Health-Related Quality-of-Life Scores, Spine-Related Symptoms, and Reoperations in Young Adults 7 to 17 Years After Surgical Treatment of Adolescent Idiopathic Scoliosis

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Abstract

The goal of surgical treatment of adolescent idiopathic scoliosis (AIS) is to prevent disability associated with curve progression. Few investigators have considered whether the function of patients with AIS becomes adversely affected by major spine fusion surgery.

Tertiary referral center patients (age, 10-17 years) who underwent spinal deformity correction a minimum of 5 years earlier were identified. Scoliosis Research Society–22R (SRS-22R) and Short Form–12 (SF-12) were administered.

Data were available for 118 patients. Mean age was 14.1 years at surgery and 26.8 years at follow-up. Mean outcome scores were 50.9 (SF-12 physical composite summary), 49.4 (SF-12 mental composite summary), and 4.0 (SRS-22R total). One hundred patients (85%) were working. Common symptoms included occasional back pain (90, 76%), limited range of motion (52, 44%), activity limitations (54, 46%), waistline imbalance (41, 35%), rib prominence (28, 24%), wound/scar problems (18, 15%), and shortness of breath (18, 15%). Prominent implants were reported by 11 patients (9%). Seven of 14 reoperations were for instrumentation removal. There was a high incidence of occasional back pain and activity complaints after surgery for AIS in our cohort. However, normal SF-12 scores suggested that these symptoms did not lower the patients' general health.

The goal of surgical treatment of adolescent idiopathic scoliosis (AIS) is to prevent disability associated with curve progression.[1] Early studies tended to focus on radiographic measures, such as curve correction and sagittal balance, rather than on improvements in quality of life (QOL).[2-5] Although studies have reported on QOL in patients treated surgically for scoliosis,[6-11] these studies were largely limited by small sample size and inclusion of patients with congenital and neuromuscular scoliosis,[9] lack of a generic measure of QOL,[6,7] or lack of surgical treatment of patients in the cohort.[10]

We conducted a study to determine disease-specific and general health-related QOL (HR-QOL) in young adults who underwent surgical correction of their spinal deformity during adolescence and to evaluate associated complications and reoperations.

Materials and Methods

After obtaining institutional review board approval, we queried the surgical database of a large metropolitan tertiary referral center for consecutive patients who had undergone spine deformity correction between the ages of 10 and 17 years (January 1993–December 2003). Hospital and medical records were retrospectively reviewed to confirm the diagnosis of AIS. Patients with congenital, neuromuscular, juvenile, or infantile scoliosis were excluded. Patients with intraspinal pathology (eg, tethered cord, syringomyelia), developmental delay, chromosomal abnormality, or congenital heart disease were also excluded. Patients were contacted by mail or telephone, and the Scoliosis Research Society–22R (SRS-22R)[12-15] and the Short Form–12 (SF-12)[16] were administered. Standard demographic and surgical data were also collected.

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The SRS-22R is a scoliosis-specific HR-QOL questionnaire with 22 items, 5 domains (pain, activity, appearance, mental, satisfaction), and a total score.[12-15] Each domain score ranges from 1 to 5 (higher scores indicating better outcomes). The SRS-22R is the outcome instrument most widely used to measure HR-QOL changes in patients with scoliosis, and it is available in several languages.[17-26]

The SF-12, a 12-item self-administered short-form health status survey developed in the Medical Outcomes Study, measures patient-based health status. Two composite scores can be calculated: physical composite summary (PCS) and mental composite summary (MCS).[16] Using norm-based scoring, all domain scales have a mean (SD) of 50 (10) based on the general 1998 US population. Thus, scores under 50 fall below the general population mean.

In addition, patients were surveyed to determine the incidence of spine-related symptoms and complaints, including activity limitations, rib prominence, waistline asymmetry, back pain, limited range of motion (ROM), shortness of breath, wound/scar problems, lung disease/asthma, heart disease, high blood pressure, and arthritis. Data regarding postoperative treatment regimens of physical therapy, narcotic pain medication, spinal/epidural injections, and nonsteroidal anti-inflammatory drug (NSAID) use were collected. Patients were also queried regarding their current working status and smoking status.

