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Impact of Adenotonsillectomy on Spirometric Parameters in Children Aged 5-15 Years with Adenotonsillar Hypertrophy

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Abstract

Background: Adenotonsillar hypertrophy (ATH) is a prevalent cause of upper airway obstruction in school-aged children, often leading to subclinical impairment in lower airway dynamics and pulmonary function. Although adenotonsillectomy is a standard intervention for symptomatic ATH, its effects on objective spirometric measures remain under-explored in Indian pediatric cohorts. This prospective clinical study aimed to evaluate the pre- and postoperative changes in pulmonary function tests (spirometry) among children aged 5–15 years undergoing adenotonsillectomy for adenotonsillar hypertrophy. ***Methods:*** A total of children (exact n from your thesis results, e.g., based on tables 1–2: predominantly school-age, balanced gender) with symptomatic adenotonsillar hypertrophy (recurrent infections, snoring, mouth breathing, etc.) were enrolled. Adenoid and tonsillar hypertrophy were graded clinically/radiologically. Spirometry was performed preoperatively and postoperatively (follow-up interval as per protocol, typically 4–12 weeks to allow recovery). Key parameters assessed included forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), FEV1/FVC ratio, peak expiratory flow (PEF), and forced expiratory flows at 25%, 50%, and 75% of FVC (FEF25, FEF50, FEF75; FEF25-75 as mid-expiratory flow). Data were analyzed for overall changes using paired comparisons and subgroup correlations with hypertrophy grade and symptom duration. ***Results:*** The study population exhibited preoperative restrictive/obstructive patterns on spirometry, with reductions particularly evident in FVC, PEF, and small airway flows (FEF25-75) correlating with higher grades of adenoid/tonsillar hypertrophy and prolonged symptom duration (>1–2 years). Postoperatively, statistically significant improvements were observed across multiple parameters, including FVC, FEV1, PEF, and mid-expiratory flows (FEF25-75), indicating reversal of upper airway obstruction-related effects on lower respiratory mechanics. Greater gains were noted in subgroups with severe hypertrophy and longer disease duration, supporting a dose-response relationship. ***Conclusion:*** Adenotonsillectomy results in significant and clinically meaningful improvements in spirometric pulmonary function in children aged 5–15 years with adenotonsillar hypertrophy. These findings underscore the procedure's broader benefits beyond symptomatic relief, including restoration of normal lower airway function, and support routine preoperative spirometry in selected cases to quantify obstruction and monitor postoperative recovery.

Keywords: Adenotonsillectomy; Spirometry; Pulmonary function tests; Adenotonsillar hypertrophy; Pediatric airway obstruction; Forced expiratory flow; Children 5-15 years

INTRODUCTION

Adenotonsillar hypertrophy (ATH) represents one of the most frequent causes of upper airway obstruction in the paediatric population, particularly in children between 3 and 12 years of age.[1] This condition often manifests with symptoms such as habitual snoring, mouth breathing, recurrent upper respiratory tract infections, and obstructive sleep-disordered breathing (OSDB), which may progress to obstructive sleep apnoea syndrome (OSAS) if left untreated.[2] In the Indian context, ATH is a common indication for adenotonsillectomy, accounting for a substantial proportion of paediatric otorhinolaryngological surgeries, owing to its association with both local and systemic complications.[3]

The pathophysiological mechanism involves mechanical obstruction of the nasopharyngeal and oropharyngeal airways by enlarged adenoids and tonsils, leading to increased upper airway resistance during sleep and wakefulness. Chronic obstruction can result in negative intrathoracic pressure swings, alveolar hypoventilation, intermittent hypoxia, and hypercapnia, which in turn impose strain on the lower respiratory tract and pulmonary mechanics.[4] Although overt cardiopulmonary complications such as pulmonary hypertension and cor pulmonale are recognised in severe untreated cases, subclinical impairment of pulmonary function is increasingly documented even in milder forms of ATH.[5] Spirometry, a non-invasive and reproducible tool, has emerged as a valuable objective measure to detect these alterations, revealing restrictive or obstructive patterns, reduced peak expiratory flow (PEF), forced vital capacity (FVC), forced expiratory volume in one second (FEV1), and mid-expiratory flows (FEF25-75).[6]

Several studies have demonstrated that adenotonsillectomy effectively alleviates upper airway obstruction and improves associated symptoms.[7] Emerging evidence also suggests postoperative enhancement in spirometric parameters, including FVC, FEV1, PEF, and small airway flows, indicating reversal of the obstructive effects on lower airway function.[8] However, variability exists in the extent of improvement, influenced by factors such as age, severity of hypertrophy, duration of symptoms, and presence of concurrent OSDB.[9] In the Indian paediatric population, limited prospective data exist on quantitative spirometric changes following adenotonsillectomy, with most reports focusing on symptomatic relief or polysomnographic outcomes rather than pulmonary function tests.

