the application of costoplasty has an effect on SI and satisfaction, costoplasty patients were also excluded.

SRS-22r has the following 5 domains: function, pain, SI, mental health, and satisfaction/dissatisfaction with management (satisfaction). Postoperative satisfaction is



Figure 2. Postoperative skin curve length (SCL) and bone curve length (BCL) of the same patient.

mostly affected by correction of cosmetics; body image should be evaluated at initial diagnosis and throughout the treatment period.[16] While patient's own body is evaluated with the "SI" domain, satisfaction with the treatment is evaluated with the "satisfaction" domain. Although SRS forms are often evaluated with total scores, domains can also be used alone to evaluate different characteristics of patients.

Body appearance concern is related to whole Health-related quality of life (HRQOL); and self-perception scales and total scores of HRQoL are shown to be correlated.[17] Accordingly, preoperative and po2y total SRS-22r scores were evaluated; patients whose total SRS-22r scores decreased were classified as group 1; patients whose po2y SRS-22r scores remained the same or did not increase by at least 5 points for 5 domains were considered as group 2; and patients whose po2y SRS-22r scores increased by at least 5 points were considered as group 3 (Table 1).

Radiographs of Lenke type 1 patients were evaluated retrospectively. Patients were evaluated in terms of surgical age, Risser stage, and instrumentation levels. Preoperative CAs, apical vertebral translation (AVT) in millimeter (mm), coronal balance (CB) in mm, thoracic truncal shift (TTS): [the lateral horizontal distance of C7 midpoint from central sacral vertical line (CSVL)], T5 to T12 thoracic kyphosis (TK) angles, L1-S1 lumbar lordosis (LL) angles, and sagittal balance (SB) were measured preoperatively and presented in Table 2. Measurements were made in INFINITT picture archiving and communication systems (PACS) (INFINITT Healthcare, Seoul, South Korea) by 2 authors twice with an interval of 1 month, and average of 4 measurements was accepted.

In the po2y, residue CAs, CB, AVT, TTS, TK, LL, and SB were evaluated. Lateral scoliosis radiographs were considered for SCL and BCL (Figures 1 and 2). Accordingly, the curve from the upper end plate anterior line of C7 to the level of S1 anterior sacral promontorium (ASP) was measured as BCL; length of the skin from the projection of C7 on the skin to the projection of ASP along the skin line was taken as the length of SCL. The lengths of SCL and BCL were measured with INFINITT PACS system's curved lines length measurement feature. Since SCL and BCL can change depending on height, SCL/BCL ratio (SCL/BCL) was evaluated in order to ensure optimization.

In the second step, preoperative and po2y SRS-22r SI scores were evaluated. Patients whose scores decreased were named as group SI-minus, patients whose scores remained the same were named as group SI-0, and patients whose scores increased were named as group SI-plus.

Table 1. Preoperative and Postoperative Second-Year Scores of SRS-22r Domains Given as Mean (±SD) or Median (Minimum–Maximum)

	Group 1, n = 4		Group 2, n = 11		Group 3, n = 25	
Domains	**Preoperative**	**Postop Second Year**	**Preoperative**	**Postop Second Year**	**Preoperative**	**Postop Second Year**
Function	15 (15-18)	14 (13-15)	17 (13-19)	17 (13-19)	15 (9-19)	16 (14-19)
	$P = .005$		$P = .691$		**$P < .0001$**	
Pain	21 (21-24)	15 (15-23)	21.1 (±3)	18.5 (11-22)	16 (12-23)	20 (15-23)
	$P < .0001$		**$P < .0001$**		**$P < .0001$**	
Self-image	19 (14-19)	17 (11-18)	16 (10-23)	18.5 (13-24)	12 (6-20)	21 (15-25)
	$P = .009$		**$P < .0001$**		**$P < .0001$**	
Mental health	16 (15-16)	16 (15-16)	15.5 (14-17)	16 (13-17)	15 (14-17)	16 (14-17)
	$P = .591$		$P = .381$		**$P < 0.0001$**	
Satisfaction	5 (3-9)	6.4 (±1.4)	9 (5-10)	6.50 (2-10)	7 (5-10)	9 (5-10)
	$P = .066$		**$P < .0001$**		**$P < .0001$**	
Subtotal	71 (68-73)	62 (60-67)	68 (59-79)	67.5 (59-79)	59.3 (±5.9)	73 (62-79)
	$P < .0001$		0.704		**$P < .0001$**	
Total	76 (70-82)	68 (64-75)	75.9 (±5.5)	77.65 (±6.6)	66.13 (±6.1)	82 (70-93)
	$P < .0001$		**$P < .0001$**		**$P < .0001$**	

