

# Effect of Surgical Correction of Pectus Excavatum on Pulmonary Function Tests

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## ABSTRACT

**Background:** Funnel chest or trichterbrust are the alternative names of Pectus excavatum, has been reported as chest wall deformity and common by far the most. In general, pectus excavatum does not have any physiologic effect on the individual, although some children may complain of pain in the area of sternum or costal cartilages especially with vigorous exercise.

**Aim:** To observe the effect of surgical correction of Pectus excavatum and to observe the effect of Ravitch's repair along with the use of metallic strut on Pulmonary Function Tests.

**Methods:** This is a prospective interventional study. This study was undertaken at the Department of Thoracic Surgery, King Edward Medical University/Mayo Hospital Lahore between June 2011 and June 2016. A total of 22 patients, 17 males and 05 females were registered in this study. Patients were evaluated clinically and history was taken on a pre-defined questionnaire.

**Results:** No significance was found ( $p$  value  $\geq 0.05$ ) in parameters before or after procedure, however paired t-test shows significant difference ( $p$  value  $\leq 0.05$ ). Mean FVC before & after surgery was  $2.89 \pm 0.81$  &  $3.12 \pm 0.88$ . Mean FEV1 before & after surgery was  $2.43 \pm 0.67$  &  $2.67 \pm 0.73$ . Mean FEF 25-75% before & after surgery was  $2.77 \pm 0.62$  &  $3.17 \pm 0.71$ . Significant improvement in FVC, FEV1 & FEF25-75% was observed after surgery.

**Conclusion:** The afore-mentioned results demonstrate that patients from ages 10 to 20 years having PE can benefit significantly from surgical correction in terms of improvement in pulmonary functions.

**Keywords:** Pectus excavatum, Pectus carinatum, FVC, FEV, FEF.

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## INTRODUCTION

Funnel chest or trichterbrust are the alternative names of Pectus excavatum (PE), has been reported as chest wall deformity and common by far the most. Prevalence of disease is high among white male children at their birth and problem is face by 1 of every 400 newborn<sup>1</sup>. Pectus carinatum (PC), remains the subsequent most communal chest wall abnormality, however five times fewer communal compared to PE<sup>2</sup>. Posterior depression of costal cartilages and sternum produces the characteristic findings of PE. Primary and second ribs and the manubrium remain in their normal position most of the time, however body of the sternum and lower cartilages remained depressed. In elder adolescents and young, the most anterior part of osseous ribs may also be curved posteriorly. Asymmetry of despair is frequently present. Often the right hand side is more depressed compared to left, and the sternum maybe rotated as well.

Severity of PE can be quantified using various techniques. Most of the techniques measure the distance of sternum from the spine usually. Though the most common technique to be used is that of Haller et al<sup>3</sup>; this techniques utilizes the ration of

antero-posterior and transverse distances derived from CT scans of chest. In this system severity of disease that needs surgery is associated with score of  $\geq 3.25$ .

Pectus excavatum usually present since birth or appears during first year of life in most (86%) of the effected children. The deformity infrequently resolves with growing and may deteriorate through the time of swift youth development. Pectus excavatum is associated with 21% of scoliosis patients, while eleven percent of such patients also have the family history of scoliosis<sup>4</sup>. Existence of PE along involvement of other disorders of musculoskeletal, like Marfan's syndrome, suggests involvement of connective tissue abnormality. Additionally about 40% of subjects having PE also have family history, suggests possibility of genetic predisposition<sup>5</sup>. Pectus excavatum is commonly present in males compared to females, presenting male to female ratio of 6:1. Pectus excavatum may also be associated with underlying congenital disorders, together with disorders of diaphragm. In about 2% of PE patients congenital heart anomalies also associated. Marfan's Syndrome should be taken in account among patients with characteristics body habitus. In general, PE does not have any physiologic effect on the individual, although some children may complain of discomfort in area around sternum or costal cartilages particularly with vigorous exercise.

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Asthma may be identified in subjects with Pectus excavatum and carinatum. In a review of 694 consecutive cases, Shamberger and Welch<sup>6</sup> found a subgroup of 35 patients with asthma (5.2%), which is comparable with the occurrence of asthma in the general pediatric population. Though discriminating a precise physiologic significance of PE is tough, numerous operating signals are renowned. A depressed look of the chest wall has remained related with deprived self-perception in kids, particularly as they meet adult age; main signal is presently psychosocial<sup>7</sup>. Development of the presence of the chest wall after restoration recovers socialization<sup>7</sup>. In reasonable sports persons, in whom a small reduction in body building forbearance can damage their concert, surgeons can too select to overhaul the PE. Archaeologically, reports of consequences and patient gratification next to the Ravitch's overhaul and his alternatives must remain outstanding. In numerous huge sequences, acceptable outcomes were described in further 90% of patients with a metallic support in the overhaul<sup>8</sup>.

There are infrequent (8%) impediments of an open repair PE<sup>9</sup>. The utmost problem is pneumothorax. This may be smack and can be observed easily. Aspiration of air is usually required for bigger pneumothoraces. Pericardial effusion, wound infection and pericarditis may also present in rare cases. In a serial study on 320 PE patients who were corrected using modified Ravitch's repair method, only 3 subjects showed mild reoccurrence<sup>10</sup>. A minor cartilage resection was required for these patients while no death was reported in this study.

