Differences in Clinical and Radiographic Outcomes in Adolescent Idiopathic Scoliosis Patients Undergoing Posterior Spinal Fusion with and without Corrective Rib Resectioning: A Retrospective Institutional Study

Brian Li[1], Sayyida Hasan[1], Katherine Eigo[1], Kyle Shutkind[1], Keshin Visahan[1], Victor Koltenyuk[1], Christian Athanasian[1], Jon-Paul Dimauro[1], Terry D. Amaral[1], Vishal Sarwahi[1]
[1]Northwell Health – Long Island Jewish Hospital, Department of Orthopedic Surgery, New Hyde Park, NY
bli5@northwell.edu

Disclosures: Brian Li (N), Sayyida Hasan (N), Katherine Eigo (N), Kyle Shutkind (N), Keshin Visahan (N), Victor Koltenyuk (N), Christian Athanasian (N), Jon-Paul Dimauro (N), Terry D. Amaral (N), Vishal Sarwahi (DePuy, A Johnson & Johnson Company – Personal Fees, Nuvasive – Personal Fees, Precision Spine – Personal Fees, Medical Devices Business Services – Personal Fees)

INTRODUCTION: Rib resectioning or thoracoplasty in patients with adolescent idiopathic scoliosis (AIS) undergoing posterior spinal fusion (PSF) surgery has been utilized to improve aesthetics of rib hump deformities resultant from the rotational nature of scoliosis. However, post-operative radiographic and clinical outcomes among patients undergoing rib resection compared to those not undergoing rib resection has not been explored extensively. The present study explores the impact of rib resectioning on imaging findings and treatment results of AIS patients undergoing PSF.

METHODS: AIS patients undergoing primary instrumentation and fusion between 2016 – 2021 at Cohen Children's Medical Center were included in our study, which has been approved by the Northwell institutional review board. Rib resectioning was conducted after spinal instrumentation. Clinical charts and operative reports were reviewed. Cases were stratified by rib resectioning status. Outcomes include estimated blood loss (EBL), surgery time, ambulation outcomes, complications, and length of stay (LOS). Pain scores were calculated from POD 0 to POD 10. Radiographic measurements such as Cobb angle, kyphosis, lordosis, and rib prominence were done. Rib prominence was measured using a lateral x-ray measuring from the edge of the most prominent rib to the posterior margin of its corresponding vertebral segment (major rib prominence); the same was done for the least prominent rib of the same vertebra (minor rib prominence). Rib difference was defined as the difference between the major rib prominence and minor rib prominence. It is a modification of the rib index originally proposed by T.B. Grivas (major rib prominence divided by the minor rib prominence) to quantify the extent of rib hump deformity. [1] Patient satisfaction ratings were collected utilizing SRS-22. Continuous variables were analyzed on Kruskal-Wallis tests, while categorical variables were analyzed using Chi-Square Tests.

RESULTS: 76 patients were included in the rib resectioning group; the control group consisted of 281 patients. The percentage of female patients in both rib-resectioning (59 [77.6%]) and control groups (198 [70.5%]) were similar (Table 3). Postoperative Cobb angle in rib-resected patients 21.3[17.1- 27.0] was similar to controls 19.0[14.7- 25.6] (p= 0.16) (Table 1). EBL in rib-resected patients (425[300-700] mL) was similar to controls (400[300-600] mL)(p= 0.23) (Table 2). Surgery time was similar in rib-resected patients (250.0[227.0- 284.0] minutes) to controls (270.0[224.0- 335.0] minutes) (p= 0.091) (Table 2). Maximum pain score at rest for rib-resected patients (6.5[4.0-8.0]) was significantly less than controls (8.0[5.0-9.0]]) (p= 0.017) (Table 2). LOS was similar in rib-resected patients (4.0[4.0-5.0] days) when compared to controls (4.0[3.0-5.0]] days) (p= 0.87) (Table 2). Rib-resected patients got out of bed (OOB) significantly later than control patients (p=0.047) (Table 2). The percentage of patients who presented with post-surgical complications within a 90-day timespan was similar in rib-resected patients (2 [3.3%]) compared to control patients (3 [2.4%]) (Table 2). Postoperative rib difference for rib-resected patients (17.8[12.0-22.9]) was significantly less than the control patients (29.5[19.2-36.0]) (p<0.001) (Table 1).

