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RESEARCH ARTICLE
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CHANGES IN MIDDLE EAR FUNCTION POST ADENOIDECTOMY IN CHILDREN WITH ADENOID HYPERTROPHY

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Abstract

Background: Adenoid hypertrophy (AH) is one of the common causes of "Eustachian tube (ET) malfunction and upper airway obstruction" in children, which often results in conductive hearing loss, recurrent ear infections, and chronic otitis media with effusion (OME). A recognized surgical procedure for nasopharyngeal blockage is adenoidectomy; however, its exact impact on middle ear function is still being researched. In order to maximize patient outcomes, it is essential to comprehend the postoperative changes in middle ear pressure and effusion resolution.

Objectives:1) To determine the degree of adenoid hypertrophy and changes in middle ear function in children by using tympanometry before adenoidectomy. 2) To analyze the changes in middle ear pressure using tympanometry preoperatively, 1 week, 3 weeks, and 6 weeks postoperatively after adenoidectomy in children with adenoid hypertrophy.

Methodology: A prospective observational study was conducted in the Department of ENT at Adichunchanagiri Institute of Medical Sciences, BG Nagara from July 2023 to January 2025 over a duration of 18 months. Pediatric patients aged 5–12 years diagnosed with grade 3 and 4 adenoid hypertrophy, with or without concurrent OME, undergoing adenoidectomy. A comprehensive preoperative assessment included otoscopic examination, pure tone audiometry, and impedance audiometry, with tympanometry, as the primary tool for assessing middle ear function. Tympanometry measurements were recorded preoperatively at 1, 3, and 6 weeks postoperatively to observe changes in middle ear functioning. Data were analyzed using SPSS software, employing paired t- tests for statistical comparison, with $p<0.05$ considered statistically significant.

Results: Preoperative tympanometry demonstrated middle ear dysfunction in 90% of patients, with "60% exhibiting Type B curves, 30% exhibiting Type C curves, and only 10% having Type A (normal) tympanograms". Post-surgery, tympanometry patterns substantially improved, with "30% of ears normal by week 1, 60% by week 3, and 85% by week 6". The audiometric evaluation exhibited a gradual lowering in hearing thresholds, with preoperative mean PTA values of "30 dB HL in the right ear and 28.75 dB HL in the left". Hearing improved marginally after the first postoperative

week, and by the third week of recovery, mean thresholds had decreased to 20 dB HL (left) and 22.5 dB HL (right). Hearing levels were close to normal by six weeks, with final values of 15 dB HL (left) and 17.5 dB HL (right). Notably, 12 patients with higher grades of adenoid hypertrophy (Grade 4) exhibited more severe preoperative hearing loss but showed the most significant postoperative recovery. **Conclusion:** Most children restore near-normal middle ear function and hearing within six weeks of surgically treating adenoid enlargement, leading to a gradual improvement in tympanometry profiles and audiometric thresholds. To prevent long-term conductive hearing loss and its potential impact on speech and cognitive development, research findings emphasize the need of early detection and treatment of adenoid hypertrophy.

Keywords: Adenoid hypertrophy, Eustachian tube dysfunction, Middle ear function, Tympanometry, Pure-tone audiometry, Pediatric hearing loss.

Introduction

Adenoid hypertrophy (AH) is a prevalent condition in the paediatric population, characterized by abnormal enlargement of the adenoid tissue located in the nasopharynx.[1,2] This lymphoid tissue plays a protective immunological role during early childhood but can become chronically inflamed or hypertrophied due to recurrent infections or allergic stimuli.[3,4] Enlarged adenoids can obstruct the nasopharyngeal airway and the Eustachian tube orifices, leading to a cascade of clinical symptoms including nasal obstruction, snoring, mouth breathing, and more critically, Eustachian tube dysfunction (ETD).

ETD is a significant cause of otitis media with effusion (OME), a condition that results in the accumulation of non-purulent fluid in the middle ear.[1,5] OME is frequently asymptomatic in the early stages but can lead to conductive hearing loss, speech and language delays, behavioural issues, and poor academic performance if left unaddressed.[2,6,7] Tympanometry and pure tone audiometry (PTA) are reliable, non-invasive tools for the early detection and monitoring of middle ear dysfunction.[8,9] The use of these tools enables objective assessment and guides timely intervention.