Another common and serious problem of classic Ravitch's repair remained reduced growth of the chest. In an older report of Haller et al on a series of 12 patients established thoracic dystrophy after PE repair<sup>11</sup>. Among all the studies, repair was executed in kids of less than four years, while children above 5 years were resected. All these patients were suffering from severe exercise intolerance with great reduction in pulmonary function clinically.

Present study was done to observe the effect of surgical correction of PE on pulmonary Function Tests and to observe the effect of Ravitch's repair along with use of metallic strut on Pulmonary Function Tests in patients with PE.

## PATIENTS AND METHODS

This is a prospective interventional study. This study was undertaken at the Department of Thoracic Surgery, King Edward Medical University/Mayo Hospital Lahore between June 2011 and June 2016. A total of 22 patients, 17 males and 05 females were registered in this study. Patients were evaluated clinically and history was taken on a pre-defined questionnaire.

Only patients with isolated respiratory symptoms with deranged PFT's were included in this study. Patients having associated syndromes, with extrapulmonary manifestations or those coming solely for cosmetic reasons were excluded from this study. Patients presenting in the Outpatients Department of Mayo Hospital, Lahore were admitted in the Department of Thoracic Surgery. The deformity was corrected by resection of sub-perichondrial costal cartilages, sternal osteotomy and placement of Abraham bar underneath the sternum. PFT's were obtained preoperatively as well as 12 months after surgery.

The data was entered and analyzed by using SPSS V.20.0. Mean  $\pm$  SD was used to present quantitative variables while frequency and percentages were used for presentation of qualitative variables. Paired sample t-test was used to see the difference in PFTs before & after the procedure. p-value  $\leq$  0.5 would be taken as significant.

## RESULTS

Table 1 shows mean values of Forced Vital Capacity (FVC), Forced Expiratory Volume (FEV) in the first, second and Forced expiratory Flow (FEF) before and after procedure in various parameters. No significance was found (p value  $\geq$  0.05) in parameters before or after procedure, however paired t-test shows significant difference (p value  $\leq$  0.05). Mean FVC before & after surgery was  $2.89 \pm 0.81$  &  $3.12 \pm 0.88$ . Mean FEV1 before & after surgery was  $2.43 \pm 0.67$  &  $2.67 \pm 0.73$ . Mean FEF 25-75% before & after surgery was  $2.77 \pm 0.62$  &  $3.17 \pm 0.71$ . Significant improvement in FVC, FEV1 & FEF25-75% was observed after surgery.

Table 1: Comparison of Mean  $\pm$  SD of FVC, FEV1 and FEF<sub>25-75%</sub> before and after procedure

	FVC		FEV1		FEF <sub>25-75%</sub>	
	Before	After	Before	After	Before	After
N	22	22	22	22	22	22
Normal parameters Mean	2.89	3.12	2.43	2.67	2.77	3.17
Normal Parameters SD	0.81	0.88	0.67	0.73	0.62	0.71
Kolmogorov-Smirnov Z	0.816	0.877	1.238	1.191	0.675	0.633
p-value	0.518	0.425	0.093	0.117	0.752	0.818
Paired Sample t-test (p-value)	-12.05(0.000)		-17.93(0.000)		-20.85(0.000)	

## DISCUSSION

PE remained foremost commonly encountered congenital thoracic defect which has the tendency to worsen with growth during the adolescent period. Whether this deformity causes significant abnormalities in cardiopulmonary function remains uncertain although many reports on pulmonary and cardiac function are performed in laboratory<sup>12,13</sup>. Many authors have elaborated decreases in pulmonary functions (primarily vital capacity and airflow rates) amongst subjects suffering from PE though results mostly fell in normal ranges<sup>14-17</sup>.

This study establishes the effect of surgical correction by Ravitch's procedure with bar placement of PE on pulmonary functions. We focused on the three most commonly affected parameters of pulmonary functions in patients with PE, namely, FVC, FEV1 in first and second and FEF25-75%.

Our results confirmed significant developments statistically in all of these parameters after surgical correction. Mean FVC improved by almost 7% from 2.89±0.81 preoperatively to 3.12±0.88 postoperatively (p-value 0.000). Mean FEV1 improved by 9.8% from 2.43±0.67 preoperatively to 2.67±0.73 (p-value 0.000). Mean FEF25-75% improved by 14% from 2.77±0.62 preoperatively to 3.17±0.71 postoperatively (p-value 0.000). These results were comparable to another study by M. Louise Lawson et al<sup>18</sup> in which similar improvements were noted in the same parameters after surgical correction of PE by Nuss procedure, after bar removal (patients older than 11 years showing 6% enhancement in FVC, 9% development in FEV1 and 15% betterment in FEF25-75% as a percentage of foreseen, all p<0.05).

## CONCLUSION

The afore-mentioned results demonstrate that patients between ages 10 and 20 years having PE can benefit significantly from surgical correction in terms of improvement in pulmonary functions.

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