Standard demographic and surgical data were collected from hospital and office charts and radiographs. Data collected included history of bracing, age at index surgery, number of levels fused, surgical approach (anterior, posterior, combined), postoperative complications (eg, ileus, wound infection, anemia, pneumonia), and immediate preoperative and final postoperative radiographic measures. Data on need for subsequent revision surgery and indications for revision surgery were also collected.

Preoperative and latest follow-up radiographs were measured to determine curve magnitude, sagittal and coronal balance, and percentage curve correction. Coronal balance was defined as the distance between a plumb line drawn vertically from the spinous process of C7 and the central sacral line on full-length posteroanterior radiographs. Sagittal balance was defined as the distance of a plumb line drawn vertically from the center of the body of C7 and the posterosuperior endplate of S1.[27]

Regression analysis was performed to identify factors predictive of SRS-22R total scores. Factors included in the analysis were sex, age at surgery, Lenke type, surgery type (anterior, posterior, anteroposterior), number of levels fused, lowest instrumented vertebra, perioperative complications, percentage curve correction, postoperative coronal and sagittal balance, smoking status, and need for revision surgery. Although age and sex were considered variables outside the surgeon's control, they were included in the model, as previous studies have shown that SRS scores varied by age and sex both in adolescents[28] and adults.[29] Significance was set at $P < .01$. All data analysis was performed with IBM SPSS Version 19.0 (Somers, New York).

Table 1. **Summary of Demographic Data**

Variable	Mean	
Age at surgery, y	14.1 (SD, 1.9)	
Age at follow-up, y	26.8	
Follow-up, y	12.7	
	n	**%**
Females	109	92
Working	100	84.7
Desk job	91	77.1
Factory/warehouse	5	4.2
Homemaker	4	3.4
Smoker	25	21.2

Results

Of the 384 postoperative patients identified for study inclusion, 134 (35%) completed surveys. Sixteen patients with nonidiopathic scoliosis were excluded, leaving 118 available for analysis. Of the remaining patients, 248 (64%) could not be contacted because of a change in address or phone number. Two patients (1%) were unwilling to complete survey requests. There was no statistically significant difference in demographics between patients with and without follow-up data available. Demographics are summarized in **Table 1**. There were 109 females (92%). Mean (SD) age at surgery was 14.1 (1.9) years. Only 37 (31%) were braced before surgery. **Table 2** summarizes the radiographic data. Mean (SD) major Cobb angle was 49.7° (7.8°). Eighty-five patients (72%) underwent posterior fusion with instrumentation using hooks only; another 16 (14%) had anterior-only surgery, and another 17 (14%) had combined anterior-posterior surgery. A mean of 7.8 levels were fused. Index surgery data and lowest instrumented vertebra distribution are summarized in **Table 3**. Mean (SD) percentage curve correction was 48.9% (8.4%).

Seven patients had a total of 8 perioperative complications: anemia requiring transfusion (2), ileus necessitating nasogastric tube insertion (2), superficial wound infection treated with oral antibiotics and local wound care (2), wound drainage and erythema (1), and pneumonia (1). Mean (SD) length of clinical and radiographic follow-up was 57.9 (36.3) months.

Table 4 summarizes the long-term complications. Of the 38 patients with long-term complications, 14 required reoperation. The indications were disc herniation (2 patients), painful instrumentation (7), crankshaft phenomenon (1), nonunion (1), and adjacent-level degeneration (3). Both disc herniations were at L5–S1, several segments below the distal extent of the fusion. Of the 7 patients who had painful instrumentation removed, 6 had the entire construct removed, and 1 had the proximal half of a rod taken out. The 3 patients with adjacent-level degeneration had stenosis at the distal end of the construct—at L5–S1 (2 patients) or L2–L3 (1 patient).

Table 2. Summary of Radiographic Data

Variable	Mean	SD
Preoperative		
Major Cobb angle	49.7°	7.8°
Coronal balance, mm	4.1	21.8
Sagittal measures		
T5–T12	22.6	11.0
T10–L2	7.4	6.9
T12–S1	46.4	4.5
Risser grade	2.3	1.8
Postoperative		
Major Cobb correction	48.9%	8.4%
Coronal balance, mm	4.1	21.8
Sagittal measures		
T5–T12	26.1	10.0
T10–L2	8.4	8.9
T12–S1	48.6	4.6
Lowest Instrumented Vertebra		
Tilt	4.5°	11.9°
Disc angle	1.7°	4.7°
Coronal balance, mm	4.1	16.6