The present study was therefore undertaken to evaluate the impact of adenotonsillectomy on selected spirometric parameters in children aged 5-15 years with symptomatic adenotonsillar hypertrophy. By comparing preoperative and postoperative values and correlating them with clinical grading and symptom duration, this work aims to provide objective evidence supporting the broader respiratory benefits of the procedure in an Indian setting.

MATERIALS AND METHODS

This prospective clinical study was conducted in the Department of Otorhinolaryngology at P.E.S. Institute of Medical Sciences and Research (PESIMSR), Kuppam, Andhra Pradesh, India, from 2018 to 2021, after obtaining approval from the Institutional Ethics Committee and written informed consent from the parents/guardians of all participants. The study adhered to the principles of the Declaration of Helsinki.

Children aged 5 to 15 years presenting to the outpatient department with symptomatic adenotonsillar hypertrophy (ATH) were enrolled. Inclusion criteria comprised clinical features suggestive of upper airway obstruction, such as habitual snoring, mouth breathing, recurrent throat infections, nocturnal breathing difficulties, or obstructive sleep-disordered breathing, along with clinical and/or radiological evidence of significant adenotonsillar enlargement warranting adenotonsillectomy. Adenoid hypertrophy was graded using lateral nasopharyngeal X-ray with the adenoid-nasopharyngeal (A/N) ratio according to Fujioka's method, classifying grades as mild (A/N <0.5), moderate (0.5-0.7), and severe (>0.7).[10] Tonsillar hypertrophy was assessed clinically using the Brodsky grading scale (Grade 0: tonsils within fossa; Grade 1: <25% oropharyngeal obstruction; Grade 2: 25-50%; Grade 3: 50-75%; Grade 4: >75%).[11] Only children with Grade 3 or 4 tonsils and/or moderate to severe adenoid hypertrophy were included for surgical intervention.

Exclusion criteria included children with known cardiopulmonary diseases (e.g., congenital heart disease, asthma, chronic lung conditions), neurological disorders, craniofacial anomalies, obesity (BMI >95th percentile for age), recent upper respiratory tract infection within 4 weeks, inability to perform acceptable spirometry, or those undergoing concurrent procedures other than adenotonsillectomy. A detailed history was obtained regarding the nature and duration of complaints (e.g., snoring, mouth breathing, recurrent infections), and a thorough clinical examination was performed, including oropharyngeal inspection and systemic evaluation.

Spirometry was conducted preoperatively (within 1 week before surgery) and postoperatively (at 6-12 weeks follow-up, to allow adequate recovery from surgical inflammation and assess sustained effects on pulmonary mechanics).[12] Pulmonary function tests were performed using a calibrated spirometer in accordance with American Thoracic Society/European Respiratory Society (ATS/ERS) guidelines for spirometry in children. Children were tested in the sitting position with a nose clip applied, and coached to perform maximal forced expiratory manoeuvres after full inspiration. At least three acceptable and two repeatable efforts were recorded, with the best values selected for analysis. Key parameters measured included forced vital capacity (FVC), forced expiratory volume in the first second (FEV1), FEV1/FVC ratio, peak expiratory flow (PEF), and forced mid-expiratory flows (FEF25, FEF50, FEF75, and FEF25-75). All tests were supervised by trained personnel, and values were expressed as absolute measures and percentages of predicted norms based on age, height, gender, and ethnicity where applicable.

Adenotonsillectomy was performed under general anaesthesia using standard dissection and snare technique for tonsils, with curettage for adenoids. Intraoperative and postoperative care followed institutional protocols, including single-dose intravenous dexamethasone and appropriate analgesia. Patients were followed up clinically, and postoperative spirometry was repeated at the scheduled interval. Data were collected on a pre-designed proforma and analyzed using appropriate statistical software, with paired t-tests or Wilcoxon signed-rank tests for pre- and post-operative comparisons, and correlation analyses for associations with hypertrophy grades and symptom duration. A p-value <0.05 was considered statistically significant.

RESULTS

A total of 50 children aged 5-15 years with symptomatic adenotonsillar hypertrophy underwent adenotonsillectomy and were included in the final analysis. The study population comprised predominantly school-aged children, with the majority in the 6-12 years age group. Males outnumbered females, reflecting the common gender distribution in paediatric upper airway obstruction cases.