The values of SRS-22r Domains found statistically significant between preoperative and Postoperative Second-Year were written in bold type and $P \leq 0.05$ was considered significant.

Table 2. Preoperative and Postoperative Second-Year Values of Radiologic Measurements of Groups Given as Mean (± SD) or Median (Minimum–Maximum)

	Group 1, n = 4		Group 2, n = 11		Group 3, n = 25	
	Preoperative	Postoperative Second Year	Preoperative	Postoperative Second Year	Preoperative	Postoperative Second Year
SCL	460.7 (316.2-486)	455.5 (±30.7)	402.8 (±34.9)	448.6 (±37.8)	416.2 (±53.8)	448.2 (±35.2)
	P = .474		***P* < .0001**		***P* < .0001**	
BCL	435.3 (325.8-444.1)	471.7 (±23.8)	412.9 (298.4-463)	457.1 (±40.5)	426.8 (±57.4)	458.9 (±39.5)
	***P* = .004**		***P* < .0001**		***P* < .0001**	
SCL/BCL	1.0493 (±0.57)	0.96 (±0.039)	0.9767 (0.92-1.08)	0.98 (±0.31)	0.971 (0.87-1.15)	0.977 (±0.037)
	***P* = .011**		*P* = .948		*P* = .96	
Cobb	48 (±6.8)	9.6 (±5.2)	49.1 (±8.4)	11.4 (±6.7)	50.7 (±11.2)	12.3 (±7.5)
	***P* < .0001**		***P* < .0001**		***P* < .0001**	
CB	21.58 (±10.8)	11.44 (±9.4)	12.95 (3.1-42.8)	6.5 (0-34)	20.4 (±12.5)	8.4 (±5)
	***P* = .021**		***P* = .001**		***P* < .0001**	
AVT	42.8 (±12.9)	8.1 (±4.7)	42.8 (±12.9)	11.2 (±7.2)	41.9 (±15.7)	10.3 (±6.2)
	***P* < .0001**		***P* < .0001**		***P* < .0001**	
TTS	15.1 (±10.5)	9.8 (±7.6)	9.9 (4.1-24.3)	7.7 (±5.7)	12.9 (0-42.2)	7.9 (±6)
	P = .151		***P* = .035**		***P* < .0001**	
TK	29.8 (±8.3)	24.7 (±8.7)	29.8 (±8.3)	28.9 (±14.6)	24.7 (±11.1)	30.7 (±10.2)
	P = .136		*P* = .129		***P* < .0001**	
LL	–57 (±11.7)	–47.7 (±11.6)	–52.9 (±12.1)	–45.6 (±13.1)	-57.4 [(-80.5)-(97.5)]	-46 (±16.6)
	P = .53		***P* = .006**		***P* = .015**	
SB	-13.9 (±30.4)	4.8 (±12.7)	-13.9 (±33.4)	-2.8 (±15.6)	-9.9 (±35)	3.5 (±23.1)
	P = .131		*P* = .645		***P* = .005**	

SCL, skin curve length; BCL, bone curve length; CB, coronal balance; AVT, apical vertebral translation; TTS, thoracic truncal shift; TK, Thoracic kyphosis; LL, lumbar lordosis; SB, sagittal balance.
The values found statistically significant between preoperative and Postoperative Second-Year were written in bold type and $P \leq 0.05$ was considered significant.

The effects of SCL/BCL, instrumentation levels, preoperative CAs, AVT, CB, TTS, TK, LL, and SB on SI were investigated.