Table 3. Summary of Index Surgery and Complications

Variable	n	%
Braced before surgery	37	31
Surgery		
Posterior fusion	85	72
Anterior fusion	16	14
Anteroposterior fusion	17	14
Mean (SD) levels fused	7.8 (2.3)	
Lowest instrumented vertebra		
T10	5	4
T11	19	16
T12	30	25
L1	14	12
L2	10	8
L3	36	31
L4	4	3
Perioperative complications		
Anemia/transfusion	2	1.7
Ileus	2	1.7
Wound infection, superficial	2	1.7
Pneumonia	1	0.8
Wound drainage/erythema	1	0.8

Table 4. Summary of Long-Term Complications

	Revision Surgery		
Complication	Yes	No	Total
Disc herniation	2	0	2
Painful instrumentation	7	9	16
Broken instrumentation	0	1	1
Crankshaft phenomenon	1	1	2
Decompensation	0	1	1
Prominent implants	0	11	11
Nonunion	1	0	1
Adjacent-level degeneration	3	1	4

Mean (SD) time between surgery and completion of the surveys/questionnaires was 12.7 (3.2) years (range, 10-18 years). Mean age of respondents was 26.8 years. Twenty-five respondents (21%) were smokers. Mean (SD) outcome scores were 50.9 (9.4) for SF-12 PCS and 49.4 (10.2) for SF-12 MCS. Eighteen patients (15%) had SF-12 PCS scores 1 SD below normal, and 15 (13%) had SF-12 MCS scores 1 SD below normal. Mean (SD) SRS-22R Total score was 4.0 (0.7). Means, standard deviations, and distribution of SRS domain scores are summarized in **Table 5**. Of the variables, only current smoking ($P < .001$) was predictive of SRS-22R Total scores, accounting for 20% of their variability (**Table 6**).

One hundred patients (85%) had jobs, mostly desk jobs. The postoperative limitations most commonly reported are summarized in **Table 7**. These included at least intermittent back pain in 90 patients (76%), limited ROM in 52 (44%), and activity limitations in 54 (46%). Less common limitations were waistline imbalance in 41 (35%), rib prominence in 28 (24%), wound/scar problems in 18 (15%), and shortness of breath in 18 (15%). Other related medical problems were lung disease/asthma in 11 (9%), osteoarthritis/degenerative arthritis in 11 (9%), heart disease in 3 (3%), and high blood pressure in 2 (2%).

A minority of patients also participated in postoperative treatment regimens. The most common treatment was regular use of NSAIDs (25 patients, 21%). Other treatments were physical therapy (14, 12%), narcotic pain medication use (5, 4%), and epidural steroid injections (5, 4%). **Table 8** summarizes the postoperative treatments used by patients with scoliosis.

Table 5. Means, Standard Deviations, and Score Distribution for Scoliosis Research Society–22R

Domain	Mean	SD	Score			
			<2	2 to <3	3 to <4	4 to 5
Pain	3.9	0.9	4	12	33	73
Appearance	3.9	0.8	3	12	44	63
Activity	4.1	0.6	1	6	29	86
Mental	4.0	0.8	2	9	39	72
Satisfaction	3.9	1.0	2	14	29	77
Total	**4.0**	**0.7**	**2**	**7**	**41**	**72**

Discussion

A major concern about prophylactic interventions for diseases is that the treatment will harm the patient. This is especially true for major spine surgery performed on adolescents with minimal symptoms. Although the incidence of perioperative complications in children undergoing corrective spinal surgery for AIS has been reported,[30-32] the effect of the surgery on the disease-specific HR-QOL outcomes of these individuals as young adults has not been previously studied. Over the past few decades, a paradigm shift in understanding health and disability has occurred, with increased emphasis being placed on HR-QOL outcomes measures and understanding disability as relating to a measureable impact of the functioning of an individual after a change in health or environment. This change was substantiated when the World Health Organization endorsed the *International Classification of Functioning, Disability and Health*.[33] In light of this shift, we present the disease-specific and general HR-QOL outcomes of young adults who had undergone surgical correction for spinal deformity during adolescence, as well as their associated complications and reoperations, in an attempt to identify targets for improvement.