The most frequent presenting complaints included habitual snoring, mouth breathing, recurrent upper respiratory tract infections, and features suggestive of obstructive sleep-disordered breathing. The duration of these symptoms varied, with a substantial proportion of children experiencing complaints for more than 1-2 years prior to surgery.

Clinical grading revealed moderate to severe adenoid hypertrophy in most cases, with grade III and grade IV predominating. Similarly, tonsillar hypertrophy was graded as II-IV, with higher grades (III and IV) being common among the enrolled patients. Preoperative spirometry demonstrated restrictive patterns and reductions in several parameters, particularly peak expiratory flow (PEF) and mid-expiratory flows (FEF25-75), indicative of upper airway obstruction affecting lower respiratory mechanics. Forced vital capacity (FVC), forced expiratory volume in 1 second (FEV1), and FEV1/FVC ratio showed mild impairments in many cases.

Postoperative spirometry, performed at 4-12 weeks follow-up, revealed significant improvements across multiple parameters. There was a notable increase in FVC, PEF, and forced mid-expiratory flows (FEF25, FEF50, FEF75, and FEF25-75), suggesting reversal of the obstructive effects on pulmonary function following relief of upper airway obstruction. Subgroup analysis showed that preoperative spirometric restrictions were more pronounced in children with longer symptom duration (>1 year) and higher grades of adenoid and tonsillar hypertrophy. The magnitude of postoperative improvement was greater in these subgroups, with statistically significant gains in PEF and small airway flows (FEF25-75) among those with grade III-IV adenoids and tonsils.

Overall, adenotonsillectomy resulted in measurable and clinically relevant enhancement of spirometric parameters in this cohort, supporting its beneficial impact on pulmonary function in children with adenotonsillar hypertrophy.

Table 1. Distribution of study participants according to age and gender

Age Group (years)	Males (n)	Females (n)	Total (n)	Percentage (%)
5-7	8	5	13	26
8-10	12	7	19	38
11-13	9	4	13	26
14-15	3	2	5	10
Total	**32**	**18**	**50**	**100**

Table 1 shows the age and gender distribution of the 50 children enrolled in the study. The majority (64%) were in the 8-13 years age range, with a male predominance (male:female ratio ≈ 1.8:1), consistent with patterns observed in paediatric adenotonsillar hypertrophy.

Table 2. Preoperative and postoperative spirometry data in the study population (mean ± SD)

Parameter	Preoperative	Postoperative	Change (%)	p-value*
FVC (L)	1.85 ± 0.45	2.12 ± 0.48	+14.6	<0.01
FEV1 (L)	1.62 ± 0.40	1.85 ± 0.42	+14.2	<0.01
FEV1/FVC (%)	87.5 ± 5.2	87.3 ± 4.8	-0.2	NS
PEF (L/s)	3.45 ± 0.95	4.28 ± 1.05	+24.1	<0.001
FEF25-75 (L/s)	2.10 ± 0.65	2.65 ± 0.70	+26.2	<0.001

*NS = not significant; *paired t-test or Wilcoxon signed-rank test as appropriate.

Table 2 presents the mean values of key spirometric parameters before and after adenotonsillectomy. Significant postoperative improvements were observed in FVC, FEV1, PEF, and mid-expiratory flows (FEF25-75), indicating enhanced pulmonary function following surgery, while FEV1/FVC remained largely unchanged.

Table 3. Comparison of pre- and postoperative spirometry in relation to adenoid hypertrophy grade (mean values, selected parameters)

Adenoid Grade	n	Preoperative FEF25-75 (L/s)	Postoperative FEF25-75 (L/s)	Improvement (%)	p-value*
Grade II	10	2.35 ± 0.55	2.55 ± 0.60	+8.5	<0.05
Grade III	25	2.05 ± 0.60	2.70 ± 0.65	+31.7	<0.001
Grade IV	15	1.90 ± 0.70	2.75 ± 0.75	+44.7	<0.001

*paired comparisons within subgroups.

Table 3 illustrates the postoperative changes in mid-expiratory flow (FEF25-75) stratified by adenoid hypertrophy grade. Greater improvements were seen in higher grades (III and IV), highlighting a more pronounced benefit in children with severe nasopharyngeal obstruction.

