e-ISSN: 0976-822X, p-ISSN:2961-6042

Available online on http://www.ijcpr.com/

International Journal of Current Pharmaceutical Review and Research 2025; 17(8); 1172-1183

Original Research Article

Study of Intermediate Term Outcome in Children after Thoracic Surgery

M. N. Praveen Raju[1], Sanjay Rao[2], Anil Sapare[3], Ashley D. Cruz[4]

[1]Consultant Pediatric surgeon, Assistant Professor, Department of General Surgery, BGS Medical College and Hospital, Dasanapura, Nagarur village, Bangalore - 562123

[2]Senior Pediatric Surgeon, Narayana Health, Mazumdar Shaw Medical Centre, Bommasandra, Anekal taluk, Bangalore- 560099

[3]Senior Pediatrics Pulmonologist, Department of Pediatrics, Mazumdar Shaw Medical Centre, Narayana Health, Bommasandra, Bangalore-560099

[4]Senior Consultant, Department of Pediatric Surgery and Urology, Narayana Health, Bommasandra, Bangalore-560099

Received: 23-06-2025 / Revised: 22-07-2025 / Accepted: 23-08-2025

Corresponding Author: M. N. Praveen Raju

Conflict of interest: Nil

Abstract:

Introduction: Thoracotomy is a commonly performed procedure surgical procedure in infants and children. The thoracotomy incision may result in long-term physical impairment and deformity. Altered pulmonary function is the main factor influencing morbidity and mortality in thoracic surgery. The normal pulmonary function is dependent on an intact thoracic cage, normal pleural cavity, and healthy lung parenchyma.

Aims and Objectives: To study the midterm outcomes after Thoracotomy and Thoracoscopy in children. (1) Changes in pulmonary function. (2) Cosmesis of scar. (3) Effect of surgery on the spine.

Place of Study: Narayana Hrudayalaya Hospitals, Bangalore.

Duration of Study: 3 years (1/9/2012 to 31/08/2015).

Type of Study: Prospective and observational study of a cohort of patients undergoing thoracic surgery

Sample Size: 45 **(**Thoracotomy + VATS).

Result: The mean age at surgery was 6 years, range between 1 day and 17 years. 55.55% (25) were Male and 44.45 % (20) were Female.

Discussion: In this study, out of 76 patients who underwent thoracic surgery, 45 came for follow up. Patient details were entered and analysed. The mean age of patients was 6 years. Total numbers of Male were 25, Female 20.

Keywords: Optimal Access, Mastectomies, Parenchyma, Pulmonary Function, Thoracotomy, VATS.

Introduction

Thoracotomy is a commonly performed procedure surgical procedure in infants and children. It provides excellent access and exposure to the thoracic viscera. Thoracotomy approach often results in division of muscles (latissimus-dorsi and serratus anterior muscles) and separation of ribs. Division of these muscles and ribs can result in significant post-operative pain and diminished pulmonary function [1].

The thoracotomy incision may result in long-term physical impairment and deformity [2]. Altered pulmonary function is the main factor influencing morbidity and mortality in thoracic surgery.

The function is decreased in the immediate post-operative period. Over the long term, the pulmonary function is the contribution of parenchyma, muscles, and diaphragm. Any insult which will affect this will cause decreased functional capacity [3, 4, 5].

Scoliosis may occur after thoracotomy but is more common and severe in patients with associated vertebral anomalies [5]. Though the degree of scoliosis found is not significant to warrant intervention, regular monitoring is important.

To prevent the morbidity associated with thoracotomy various modifications have been tried, thoracosopy, muscle sparing, mini-thoracotomy and thoracotomy along the axillary skin crease are a few modifications [6].

Thoracoscopy is a minimally invasive procedure. It is routinely used for lobectomies, mastectomies, and EA repairs. It offers the advantage of less pain and better cosmesis [6].

Most open thoracic surgery operation is performed through a lateral thoracotomy. The purpose of approaches is to provide optimal access, adequate exposure of viscera requiring surgical attention. Potential for complication and morbidity after large thoracotomy incisions have encouraged the development of VATS.

Aims and Objectives

- To study the midterm outcomes after Thoracotomy and Thoracoscopy in children
  1. Changes in pulmonary function
  2. Cosmesis of scar
  3. Effect of surgery on the spine

Material and Methods

Place of Study: Narayana Hrudayalaya Hospitals, Bangalore.

Duration of study: 3 years (1/9/2012 to 31/08/2015).

Type of study: Prospective and observational study of a cohort of patients undergoing thoracic surgery

Sample size: 45 **(**Thoracotomy + VATS).

Source of data: Continually updated prospective database of children who underwent thoracic surgery in our institute

Inclusion Criteria

Patients were included if they met all the following criteria

1. <18 years of age
2. Had undergone thoracic surgery
3. Have had at least 1-year follow-up after their thoracic surgery

Exclusion Criteria

1. Patients with congenital heart disease, as it will affect the physiology of exercise stress test

Methodology

Patients who had undergone thoracic surgery (Thoracotomy and VATS) were included in the study. Prospective patient data was maintained in an excel sheet. Patients who had finished at least 1 year of follow-up were included in the study. They were invited for follow-up.