DISCUSSION: No differences were found between the two groups in terms of the EBL, LOS, postoperative Cobb angle, or surgery time. There were also no differences in self-reported SRS-22 results. Rib-resected patients took slightly longer on average to ambulate than control patients, but there was significantly higher self-reported pain by control patients during rest in the postoperative period. Rib-resected patients had a significantly smaller postoperative rib difference than the control patients, with the rib difference dropping by nearly half (31.9 to 17.8) from pre-op to post-op for the resection group with visible decreases in distance between the major and minor rib prominences radiographically. This suggests an increased degree of rib hump deformity correction in AIS patients who undergo rib resectioning. While more analysis remains to be done on the topic, we believe that rib resectioning is a viable option for improving corrective outcomes in patients undergoing posterior spinal fusion for AIS.

SIGNIFICANCE/CLINICAL RELEVANCE: This study offers valuable insight into the impact of rib resectioning in AIS patients undergoing posterior spinal fusion, revealing that although surgery time and other metrics were comparable to non-rib-resected controls, patients undergoing rib resection reported lower pain levels at rest and demonstrated significant radiographic improvements in rib hump deformity. Given its potential for enhancing aesthetic correction and reducing postoperative discomfort, rib resectioning may be a viable surgical option for optimizing patient experiences and cosmetic outcomes in AIS treatment.

SOURCES: 1. Grivas TB. Rib index. Scoliosis. 2014;9(1):20. Published 2014 Nov 20. doi:10.1186/s13013-014-0020-9

Table 1. Comparison of demographic and radiographic variables between AIS patients that underwent rib resectioning and those that did not. Data is presented as averages and 95% confidence intervals. Statistical values with p < 0.05 are considered statistically significant and bolded.

	Rib Resectioning (n = 76)	Standard (n = 281)	P
Age (years)	14.7 [13.0- 17.0]	15.1 [13.7- 16.5]	0.669
BMI (kg^2/m)	21.5 [19.4- 24.1]	20.8 [18.5-24.5]	0.50
Preop Cobb (°)	55.0[47.8- 63.8]	52.9 [45.0- 61.0]	0.173
Postop Cobb (°)	21.3[17.1- 27.0]	19.0[14.7- 25.6]	0.159
Pre Kyphosis (°)	32.0 [19.0- 44.0]	25.0[16.5-34.0]	**0.012**
Post Kyphosis (°)	29.7[24.8- 37.6]	22.6[15.6- 31.0]	**<0.001**
PreOp Rib Difference	31.9[21.5-43.5]	27.6[18.6-38.8]	0.053
PostOp Rib Difference	17.8[12.0-22.9]	29.5[19.2-36.0]	**<0.001**
Levels Fused	13.0[11.0-13.0]	13.0 [12.0-13.0]	0.533
Fixation Points	25.0[21.0-25.0]	25.0[22.0-26.0]	0.337

Table 3. Comparison of categorical variables between AIS patients that underwent rib resectioning and those that did not. Data is presented as frequency and percentage. Statistical values with p < 0.05 are considered statistically significant and bolded.

	Rib Resectioning (n = 76)	Standard (n = 281)	P
Female, n(%)	59 (77.6%)	198 (70.5%)	0.22
Transfusion, n(%)	16 (21.1%)	53 (18.9%)	0.67
90 Day Complications, n(%)	2 (3.3%)	3 (2.4%)	0.66

Table 2. Comparison of hospital course and surgical outcomes between AIS patients that underwent rib resectioning and those that did not. Pain scores are only calculated for the first three days (POD 0 – POD 2). Data is presented as averages and 95% confidence intervals. Statistical values with p < 0.05 are considered statistically significant and bolded.

	Rib Resectioning (n = 76)	Standard (n =281)	P
EBL (mL)	425[300-700]	400[300-600]	0.23
Surgery Time (mins)	250.0[227.0- 284.0]	270.0[224.0- 335.0]	0.091
Max Pain Score *At Activity*	5.0[3.0-8.0]	6.0[3.0-8.0]	0.447
Max Pain Score *At Rest*	6.5[4.0-8.0]	8.0[5.0-9.0]	**0.017**
OOB			**0.047**
POD 0	21 (27.6%)	69 (24.6%)	
POD 1	18 (23.7%)	51 (18.1%)	
POD 2	7 (9.2%)	57 (20.3%)	
POD 3	1 (2.0%)	6 (3.3%)	
POD 4	1 (2.0%)	1 (0.5%)	
POD 5	1 (2.0%)	0 (0%)	
LOS (days)	4.0[4.0-5.0]	4.0[3.0-5.0]	0.87