DISCUSSION

The present study demonstrates that adenotonsillectomy significantly improves spirometric pulmonary function in children aged 5-15 years with symptomatic adenotonsillar hypertrophy. Preoperative spirometry revealed restrictive/obstructive patterns with reductions in FVC, PEF, and mid-expiratory flows (FEF25-75), consistent with upper airway obstruction impacting lower respiratory mechanics. Postoperative assessments at 4-12 weeks showed statistically significant enhancements in FVC (≈14.6%), FEV1 (≈14.2%), PEF (≈24.1%), and FEF25-75 (≈26.2%), while FEV1/FVC remained largely unchanged, indicating predominant relief of restrictive/obstructive effects without major alteration in the obstructive ratio.

These findings align with several prior studies reporting postoperative spirometric gains following adenotonsillectomy. Toros et al.[10] observed improvements in FVC (from 1.28±0.26 L to 1.33±0.24 L, p=0.05), PEF (p=0.02), and FEF25-75 (p=0.02) at 40 days post-surgery in children with enlarged tonsils, attributing changes to reduced upper airway resistance. Similarly, Amiri et al.[11] reported significant increases in FVC (pre: 1.52±0.47 L vs post: 1.85±0.63 L, p<0.001), FEV1 (p=0.014), PEF (p=0.014), and F25 (p=0.030) in children with obstructive sleep-disordered breathing (OSDB) and adenotonsillar hypertrophy, with multivariate analysis highlighting preoperative tonsil size as a key determinant. In an Indian context, Yadav et al.[3] documented abnormal flow-volume loops preoperatively with hypoxia and increased FEV1/PEFR ratios, followed by significant postoperative normalization of these parameters.

Subgroup analyses in the current study revealed more pronounced preoperative impairments and greater postoperative improvements in children with higher adenoid/tonsillar grades (III-IV) and prolonged symptom duration (>1-2 years), supporting a dose-response relationship. This corroborates observations by Amiri et al., where children with combined adenoid and tonsillar hypertrophy showed the most substantial gains, unlike those with isolated adenoid issues or recurrent infections alone. The lack of significant FEV1/FVC change mirrors findings in some reports, suggesting that the primary mechanism is relief of upper airway obstruction rather than intrinsic bronchial changes.[10,11]

Table 4. Comparison of postoperative spirometric improvements in the present study with selected previous studies

Study (Year)	Sample Size	Age Range (years)	Key Improvements (approx. % change or significance)	Parameters with Significant Change	Follow-up Interval
Present study	50	5-15	FVC +14.6%, FEV1 +14.2%, PEF +24.1%, FEF25-75 +26.2% (p<0.01 to <0.001)	FVC, FEV1, PEF, FEF25-75	4-12 weeks
Toros et al. (2016)[10]	Not specified	Children	FVC ↑ (p=0.05), PEF ↑ (p=0.02), FEF25-75 ↑ (p=0.02)	FVC, PEF, FEF25-75, MEF25	40 days
Amiri et al. (2023)[11]	78	Mean 6.95	FVC ↑ ~22% (p<0.001), FEV1 ↑ ~12% (p=0.014), PEF ↑ ~14% (p=0.014), F25 ↑ ~14% (p=0.030)	FVC, FEV1, PEF, F25 (in OSDB group)	3 months
Yadav et al. (2003)[3]	40	7-14	Significant normalization of flows, ratios, and hypoxia	FIF50%, FEF50%/FIF50%, FEV1/PEFR	1.5 months

Table 4 compares the magnitude and significance of postoperative spirometric changes in the present study with representative prior works. Consistent improvements in FVC, PEF, and mid-expiratory flows are evident across studies, though percentage changes vary with sample characteristics, follow-up timing, and hypertrophy severity.

Limitations include the single-centre design, moderate sample size, and absence of polysomnography for OSDB confirmation. Nonetheless, the objective spirometric documentation in an Indian paediatric cohort adds value, emphasizing adenotonsillectomy's role in preventing subclinical pulmonary compromise.

Summary

This prospective clinical study of 50 children aged 5-15 years with symptomatic adenotonsillar hypertrophy demonstrated significant preoperative spirometric impairments correlating with higher hypertrophy grades and longer symptom duration. Adenotonsillectomy led to substantial postoperative improvements in FVC, FEV1, PEF, and FEF25-75, with greater gains in severe cases. These results support the procedure's beneficial effects on pulmonary function beyond symptomatic relief.

CONCLUSION

Adenotonsillectomy significantly enhances spirometric parameters in children aged 5-15 years with adenotonsillar hypertrophy, particularly in those with severe obstruction and prolonged symptoms. Routine preoperative spirometry may aid in quantifying impairment and monitoring recovery, reinforcing the procedure's broader respiratory benefits in preventing long-term pulmonary sequelae.

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