Adenoidectomy, the surgical removal of hypertrophied adenoids, is a well-established intervention aimed at relieving upper airway obstruction and improving middle ear ventilation.[10,11] Although the procedure is widely practiced, variations exist in the extent of improvement reported in middle ear function following surgery.[12,13,14] This study was designed to quantify the changes in tympanometry profiles and hearing thresholds at multiple time intervals post-adenoidectomy, thereby establishing evidence for its effectiveness in reversing middle ear dysfunction caused by AH.

Materials and Methods

This prospective observational study was carried out over a period of 18 months, from July 2023 to January 2025, in the Department of ENT at Adichunchanagiri Institute of Medical Sciences, Karnataka. The study population included 50 paediatric patients aged between 5 and 12 years who presented with symptoms of nasal obstruction and were diagnosed with Grade 3 or 4 adenoid hypertrophy (AH) via endoscopic evaluation. Children with chronic suppurative otitis media (CSOM), cleft palate, craniofacial anomalies, neuromuscular disorders, or those who had undergone previous ENT surgeries were excluded. Ethical clearance was obtained from the Institutional Ethical Committee, and informed consent was secured from parents or guardians.

Inclusion Criteria: Children aged 5 to 12 years, Diagnosed with Grade 3 or 4 adenoid hypertrophy, With or without signs of otitis media with effusion and medically fit for surgery. **Exclusion Criteria:** Children with chronic suppurative otitis media (CSOM), Children with cleft palate or craniofacial anomalies, History of previous ENT surgeries, Presence of neuromuscular or systemic disorders, Parental refusal to consent for participation. All enrolled patients underwent a thorough otorhinolaryngological examination, including otoscopy, nasopharyngoscopy, tympanometry, and pure tone audiometry (PTA) prior to surgery. Tympanometry classified middle ear compliance into Type A (normal), Type B (suggestive of middle ear effusion), and Type C (indicating negative middle ear pressure). PTA thresholds were measured at frequencies of 500, 1000, and 2000 Hz.

Adenoidectomy was performed under general anaesthesia. [15,16] Postoperative assessments using tympanometry and PTA were conducted at 1 week, 3 weeks, and 6 weeks following surgery.

Statistical analysis: The data will be put into Microsoft Excel and evaluated with SPSS. Data will be expressed proportionally. For continuous variables, a paired student T-test will be employed to determine significance. P-values < 0.05 will be regarded statistically significant.

Results

The study comprised 50 paediatric participants aged between 5 and 12 years, with a nearly balanced gender distribution—27 males (54%) and 23 females (46%). Age-wise, most children belonged to the 8–10-year age group (45%), followed by 5–7 years (27.5%) and 11–12 years (27.5%). These demographic characteristics are summarized in Table 1. All children had Grade 3 or 4 adenoid hypertrophy, with associated symptoms of nasal obstruction and suspected middle ear involvement. Tympanometry findings prior to surgery revealed 60% of patients had Type B curves, indicating middle ear effusion, and 30% had Type C curves, reflecting Eustachian tube dysfunction. Only 10% had Type A curves, which are indicative of normal middle ear pressure.

Table 1: Demographic Profile of Study Participants

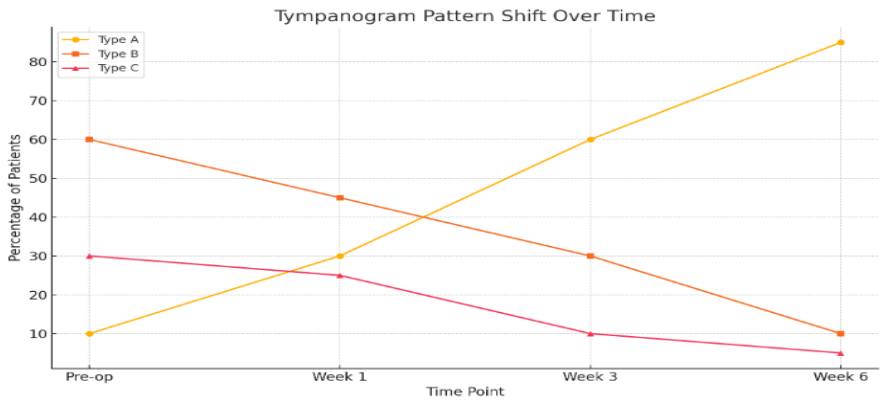
Parameter	Category	Frequency	Percentage
Age Group	5–7 years	14	27.5%
	8–10 years	23	45.0%
	11–12 years	13	27.5%
Gender	Male	27	54%
	Female	23	46%

Postoperative tympanometry showed significant improvement in middle ear status over time. At 1 week following adenoidectomy, 30% of tympanograms had shifted to Type A. By the 3rd week, 60% of the patients exhibited Type A tympanograms, and by 6 weeks post-surgery, 85% had Type A tympanograms, with only 10% showing Type B and 5% Type C patterns (Table 2). This progressive trend is visually represented in Graph 1, illustrating the shift in tympanogram patterns toward normalcy. These findings confirm that adenoidectomy promotes restoration of middle ear function by improving aeration and resolving effusion.