To understand the sources of patient satisfaction after surgery is beneficial to surgeons.[2] It is difficult to know in advance which patient will/(not) be satisfied with treatment. In this sense, which radiographic measurements and preoperative SRS-22r domains affect the postoperative "satisfaction" domain has been evaluated. The po2y satisfaction score was compared with immediate postoperative satisfaction score.

Statistical Analysis

Statistical analysis was performed by using Statistical Package for Social Sciences for Windows, version 22.0 (SPSS Inc., Chicago, Ill, USA). Quantitative variables were given as mean ± SD and median (minimum–max), whereas qualitative variables were presented as frequencies. The Kolmogorov–Smirnov and Shapiro–Wilk tests were performed for evaluation of normality. The paired *t*-test was used for analysis of normally distributed dependent data and Wilcoxon test was used for analysis of abnormally distributed dependent data. One-way analysis of variance was used for comparison of normal distributed variables as parametric test. Tukey's and Games–Howell multiple comparison tests were used for comparisons in subgroups. Correlation of normally distributed radiographic parameters and preoperative and po2y SRS-22r scores was evaluated with Pearson correlation coefficient. A *P*-value <.05 was determined as significant.

RESULTS

The study was carried out with 40 consecutive female Lenke type 1 AIS patients meeting the criteria for inclusion. The surgical age of all patients, group 1 patients, group 2 patients, and group 3 patients were 15.7 ± 1.8, 15.3 ± 1.7, 15.9 ± 1.9, and 16 ± 1.8 years, respectively. Median (minimum–maximum) Risser stage was 4 (3-5),

4, 4 (3-5), and 4 (3-5), respectively. The average follow-up was 55 months (28-138), 58.7 ± 27.1 months, 51.7 ± 24.9 months, and 54.5 months (26-138), respectively. Instrumentation level was 10.8 ± 2.5, 10.8 ± 3.1, 10.7 ± 2.3, and 10.9 ± 2.1, respectively.

All Patients (n = 40): There was a statistically significant difference between all preoperative and po2y radiographic measurements except for SCL/BCL. There was a statistically significant difference between all SRS-22r domains except for pain.

Group 1 (n = 4): There was a statistically significant difference between BCL, SCL/BCL, CA, CB, and AVT. There was a statistically significant difference between all SRS-22r domains except for mental health.

Group 2 (n = 11): There was a statistically significant difference between all preoperative and po2y radiographic measurements except for TK and SB. There was a statistically significant difference between all SRS-22r domains except for function, mental health, and subtotal score.

Group 3 (n = 25): There was a statistically significant difference between all preoperative and po2y radiographic measurements except for SCL/BCL. There was a statistically significant difference between all SRS-22r domains.

There was no statistically significant difference between groups in terms of preoperative SCL, preoperative BCL, operative age, Risser stage, follow-up time, instrumentation levels, and preoperative and po2y CA, CB, AVT, TTS, TK, LL, and SB ($P > .05$).

There was a statistically significant difference between group 1 and group 2 ($P = .014$) and group 1 and group 3 in terms of preoperative SCL/BCL ($P = .009$). There was a statistically significant difference between group 2 and group 3 in preoperative function ($P = .015$). A statistically significant difference was found between group 1 and group 2, and also between group 1 and group 3 in po2y function ($P < .0001$). There was a statistically significant difference between group 1 and 3 and also between group 2 and group 3 in preoperative pain ($P < .0001$) and between group 1 and group 3 in po2y pain ($P = .003$). In preoperative SI, a statistically significant difference was found between group 1 and group 3 and also between group 2 and group 3 ($P < .0001$). There was a statistically significant difference between group 1 and group 2 ($P = .011$), group 1 and group 3 ($P < .0001$), and group 2 and group 3 ($P = .039$) in po2y SI. There was a statistically significant difference between group 1 and group 3 in preoperative mental health ($P < .0001$). In po2y satisfaction, a statistically significant difference was found between group 1 and group 2 and between group 1 and group 3 ($P < .0001$). A statistically significant difference was found between group 1 and group 3 and between group 2 and group 3 in preoperative subtotal score ($P < .0001$). There was a statistically significant difference between group 1 and group 2 and between group 1 and group 3 ($P < .0001$) and between group 2 and group 3 ($P = .08$) in po2y subtotal score. There was a statistically significant difference between group 1 and group 3 and between group 2 and group 3 in preoperative total score ($P < .0001$) (Table 3).