Each patient was subjected to PFT, six-minute walk test, the clinical exam for scar assessment and x-ray chest.

Pulmonary function test was performed in children more than 6 years of age. At rest, each patient was asked to blow into the PFT machine.

FEV1/FVC of <70% predicted was taken as obstruction

FVC and FEV1 <80% of predicted with normal FEV1% was taken as restrictive.

The PFT machine used was Easy One spirometer, manufactured by Medizinetechnik, AG, Zurich, Switzerland as shown below.

Figure 1: Spirometer

Statistical analysis: The data collated was entered in an excel sheet. Data analysis was done by statistician with the help of computer using SPSS statistical package- Version 17.

Using this software, range, means, and standard deviation was calculated for quantitative variables like age, duration of follow-up. Frequencies and percentages were calculated for qualitative variables like sex, diagnosis, surgery was done etc. Chi-square, 't' value and 'p' values were calculated. ANOVA and Student 't'test were used to test the significance of a difference between quantitative variables and Yate's and Fisher's chi-square tests for qualitative variables. A 'p' value less than 0.05 denote significant relationship

Results

Profile of Cases Studied: Of 76 eligible children, data was available for 45. This cohort of 45 formed the basis of analysis.

Table 1: Age Distribution at the time of follow-up

Age Group (Years)	Cases	
	No	%
0-5	27	60
6-10	5	11
11-15	11	24
>15	2	5
Total	45	100.0
Range Mean Median S.D.	1-18 Years 6 Years 8 Years 5.23	

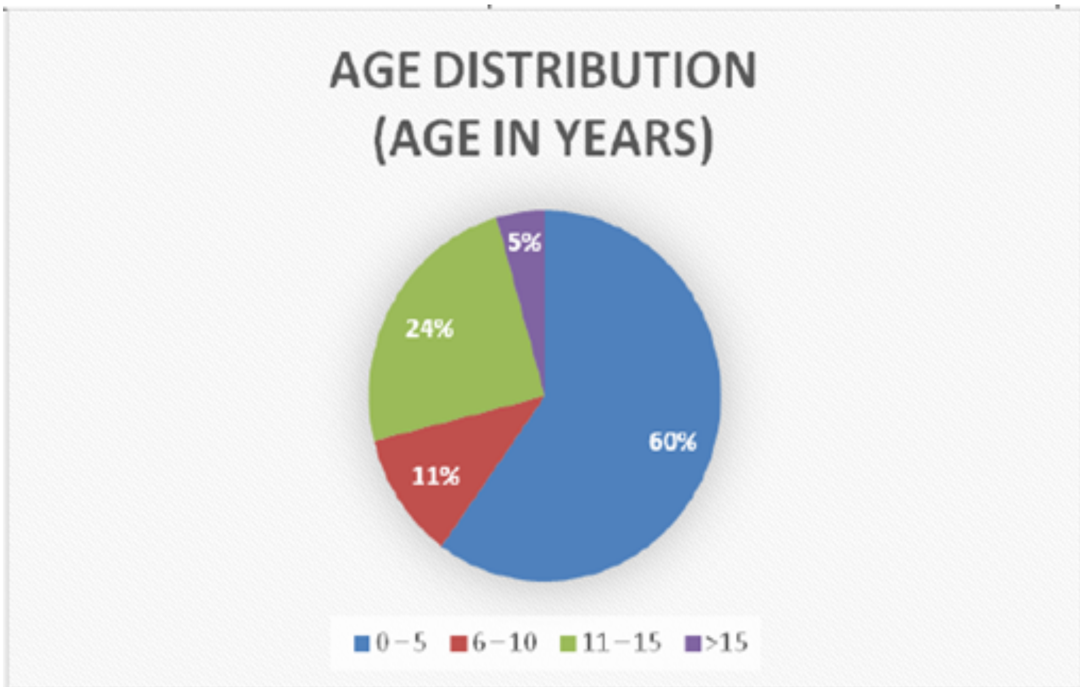

Chart 1: Pie chart showing age distribution at follow up

Sex Distribution: Out of 45 patients, 25 were boys and 20 were girls.

