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Study of Post-operative Pulmonary Function in Adolescent Idiopathic Thoracic Scoliosis

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Abstract
Background*: The impact of deformity correction on lung function in adolescent idiopathic thoracic scoliosis is not much studied. Addition of thoracoplasty to the posterior spinal fusion is thought to have significant negative influence on the pulmonary function. We did a prospective study to evaluate the effect of posterior instrumentation and fusion on lungs.*
Material and methods: *Of 18 selected patients with posterior arthrodesis , thoracoplasty was also performed in nine patients. These patients were separately grouped to check any additional impact of thoracoplasty on lungs. Pulmonary function was evaluated by spirometry. Pre-operative and two year post-operative FVC,TLC and FEV_1 values were collected and compared.*
Result: *We could not find any statistically significant difference between these values in either of the group.*
Conclusion*: We conclude that deformity correction through posterior approach and thoracoplasty do not have any deleterious effect on lung function.*
Keywords: *Pulmonary function, thoracoplasty, idiopathic thoracic scoliosis*

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Introduction

Impairment of lung function in adolescent idiopathic thoracic scoliosis is documented in several studies.[1,2] The effect of posterior instrumentation and arthrodesis on ventilatory function in these patients is not well reported. The spinal deformity in scoliosis is sometimes associated with rib hump. Rib hump arises due to rotation of vertebrae with posterior crowding of ribs on convex side. This rib hump is the main cosmetic concern of patients in many cases of adolescent scoliosis. Rib hump may not be corrected by segmental spinal instrumentation in rigid curves.[3] Thoracoplasty is indicated in such cases in addition to surgical correction of deformity. But, lung function is presumed to decrease further with thoracoplasty as thoracic cage is disrupted. We did a prospective study of pre-operative and two year post-operative lung function in patients with idiopathic thoracic scoliosis. Patients in whom thoracoplasty was done were evaluated as a separate group to determine the additional negative impact of thoracoplasty on lungs.

II. Materials And Methods

Eighteen adolescent patients with idiopathic thoracic scoliosis who were operated in Nizam's Institute of Medical Sciences in 2006 and 2007 were taken into this study. Those who were followed up for at least two years were included. Patients who were lost to follow-up and patients with congenital, infantile, lumbar and other forms of scoliosis were excluded. The patients were divided into two groups based on the surgical procedure they underwent, as shown in Table 1.

Table 1: Division of patients into two groups

Group A	Posterior instrumentation (PI) + posterior spinal fusion (PSF)	9 patients
Group B	PI + PSF+ Thoracoplasty	9 patients

Thoracoplasty was done when flexibility of curve was less than 30^o, rib hump was more than 4 cm and axial trunk rotation was greater than 20^o. A mean of five ribs were resected. Group A consisted of three girls and six boys, with an average age of 17 years. In group B, five girls and four boys were present, with the same mean age of 17 years. The scoliotic curves were classified according to Lenke's, as shown in Table 2.

Table 2: Scoliotic curves according to Lenke's classification

Type of curve	Group A	Group B
Type 1	1	1
Type 2	1	0
Type 3	5	7
Type 6	2	1

Pulmonary function was assessed pre-operatively and post-operatively, with a dry rolling seal spirometer. Total lung capacity (TLC), forced vital capacity (FVC) and forced expiratory volume in one second (FEV_1) were taken as indicators of lung function. Percentage predictions as compared to age, sex and height matched normal population were calculated. Instead of the actual height of children with scoliosis, the corrected height was calculated from their arm span, using a formula devised by Kono et al.[4] This corrected height was used in choosing the control group for calculation of percentage predictions. The pre-operative and post-operative values of FVC, TLC and FEV_1 were compared. Both the absolute values and percentage predictions were used for comparison. Paired 't' test was done for groups A and B and Pearson correlation co-efficients were calculated. A 'p' value of less than 0.05 was taken as significant.

III. Results

The average values of pre-operative and post-operative scoliosis and kyphosis are shown in Table 3.

Table 3: Average pre-operative and post-operative scoliosis and kyphosis

	Group- A	Group-B
Mean pre-op scoliosis	79°	59°
Mean pre-op kyphosis	47°	38°
Mean post-op scoliosis	47°	22°
Mean post-op kyphosis	31°	39°
Correction of scoliosis	40.50%	62.71%

The pre-operative and post-operative absolute values of FVC,TLC and FEV_1 are summarized in Table 4.

Table 4: Comparison of pre-operative and post-operative absolute values of lung function

	FVC (L) pre-op	**FVC (L) post-op**	**FEV1 (L) pre-op**	**FEV1 (L) post-op**	**TLC (L) pre-op**	**TLC (L) post-op**
Group-A						
Average	1.76	1.56	1.69	1.51	2.09	1.82
Standard deviation	0.59	0.56	0.5	0.5	0.71	0.74
Range	1.16-2.68	0.87-2.67	1.05-2.55	0.82-2.46	1.34-3.17	1.03-3.26
***P* value**	**0.13**		**0.1595**		**0.1495**	
Group-B						
Average	1.89	1.83	1.79	1.62	2.18	2.16
Standard deviation	0.69	0.5	0.6	0.5	0.96	0.62
Range	1.17-3.45	1.19-2.68	1.16-3.1	1.13-2.64	1.32-4.34	1.4-3.14
***P* value**	**0.7045**		**0.8055**		**0.3723**	

The pre-operative and post-operative percentage predictions of FVC,TLC and FEV_1 are shown in Table 5.