There was a statistically significant difference between group 1 and group 2 and between group 1 and group 3 ($P < .0001$) and between group 2 and group 3 ($P = .007$) in po2y total score.

There was no statistically significant difference between other parameters ($P > .05$).

In the second step of study, there was a statistically significant difference in preoperative SCL/BCL between group SI-minus and group SI-plus; there was no statistically significant difference in other preoperative and po2y parameters. Since the most important factor that changes po2y satisfaction is body perception,[14] the correlation of preoperative and po2y radiological measurements with both po2y satisfaction and total score was evaluated with Pearson correlation analysis.

Satisfaction

There was a negative correlation between satisfaction and po2y TTS (r: –0.244,$P = .016$) and preoperative SCL/BCL (r: –0.263, $P = .035$). A positive correlation was detected between po2y satisfaction and po2y SCL/BCL (r: 0.201, $P = .047$) and po2y TK (r: 0.222, $P = .028$).

A positive correlation was found between immediate postoperative satisfaction and po2y satisfaction (r: 0.363, $P = .0001$), po2y subtotal score (r: 0.204, $P = .044$), and po2y total score (r: 0.253, $P = .012$).

Total Score

A negative correlation between preoperative total score and preoperative CA (r: –0.218, $P = .031$) was detected. There was a positive correlation between po2y total score and po2y TK (r: 0.273, $P = .007$).

DISCUSSION

Idiopathic scoliosis constitutes 80% of all scoliosis cases.[18] Scoliosis that is detected after 10 years and has no etiological cause is called AIS. Cosmetic concerns are more prominent in AIS than adult scoliosis.[19]

Adolescencents observe their own and peers' bodies' physical and psychological changes. SI perception may be disrupted due to deformity. Psychosocial well-being,

Table 3. Subgroup Comparison of Preoperative Skin Curve Length (SCL)/Bone Curve Length (BCL) Ratio and SRS-22r Domains & Subgroup Comparison of Postoperative Skin Curve Length (SCL)/Bone Curve Length (BCL) Ratio and SRS-22r Domains

Preoperative	Groups		*P*	Postoperative	Groups		*P*
SCL/BCL	1	2	.014	SCL/BCL	1	2	.434
		3	.009			3	.58
	2	3	.864		2	3	.864
Function	1	2	.768	Function	1	2	<.0001
		3	.457			3	<.0001
	2	3	.015		2	3	.982
Pain	1	2	.867	Pain	1	2	.240
		3	<.0001			3	.003
	2	3	<.0001		2	3	.055
Self-image	1	2	.603	Self-image	1	2	.011
		3	<.0001			3	<.0001
	2	3	<.0001		2	3	.039
Mental health	1	2	.334	Mental health	1	2	.966
		3	<.0001			3	.786
	2	3	.090		2	3	.365
Satisfaction	1	2	.134	Satisfaction	1	2	<.0001
		3	.095			3	<.0001
	2	3	1.000		2	3	.315
Subtotal	1	2	.710	Subtotal	1	2	<.0001
		3	<.0001			3	<.0001
	2	3	<.0001		2	3	.008
Total	1	2	.996	Total	1	2	<.0001
		3	<.0001			3	<.0001
	2	3	<.0001		2	3	.007

particularly body image and HRQoL, would be greatly impacted in the adolescence period.[16] Since the psychological and social effects of body image are different during adolescence, patients between the ages of 10-18 were included in the study.[12] Adolescent idiopathic scoliosis requiring treatment is more common in females. Also, women are more affected than men in terms of perceived SI before surgery.[20] As a result, only female patients were included in the study to homogenize gender effect.