Table 2: Sex Distribution

Sex	Cases	
	No	%
Male	25	55
Female	20	45
Total	45	100.0

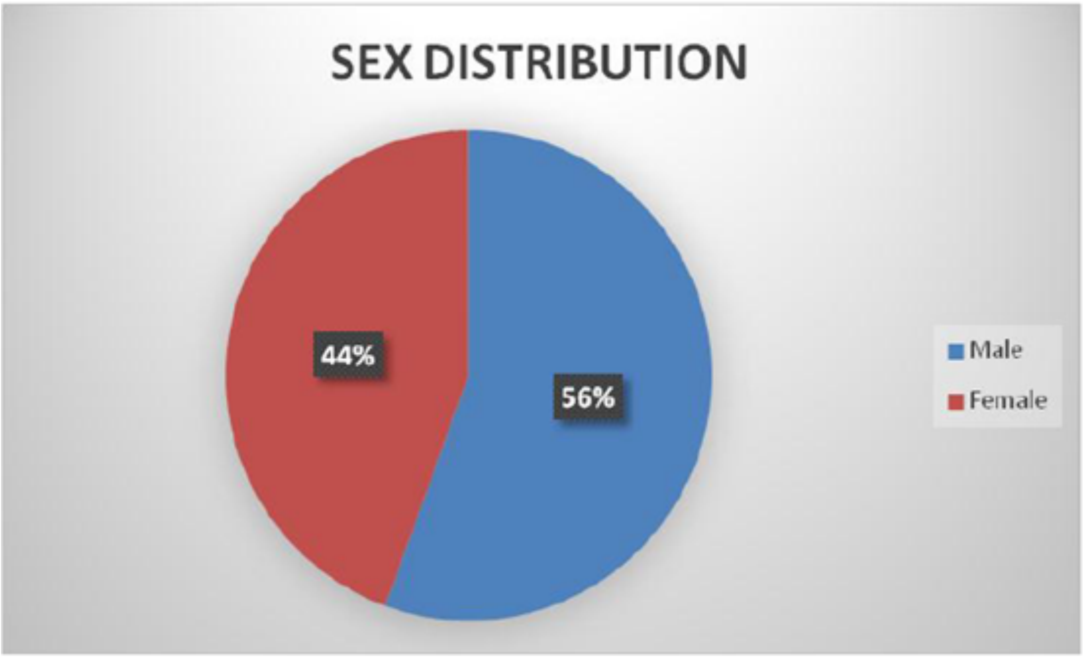

Chart 2: Pie chart showing distribution of sex in study population Sex Cases No % Male 25 55. Female 20 45 Total 45 100.0

Diagnosis: Diagnosis was divided into congenital, infections, malignancy and acquired conditions. Empyema was the commonest diagnosis (35.6%). Others were Hydatid, TEF, CCAM, mediastinal masses, emphysema, and eventration.

Table 3: Diagnosis in the study population

Diagnosis	Cases	
	No	%
Congenital	**17**	**38**
Infections	**18**	**40**
Malignancy	**05**	**11**
Acquired	**05**	**11**
Total	**45**	**100**

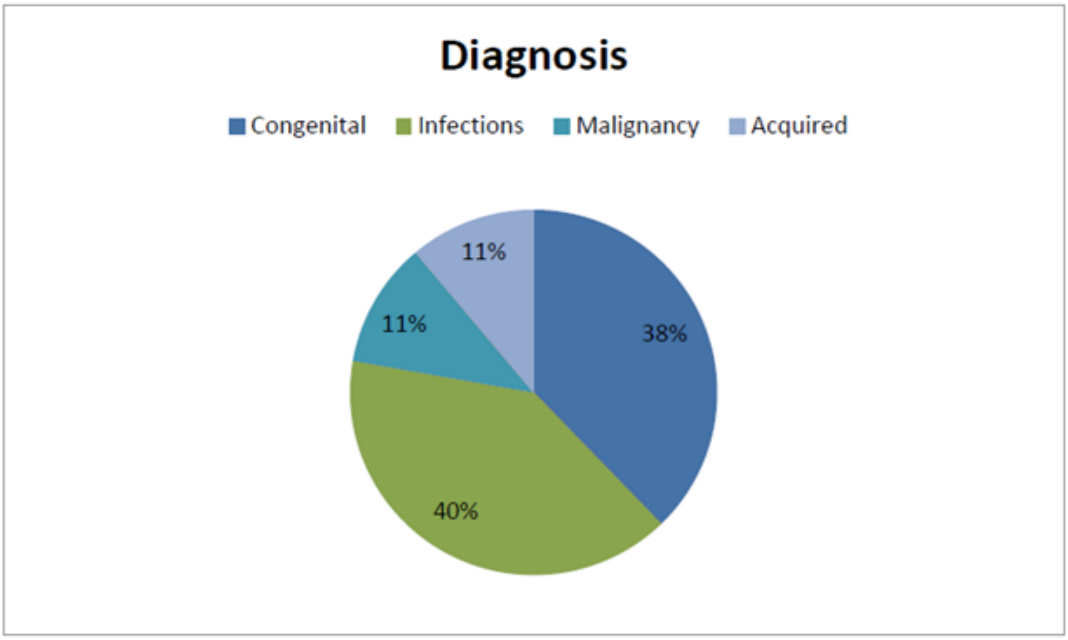

Chart 3: Pie chart showing the various diagnosis in the study population

Table 4: Diagnosis in the study population as per etiology

Diagnosis	Cases	
	No	%
TEF	7	16
CCAM	5	11
Eventration	1	2
Left upper lobe CLE	1	2
Sequestration	1	2
Empyema	16	36
Pulmonary Hydatid	4	9
Bronchiectasis	1	2
Lymphangioma	1	2
Thymoma	1	2
PNET	1	2
Teratoma	3	7
Esophageal Perforation	1	2
Esophageal stricture	1	2
Pneumatocele	1	2
Total	45	100.0

Age at Surgery: These cohorts of children were seen at follow up. The difference in age at surgery and age at follow up was noted. The duration of follow up was at least 1 year. The mean age at surgery was 6 years, range 1 day to 17 years. The mean age at follow-up was 8.78 years.