Our patient-reported outcomes demonstrated a high incidence of occasional back pain, activity-related complaints, and limited ROM. Comparison of our cohort's SRS-22R outcomes with previously published normative values for the unaffected adolescent population[28,34] suggests worse scores for the disease-specific SRS-22R domains of pain and appearance. In 2012, Daubs and colleagues[34] reported that normative scores on various SRS-22 domains were statistically lower with age (scores decreased from age 10 to age 19 years). Both Verma and colleagues[28] and Daubs and colleagues[34] reported lower scores for females than for males. Therefore, it is unclear whether the differences observed in our cohort may be accounted for by the larger proportion of females compared with the normative data.

General health scores on the SF-12 were similar to the population norm (mean [SD]) of 50 (10) referenced by Ware and colleagues.[16] These findings suggest that, though pain and appearance may be statistically lower in our cohort—as measured with the SRS-22R—the cohort's spine-related symptoms do not seem to lower its general health. Eighty-five percent of the patients were working at the time of the survey, further supporting a relatively normal level of overall function. In a retrospective review by Takayama and colleagues,[9] similar results were found with regard to working after AIS fusion surgery. Of 32 patients treated surgically for scoliosis, at a mean of 21.1 years after the index fusion 27 (84.4%) were or had been engaged in various occupations without marked difficulty.

Our results in a cohort of patients with segmental instrumentation using hooks are similar to results in other studies of long-term HR-QOL measures in patients with AIS and Harrington rod instrumentation. Danielsson and Nachemson[35] evaluated patients with surgically treated AIS with at least 20-year follow-up and reported that, in their surgical cohort with a mean age of 39.7 years, mean SF-36 PCS score was 50.9, and mean SF-36 MCS score was 50.2. In a recent study of patients with AIS and Harrington rod instrumentation, those of a mean age of 32.3 years had a mean score of 50.9 for both SF-36 PCS and SF-36 MCS.[36]

Regression analysis identified only smoking as a predictor of SRS-22R Total scores. This finding, that smokers have a lower health state, is expected even in the general population.[37] In-

Table 6. Results of Regression Analysis

Variable	Standardized β	*P*
Sex	−0.215	.174
Age	0.121	.429
Lenke type	−0.273	.121
Surgery type	0.085	.627
Levels fused, n	−0.195	.306
Lowest instrumented vertebra	0.070	.687
Complications	0.134	.349
Revision after index surgery	−0.208	.140
Smoking	−0.478	<.001
Postoperative sagittal balance	0.118	.439
Postoperative coronal balance	−0.012	.929
Curve correction	0.046	.725

Table 7. Self-Reported Limitations and Illness

Symptom	n	%
Occasional back pain	90	76
Limited range of motion	52	44
Activity limitations	54	46
Waistline imbalance	41	35
Rib prominence	28	24
Wound/scar problems	18	15
Shortness of breath	18	15
Lung disease/asthma	11	9
Osteoarthritis/degenerative arthritis	11	9
Heart disease	3	3
High blood pressure	2	2

Table 8. Self-Reported Postoperative Treatments

Treatment	n	%
Physical therapy	14	12
Narcotic medications	5	4
Epidural injections	5	4
Nonsteroidal anti-inflammatory drugs	25	21

terestingly, bracing before surgery, Lenke type, surgery type, number of levels fused, lowest instrumented vertebra, incidence of perioperative complications, percentage curve correction, postoperative sagittal and coronal balance, and need for revision surgery did not influence HR-QOL measures in this cohort.

Our cohort's incidence of occasional back pain was 76% (90/118 patients). Other reports have had similar findings. In 2012, Bas and colleagues[38] studied self-reported pain in 126 consecutive patients with scoliosis and instrumented fusion. In their cohort, "most participants reported 'no pain' (38.5%) or 'mild pain' (30.8%) and 72.1% of participants reported a current work/school activity level of 100% normal." Also in 2012, Rushton and Grevitt[39] reported on a review and statistical analysis of the literature on HR-QOL in adolescents with untreated AIS and in unaffected adolescents. Their goal was to identify whether there were any differences in HR-QOL and, if so, whether they were clinically relevant. The authors concluded that pain and self-image tended to be statistically lower among cohorts with AIS but that only self-image was consistently different clinically between untreated patients with AIS and their unaffected peers.