Table 5: Comparison of pre-operative and post-operative percentage predictions of lung function

FVC(%)	**FVC(%)**	**FEV1(%)**	**FEV1(%)**	**TLC(%)**	**TLC(%)**	
Pre op	Post.op	Pre op	Post.op	Pre op	Post.op	
57.42	60	53.57	49	56.9	62	
79	79	79	84	79	75	
100.8	59	94.44	62	94.3	54	
95.39	81	106.63	86	81	69	
86	68	84	83	82	58	
86.71	135	60.61	80	70	116	
78.82	75	75.47	82	76.1	63	
57.2	44	58.45	48	54.3	41	
53.61	52	54.83	55	49.2	67	
77.21	**72.6**	**74.1**	**69.9**	**71.4**	**67**	
0.576		**0.434**		**0.401**		

Pre op	Post.op	Pre op	Post.op	Pre op	Post.op
102.5	102	95.67	99	117	92
113.5	104	127.87	111	124	93
117.7	89	98.41	83	114	89
56.25	74	65.76	80	48.5	67
66.67	80	75	85	56.6	72
56.25	85	65.76	88	48.5	76
86	45	84	47	82	42
87.09	69	92.52	73	76.4	60
48.55	50	61.05	62	39.8	43
81	**77.6**	**85**	**81**	**78.5**	**70**
0.605		**0.526**		**0.353**	

Comparison of absolute values and percentage predictions showed that there was no statistically significant difference in pre-operative and post-operative lung function in both the groups.

IV. Discussion

Satoru Demura et al reviewed multicenter database of 154 patients with adolescent idiopathic scoliosis who underwent posterior instrumented spinal fusion.[5] At two year follow up, improvement in absolute values of FVC,TLC and $FEV_1$was noted, however percentage predicted values remained unchanged. Sixty patients who underwent PSF and thoracoplasty were evaluated for pulmonary function two years after surgery by Zhicai Shi et al.[6] They concluded that both absolute values and percentage predictions remained constant, without any improvement or worsening. Respiratory function evaluation at five year follow up in 40 patients was done by Greggi et al.[7] They reported that pulmonary function improved in patients with PSF alone, and remained same at pre-operative values in thoracoplasty patients. Vedantam et al studied pre-operative and post-operative lung function at two year follow-up in 98 patients.[8] They concluded that absolute values of FVC,TLC and FEV_1 were increased in patients with PSF and remained constant in patient with PSF and thoracoplasty. Percentage predictions were not compared in this study. Kim et al evaluated pre-operative and post-operative FVC and FEV_1 at five year follow-up in 49 patients with posterior instrumentation and posterior spinal fusion (group 1) and in 41 patients with PSF+ thoracoplasty (group 2) and in 16 patients with anterior spinal fusion (group 3). [9]In group 1, absolute values were increased, but percentage predictions remained the same. In groups 2 and 3, absolute values showed no change, but percentage predictions were diminished. Twentypatients who underwent PSF+ thoracoplasty or ASF were studied by Chen et al.[10] They found that percentage predictions of pulmonary function were similar to pre-operative values in thoracoplasty patients, but were diminished in patients with ASF at two year follow up. Kumano et al demonstrated improvement of respiratory function in 20 patients with PSF after more than two years of follow-up.[11] But they also reported that this improvement was not seen in patients in whom ASF was done. Hasan-Allah Sadeghi et al studied post-operative pulmonary function in 18 patients, in whom ASF was done in 16 patients. [12] At three year follow-up, they observed that absolute values of FVC and FEV_1 remained similar as that of pre-operative values, while percentage predictions declined.

In all these studies including ours, lung function was evaluated by means of absolute values of FVC etc (in liters) and percentage predictions. Since lungs undergo natural growth during the adolescent age, improvement in absolute values cannot be attributed solely to the deformity correction. But this age related growth can be offset when percentage predictions are compared. Hence percentage predictions are more indicative of the effect of surgery on lung function than absolute values of FVC etc. Summary of discussion is shown in Table 6. Only studies showing percentage predictions were taken into consideration.

Table 6: Changes in pulmonary function at two or more years of follow-up.

	No. of studies showing improvement of lung function	No. of studies showing no change	No. of studies showing deterioration
PSF	2 {7,11[#]}	4[*] {5,6,9[#]}	0
PSF+thoracoplasty	0	4[*]{6,7,10}	1 {9}
ASF	0	1 {11}	3 {9,10,12}

[*] our study was included in this group.
[#] Reference numbers

V. Conclusion

In our series, pulmonary function was not significantly affected with surgery. Thoracoplasty did not have any independent adverse effect on pulmonary function. Hence it is a safe procedure which can be considered along with posterior spinal arthrodesis to improve cosmesis, where rib hump is the main concern.

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