Table 5: Age at surgery

Parameter	Age (Years) at Surgery
Range	1 days- 17
Mean	6
S.D.	4.3

Surgery: Thoracotomy and VATS: A total 32 thoracotomies and 13 thoracoscopies were done. Thoracotomy formed the bigger group of patients.

Table 6: Surgery- VATS and Thoracotomy

Surgery done	Cases	
	No	%
Video-Assisted Thoracoscopic Surgery	13	30
Thoracotomy	32	70
Total	45	100.0

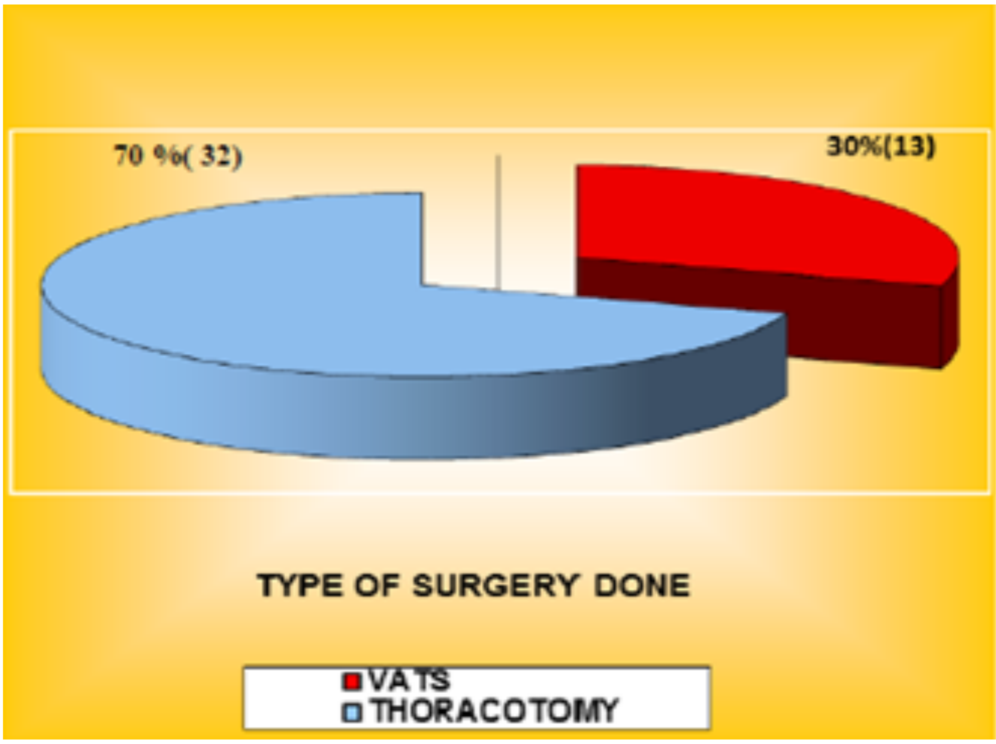

Chart 4: Pie chart showing distribution of VATS and thoracotomy

Pulmonary function test: The PFT were carried out in 26 out of 45 patients.13 children were found to have restriction and 13 children normal pulmonary function tests. No obstructive pattern was found on PFT's.

Table 7: Results of Pulmonary Function Test

Pulmonary Function Test	Cases	
	No	%
Normal	13	50
Restrictive	13	50
Total	26*	100.0

*For 19 cases PFT not done

PFT was not carried out in 19 children. As per the study protocol children less than 6 years could not follow the instruction for performing pulmonary function test.