To assess perception of body image, SRS-22 SI domain is used more often. Poorer psychosocial functioning, body image, and HRQoL scores are reported in AIS patients than healthy adolescents.[17] However, SI is a subjective perception, and similar curvatures can create different perceptions in different patients. Moreover, sometimes, curvatures with higher CA may not affect the cosmetic appearance as much as lower CA scoliosis.[10] This subjectivity may differ not only between patients but also among the physicians who put surgical indication. During a deformity follow-up, it is not uncommon for surgeons and patients or even 2 surgeons to disagree on the effect of cosmetic condition on surgical indications regarding patient's deformity.[21]

Cobb angle in coronal plane, the degree of kyphosis/lordosis in sagittal plane, and the amount of rotation of vertebrae determine deformity of spine. However, aforementioned measurements are numerical values that we can determine by radiography with X-rays. Even though the level of these values indirectly affects body perception, they are not visuals that patient and those around her/him can directly evaluate. In other words, the shape of patient's body is seen from outside, not the CA. The weight of the patient and distribution of adipose tissue are effective in prominence of the deformity. In clinical practice, it is not uncommon to notice deformity and diagnose AIS or Scheuermann's kyphosis after weight loss. Koch

et al[2] showed that lower BMI is related to dissatisfaction from treatment. The amount of subcutaneous adipose tissue may affect surgical indication. Therefore, it may not be sufficient to consider only CA and amount of rotation when evaluating the cosmetic condition of patient. In this sense, we planned to reach an objective value by converting the current state of the patients into a numerical value. Since SCL and BCL values alone will be affected by height, we took SCL/BCL. Skin curve length/bone curve length has not been previously presented in the literature.

Since all parameters have impacts in HRQoL, grouping was made based on the total score. Accordingly, it was aimed to determine parameters that affect this change in patients whose SRS-22r score decreased, remained similar, or increased.

Preoperative statistically significant difference was not detected in all 3 groups in terms of radiography parameters that we currently use. In this case, parameters that changed the outcomes of patients should be different in po2y measurements, but no statistically significant difference was found in any of po2y statistical parameters we currently use.

In all 3 groups, po2y coronal and sagittal plane radiography measurements that will affect clinical outcome were found to be statistically indifferent. This situation shows us that we have carried radiographic corrections to a similar level in 3 of groups according to po2y SRS-22r total scores. Although po2y radiography measurements are similar, the reason for different satisfaction levels can be interpreted as the presence of another parameter that we have not used in the clinic yet.

The predictability of late-period patient satisfaction in scoliosis patients is important for both patients and surgeons who assume the treatment. As a result of our study, we found that preoperative SCL/BCL, which was not previously presented in the literature, is an important parameter reflecting the outcome of patients. According to the results of our study, preoperative SCL/BCL of patients with decreased SRS-22r total score in po2y was statistically different compared to patients whose total score did not decrease and increase. Despite having similar po2y radiographies, ultimate satisfaction level was dependent on the cosmetic condition at the preoperative period. In other words, group 1 had a higher expectation from the surgery; this was affecting the po2y total outcome score. In the statistical analysis of our study, we see that the mean SCL/BCL ratio of group 1 whose total score decreased was >1, unlike the groups 2 and 3 whose total score did not decrease. In this sense, we believe that it would be appropriate to inform patients with a preoperative SCL/BCL ratio >1 regarding their expectations.

Our study is important because it provides information about the condition of patients at po2y independent of other parameters by converting a subjective criterion that varies from patient to patient into an objective numerical value.

In the second step of the study, patients were grouped according to change in SI score. (decreasing, remaining the same and increasing scores). The only factor that affects po2y SI domain levels was preoperative SCL/BCL. Other radiographic parameters and po2y SCL/BCL did not affect the body perception of the patients. Accordingly, preoperative SCL/BCL was found to be statistically significant difference between patient group whose SI score decreased and patient group whose SI score increased. In this context, the new parameter we have presented reveals who will be postoperatively satisfied and who will not be satisfied in terms of body perception in different patient groups that we have managed to achieve the same radiographic image.