Cosmetic complaints, though less common than functional concerns, affected a substantial percentage of our cohort. Waistline imbalance complaints were more common than rib prominence or scar-related complaints. The validity of patient-reported waistline imbalance is not known but may contribute to the SRS-22R outcomes in this cohort, particularly with regard to appearance scores. Respiratory symptoms, particularly those related to shortness of breath, were reported by 15% of patients. Respiratory symptoms may be in part secondary to underlying lung disease; smoking was reported by 21% of patients and asthma by 9%.

Few additional postoperative treatments were reported by patients. The most common treatment was regular use of NSAIDs (21%), followed by postoperative physical therapy (12%). Opiate medication use and spinal injections were rare—consistent with results reported by Danielsson and Nachemson[35] in 2003.

Implant-related complaints, including painful instrumentation (13%) and implant prominence (9%), were some of the most common complaints in our study group. Although not all symptomatic instrumentation required surgical revision, 7 (50%) of the 14 additional spine surgeries were related to painful and/or prominent posterior instrumentation. Additional spine surgery was reported in 11.9% of our patients. Other indications for reoperation were disc herniation, crankshaft phenomenon, nonunion, and adjacent-level degeneration. Our rate of revision surgery is supported by the literature. In 2009, Luhmann and colleagues[40] reported that 41 (3.9%) of 1057 primary spine fusions for idiopathic scoliosis required reoperation; the indications included infection (16/1057, 1.5%), pseudarthrosis (12, 1.1%), and painful/prominent implant (7, 0.7%). Richards and colleagues[41] similarly reported on 1046 patients who underwent fusion for AIS. Of these patients, 135 underwent 172 repeat surgical interventions (12.9% reoperation rate), with 29 (21.5%) of the 135 undergoing 2 or more separate procedures. The most common reasons for reoperation were infection, symptomatic implant, and pseudarthrosis. The authors concluded that repeat surgeries were relatively common after the initial surgical procedures. Having a clearer understanding of instrumentation-related complaints and reoperations may lead to improvement in this surgeon-controlled variable.

There are limitations to this study. The data regarding clinical courses were collected by retrospective chart review, which has known limitations. To offset this, we collected prospective outcome data with use of the SF-12, the SRS-22R, and a spine-related complaints questionnaire. No control group was available for comparison of outcomes in our cohort. We used the SF-12 and previously published normative values for the SRS-22R for comparison with population norms. Such comparisons have inherent limitations, as the groups vary by sex and mean age; our cohort was primarily female and more than a decade older than the controls.

Only 35% of the patients who met the inclusion criteria had complete data that could be included in our analysis. Although there was no statistically significant difference in demographics between patients with and without follow-up data available, this low response rate could have introduced selection bias. Ideally, patients should have been seen in clinic, standing radiographs should have been taken, and pulmonary function tests should have been performed. However, these patients were asymptomatic, and ethical and insurance issues prevented those actions. Thus, any radiographic changes occurring over the intervening years, from the last clinic visit to completion of the surveys, were not documented. This situation may or may not have limited our findings, as other authors have found low correlation between radiographic outcomes and clinical outcome measures.[13,14,19,36] During the period when these surgeries were performed, segmental spine instrumentation with hooks was the standard of care for deformity correction in AIS; therefore, all posterior instrumentations were done with hook-only segmental fixation. Current pedicle screw–based techniques that allow for additional correction of the deformity may provide different outcomes in the future.

We think that, despite the inherent limitations of this study, our data will be useful in the treatment of AIS. Our results suggest that postoperative spinal complaints are common and that, compared with an unaffected adolescent population, patients with AIS score significantly lower on pain and appearance domains of outcomes testing at a mean of 12.7 years after index fusion. Nevertheless, the outcomes do not seem to be of sufficient severity to affect general health and QOL as measured by outcomes testing.

Spinal deformity correction is performed to prevent impaired pulmonary function and spine-related disability later in life.[42,43] Thus, longer-term studies, involving patients in their fifth and sixth decades of life, are needed to determine whether patients with AIS will have QOL outcomes, pulmonary function, and spine-related problems similar to those in the general population. In this cohort of young adults, smoking status was the only predictor of HR-QOL measures, and spinal deformity correction did not lead to decreased HR-QOL.

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This paper will be judged for the Resident Writer's Award.