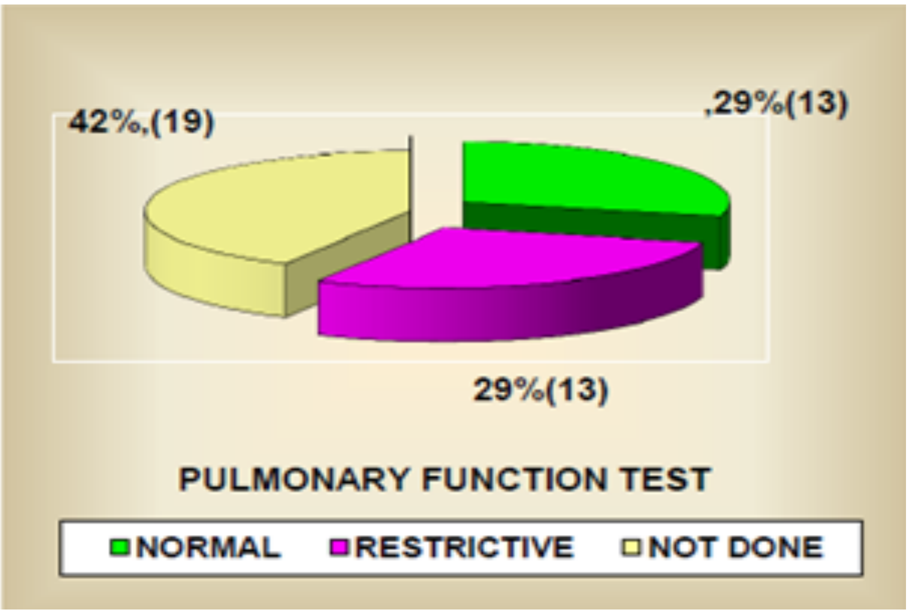

Chart 5: Pie chart showing distribution of results of pulmonary function test

Scar Assessment: The scar score ranged from 0 to 8, mean scar score was 3.69. A lower scar score indicates a more acceptable and finer scar.

Table 8: Scar Assessment Score

Scar Assessment Score	Cases	
	No.	%
0	1	2
1	6	13
2	8	18
3	5	11
4	9	20
5	9	20
6	2	4
7	4	9
8	1	2
Total	45	100.0
Range Mean S.D.	0-8 3.69 1.98	

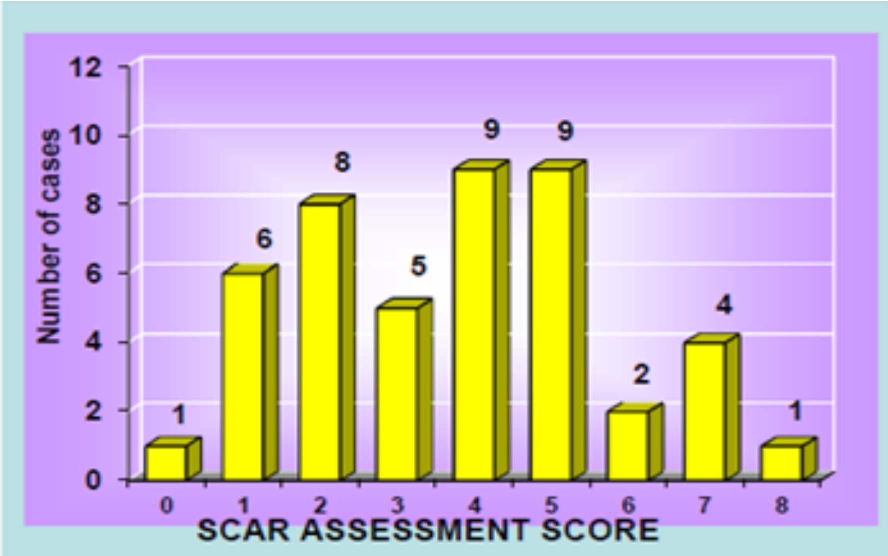

Chart 6: Bar graph showing scar assessment score in the study population

Type of surgery and Scar assessment score: The mean scar score of thoracotomies was significantly higher than VATS. Lesser score was indicative of better cosmesis. The range of scar score was higher in thoracotomy. The mean score was 4.19 in thoracotomy group and 2.46 in VATS group. The thoracotomy group had higher scar scores.

Table 9: Type of surgery and Scar assessment score

Type of Surgery	Scar Assessment Score		
	Mean	S.D.	Range
VATS	2.46	1.51	0-4
Thoracotomy	4.19	1.94	1-8
'P'	0.0064 (Significant)		

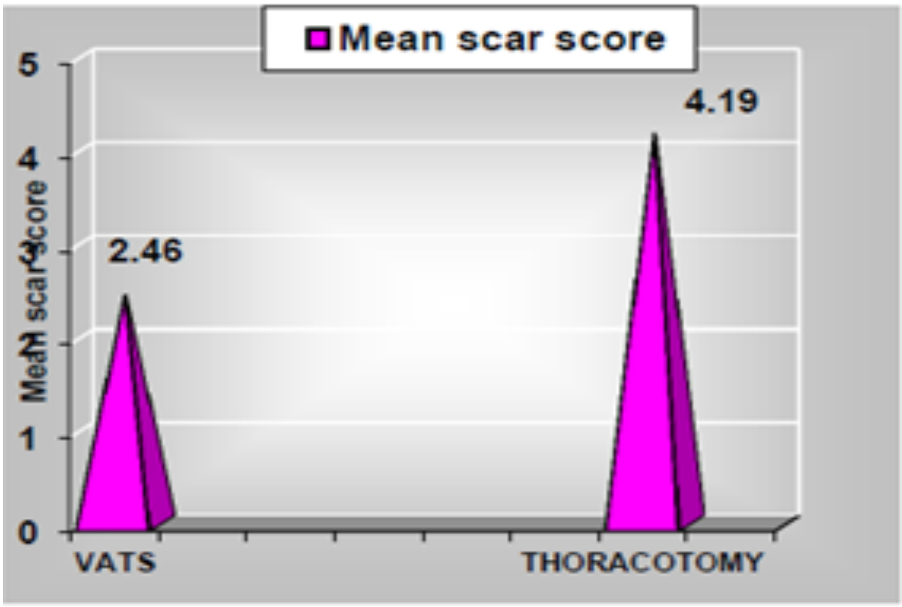

Chart 7: Bar graph showing Scar score in VATS and thoracotomy
X axis- VATS and thoracotomy
Y axis- mean scar score