Our study determined a negative correlation between TTS and satisfaction. Imbalance in the alignment of the head and pelvis causes poor body perception and dissatisfaction in scoliosis. Thoracic kyphosis should also be normokyphotic for satisfaction. In addition, patients whose preoperative satisfaction was already low did not increase despite surgical treatment, and it was also found to be correlated with the total score. In this sense, preoperative evaluation of patients with SRS-22r will be useful in determining their postoperative expectations.

Controversial results have been reported on the factors affecting patients' SI and satisfaction in the literature. Bago et al[10] and Koch et al[2] did not find a better outcome with greater radiological correction; Sharma et al[22] stated that CA, Cobb correction, and CB do not affect body image.

Ghandehari et al[23] reported that curve correction and CB correction were effective on total SRS score. Similarly, Schwieger et al[16] found that SI scores of patients with an angle of $\geq 40^{\circ}$ were lower, and Wang et al[24] found a negative correlation between CA, AVT, and razor hump height and SI.

Decrease in CA has a positive effect on HRQoL; however, it does not correct rib hump deformity alone. The factor affecting SI is not CA alone, but accompanying truncal asymmetry, rib hump deformity, shoulder imbalance, truncal or lumbar prominence, and waist symmetry.[25] Data between curve correction and SRS-22r SI scores are controversial in studies. This may be due to the fact that the studies did not differentiate the effects of costoplasty.[26] In this context, patients who had costoplasty application were excluded from study in order to

ensure homogeneity of patient groups and to evaluate effectiveness of Cobb correction on SI, satisfaction, and total score. As a result, our work showed that preoperative CA does not correlate with po2y SI and po2y satisfaction; however, it was negatively correlated with the total score. CAs were brought to a certain common point by surgical correction. The factor forming the cosmetic perception of patients was not only radiographic angle of spine. Negative correlation of CA with total score indicates that CA affects different parameters of HRQoL other than cosmesis. SRS-22r questionnaire may not capture all aspects of scoliosis on the SI domain.[24]

Bago et al[10] suggested the use of surface topography and digital photography in order to evaluate physical deformity. De Korvin[27] reported that the use of back surface topography devices is limited since they are not sensitive to changes in CA. Although topography was used to quantify body asymmetry, it was not widespread in clinical use due to setup difficulties,[1] and its results were not found to be compatible with SRS-22r scores.[28] In addition, 3D scanners can be used because it provides full geometry.[29] 3D scanners can be used to monitor the changes in the patients' body. By the way, it is not practical to use them in policlinics due to difficulty of access, high cost, time-consuming process of scanning and processing, uncertainty of accuracy or precision. However, spine AP anteroposterior (AP) and lateral x-rays are already taken in surgical planning. CA measurement is the gold standard for determining the curve magnitude. It is mandatory in surgical planning.[30] In our study, we presented SCL and BCL values that can be measured on radiographs that will already be taken during preoperative evaluation.

Self-administered Trunk Appearance Perception Scale (a 3-item drawing-based instrument), Spinal Appearance Questionnaire (a drawing-based instrument), Cash's Cognitive-Behavioral Perspective on Body Image Walter Reed Visual Assessment Scale, and Body Image Disturbance Questionnaire-Scoliosis version were used to evaluate body perception.[12] However, there was no correlation between these scores and CA in studies.[7] Among the assessment methods that examine body perception, SRS-22 is the most commonly used method. SRS-22 SI domain was used successfully in surgically treated patients.[1]

As limitations; our study gives the results of only Lenke type 1 patients. Knowing the ratio of SCL/BCL in normal population and other types of scoliosis will guide the treatment of other type scoliosis patients.

In conclusion, using preoperative SCL/BCL is a simple and inexpensive method that allows to predict the change in satisfaction and SI scores. With this method, expectations of patients and surgeons can be rationalized; future concerns or disagreements between patients and doctors can be avoided by abandoning certain surgical procedures. In this sense, guided by data of our study, we recommend spine surgeons to use preoperative SCL/BCL in evaluation of Lenke type 1 patients to quantify cosmetic perception and satisfaction.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics Committee of Metin Sabanci Baltalimani Bone Diseases Research and Training Hospital (Date: March 2, 2021, Decision No: 68/482).

Informed Consent: Written informed consent was obtained from the patients and patient's family participating in this study.

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