Age and Scoliosis: The mean Cobb's angle was seen to be more in older patients. There was the significant difference in scoliosis score as the patient's age increased. The younger patients had mean angle which was lesser compared to older children. Higher degree was seen in children treated for infectious disease like empyema, Hydatid, and mediastinal tumors. Children more than 12 years had higher degree of Cobb's compared to children less than 12 years. This could be because older children are in adolescent age group, with less pliability of ribs and spine. The pathology also could add to scoliosis. Infectious disease scores were higher.

Table 10: Multivariate analysis of Age and Scoliosis in VATS and thoracotomy

Age at follow up	Scoliosis (degrees)	
	Mean	S.D.
Up to 1 Yr	1.17	2.37
2-5 Yrs	1.07	2.02
6-10 Yrs	4.0	3.0
11-15 Yrs	4.91	1.76
Above 15 Yrs	4.5	2.12
'P'	0.0002 (Significant)	

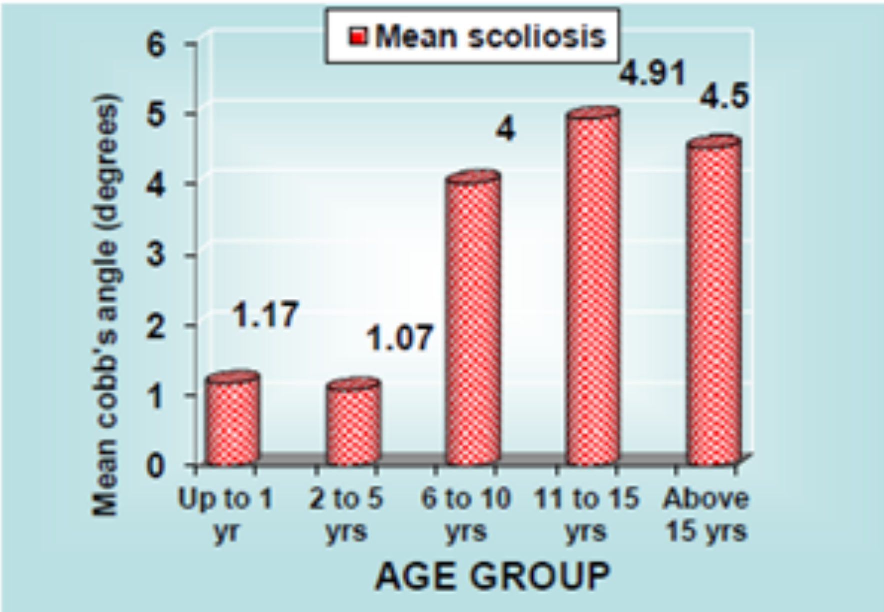

Chart 8: Bar Graph Depicting Mean Cobb's Angle and Age Group.

Side of Surgery & Scoliosis

The mean Cobb angle was more on right side compared to left. There were also more cases of right side operated children.

Table 11: Side of Surgery & Scoliosis

Side of Surgery	Scoliosis (Degrees)	
	Mean	S.D.
Right	2.93	2.69
Left	1.89	2.72
'P'	0.2138 (Not Significant)	

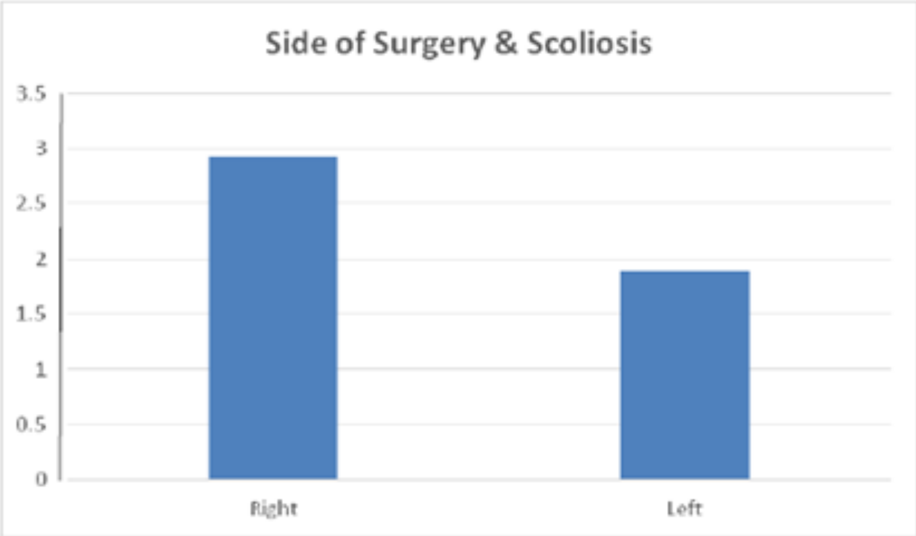

Chart 9: Bar graph showing degree of scoliosis in children operated on right side and left side
X axis-side of surgery
Y axis- Cobb's angle

Discussion

In this study, out of 76 patients who underwent thoracic surgery, 45 came for follow up. Patient details were entered and analysed. The mean age of patients was 6 years. Total numbers of boys were 25, girls 20. The most common diagnosis was empyema, followed by TEF. The mean duration of follow-up after the procedure was 2.85 years. Of 45 procedures, 32 were thoracotomy and 13 VATS. 27 were done on the right side and 13 on the left side.

We set out to see the consequences of thoracotomy on pulmonary function, scoliosis, and scar. At follow-up, 13 children had a restrictive pattern and 13 children had a normal pulmonary function. Six-minute walk test was used as exercise stress test and was normal in all the subjects more than 6 years .Scoliosis was found to be of lesser degree on Cobb's angle. But the degree of scoliosis was more in older age group (11-15 years). The scar score of thoracotomies was significantly more than VATS.

Conclusion

1. Patients undergoing thoracic surgery were studied prospectively.
2. They were followed up after minimum 1 year from the time of surgery. They were assessed for intermediate term outcome after looking at following parameters. Pulmonary function test, six-minute walk test, scoliosis using Cobb 'angle and scar using Vancouver scar scale.
3. The pulmonary function and exercise tolerance was found to be comparable in thoracotomy group and VATS group. All the children in both the groups had no exercise intolerance on six-minute test. The pulmonary function tests indicated normal or minimal restriction. Thoracotomy or VATS did not affect the pulmonary growth or reserve to cause restriction in activity.
4. The degree of Cobb's angle was less than 10 degrees, which was defined as not significant. On followup, children older than 12 years were found to have higher degree of Cobb's angle. Pathology did not have effect on development of scoliosis. Maybe in the adolescent period, the degree of scoliosis increases. But does not necessitate intervention as the pulmonary reserve and exercise tolerance is normal
5. Aesthetics after thoracotomy are important as the scar is large. The mean scar score was high in thoracotomy. No hypertrophy of scar or keloid formation was seen. VATS has the advantage of minimal scar

References

1. Pedersen R, Markøw S, Kruse-Andersen S, Qvist N, Gerke O, Husby S et al. Long-term pulmonary function in esophageal atresia-A case-control study. Pediatric Pulmonology. 2016 May 10
2. Agarwala S, Bhalla A, Panda S, Bhatnagar V, Kabra S, Jayaswal A. A survey of musculoskeletal and aesthetic abnormalities after thoracotomy in pediatric patients. Journal of Indian Association of Pediatric Surgeons. 2013; 18(4):136.
3. Hallfeldt K, Knoefel W, Thetter O, Deubler E, Schweiberer L. Respiratory function after thoracic operations. The Annals of Thoracic Surgery. 1990; 50(4):688.
4. Panda SS, Agarwala S, Kabra SK, Bhatnagar V.A survey of pulmonary function abnormalities following thoracotomy.Indian J Pediatr. 2014 Jul;81(7):660-4.

5. Wong-Chung J, France J, Gillespie R. Scoliosis Caused by Rib Fusion After Thoracotomy for Esophageal Atresia Report of a Case and Review of the Literature. Spine. 1992; 17(7):851-853.
6. Lawal T, Gosemann J, Kuebler J, Glüer S, Ure B. Thoracoscopy Versus Thoracotomy Improves Midterm Musculoskeletal Status and Cosmesis in Infants and Children. The Annals of Thoracic Surgery. 2009; 87(1):224-228.
7. B D Chaurasia ,Human anatomy, Regional and Applied, Volume 1, 4th edition
8. Richard L Drake, Adam W M Mitchell.Gray's Anatomy for Students, International Edition 3rd Edition ,Student consult,Elseiver
9. Netter FH. Atlas of Human Anatomy, Professional Edition. Netter Basic Science. 2011. Netters_Surgical_Anatomy_2013
10. Guyton AC, Hall JE. Textbook of Medical Physiology. Vol. 51, Physiology. 2006.
11. Ng CSH, Rocco G, Yim a. PC. Video-assisted thoracoscopic surgery (VATS) pleurodesis for pneumothorax. Multimed Man Cardio-Thoracic Surg .2005;2005(425):1–7.
12. Walker WS, Craig SR. Video-assisted thoracoscopic pulmonary surgery--current status and potential evolution. European Journal of Cardiothoracic Surgery 1996;10(3):161–7
13. Seong YW, Kang CH, Kim JT, Moon HJ, Park IK, Kim YT. Video-assisted thoracoscopic lobectomy in children: Safety, efficacy, and risk factors for conversion to thoracotomy. Annals of Thoracic Surgery. 2013; 95(4):1236–42.
14. Raja R Gopaldas .Video-assisted thoracoscopic v/s open thoracotomy lobectomy in a cohort of 13,6,19 patients, annals of thoracic surgery, volume 89, issue 5, may 2010
15. Nasr A, Bass J. Thoracoscopic vs open resection of congenital lung lesions: A meta-analysis. In: Journal of Pediatric Surgery. 2012. p. 857–61.
16. N Rahman, Kokila Lakhoo. A comparison between open and thoracoscopic resection of congenital lung lesions ,published in the journal of pediatric surgery ,volume 44 ,issue 2, Feb 2009 ,pages 333-336
17. Lawal TA, Gosemann JH, Kuebler JF, Glüer S, Ure BM. Thoracoscopy Versus Thoracotomy Improves Midterm Musculoskeletal Status and Cosmesis in Infants and Children. Ann Thorac Surg. 2009; 87(1):224–8.
18. SS Rothenberg.2 decades of experience with thoracoscopic lobectomy in infants and children, standardizing the technique for advanced thoracoscopicsurgery. Journal of Laproendoscopic and advanced surgical techniques, May 2015, 25 (15:423-428)
19. Lan T. Vu, Diana L. Farmer, Kerilyn K. Nobuhara, Doug Miniati, Hanmin Le. VATS vs Open resection for congenital cystic adenomatoid malformation of lung. Journal of Pediatric surgery Vol 43 issue 1, Jan 2008, 35-39
20. Laje P, Pearson EG, Simpao AF, Rehman MA, Sinclair T, Hedrick HL, et al. The first 100 infant thoracoscopic lobectomies: Observations through the learning curve and comparison to open lobectomy. J Pediatr Surg. 2015; 50(11):1811–6.
21. Rothenberg SS ,Pokorny WJ ,Experience with a total muscle sparing approach for thoracotomy in neonates ,infants, and children
22. Hazelrigg SR, Landreneau RJ, Boley TM, Priesmeyer M, Schmaltz RA, Nawarawong W, et al. The effect of muscle-sparing versus standard posterolateral thoracotomy on pulmonary function, muscle strength, and postoperative pain. J ThoracCardiovasc Surg. 1991;101(3):391–4.
23. Jawad AJ. Experience with modified posterolateral muscle-sparing thoracotomy in neonates, infants, and children. Pediatric Surgery International. 1997; 12(5–6):337–9.
24. Vercelli S, Ferriero G, Sartorio F, Stissi V, Franchignoni F. How to assess postsurgical scars: a review of outcome measures. Disabil Rehabil. 2009;31(25):2055–63.
25. Sabiston DC. Sabiston Textbook Of Surgery: The Biological Basis of Modern Surgical Practice. Expert consult. 2013. 1689-1699 p.
26. Kumar ,Abbas, Fausto. Robbins and Cotran pathologic basis of disease, 7th edition. 2005;
27. Fearmonti R, Bond J, Erdmann D, Levinson H. A review of scar scales and scar measuring devices. Eplasty 2010;10:e43
28. Seong Hwan Bai and Young Chan Bai .Analysis of frequency of use of different scar assessment scales based on scar condition and treatment method, March 2014,41(2):111-115 English
29. Findik G, Gezer S, Sirmali M, Turut H, Aydogdu K, Tastepe I, Karaoglanoglu N, Kaya S Thoracotomies in children. Pediatric Surgery Internatinal. 2008 Jun;24(6):721-5.
30. Sistonen SJ, Helenius I, Peltonen J, Sarna S, Rintala RJ, Pakarinen MP. Natural history of spinal anomalies and scoliosis associated with esophageal atresia. Pediatrics. 2009;124(6):e1198–204.
31. Nomori H, Ontsuka T, Horio H ,Naruki T, Suemasu K .Differences in impairment of vital capacity and 6 minute walk test after a lobectomy performed by thoracoscopic surgery,an anterior limited thoracotomy, an anteroaxillary thoracotomy and a posterolateral thoracotomy; Surgery today 2003;33(1):7-12

32. Bianchi A, Sowande O, AlizaiK,Rampersad B Aesthetics and lateral thoracotomy in the neonate .J Pediatr Surg. 1998 Dec;33(12):1798-800.
33. Shu Q, Zhang Z, Zhu X, Li J, Lin R, Yu J, Chen Z. Transaxillary minithoracotomy in intrathoracic surgery for 316 infants and children China Medical Journal (Engl). 2003 Jul; 116(7):1008-10.
34. Van Biezen FC, Bakx PA, De Villeneuve VH, Hop WC. Scoliosis in children after thoracotomy for aortic coarctation. J Bone Joint Surg Am. 1993;75(4):514–8.
35. Bal S, Elshershari H, Celiker R, Celiker A.Thoracic sequels after thoracotomies in children with congenital cardiac disease. Cardiol Young. 2003 Jun;13(3):264-7