Table 2: Tympanometry Patterns Over Time

Time Point	Type A (%)	Type B (%)	Type C (%)
Pre-op	10	60	30
Week 1	30	45	25
Week 3	60	30	10
Week 6	85	10	5

Graph 1: Tympanogram Pattern Shift Over Time



Audiological assessment with pure tone audiometry (PTA) showed consistent improvement in hearing thresholds following adenoidectomy. The mean preoperative PTA was 30.0 dB HL in the right ear and 28.75 dB HL in the left ear. Postoperative PTA at week 1 showed modest improvement, and this trend continued through week 3. By week 6, the average PTA values had decreased to 17.5 dB HL in the right ear and 15.0 dB HL in the left ear, representing a significant improvement in conductive hearing ability (Table 3). Stratified analysis based on adenoid grade revealed that children with Grade 4 hypertrophy had more severe hearing loss initially but demonstrated greater gains postoperatively. These patients had a mean PTA improvement of 13.75 dB HL and 93% converted to Type A tympanograms, compared to 10.5 dB HL improvement and 72% normalization among Grade 3 cases (Table 4). All improvements were found to be statistically significant ($p < 0.01$).

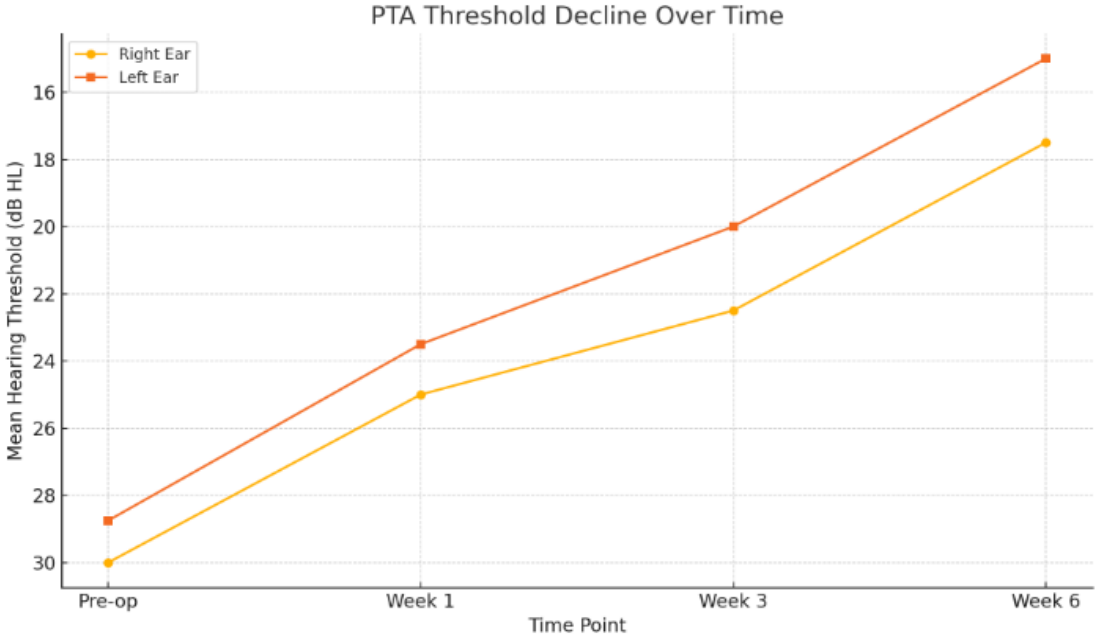
Table 3: Mean PTA Thresholds Over Time

PTA	RIGHT		LEFT	
	MEAN	SD	MEAN	SD
Preoperatively	27.3284	9.72760	28.8235	10.23905
1 WEEK	26.7206	9.36518	26.9647	8.28046
3 WEEKS	23.0392	7.31546	22.3500	6.18636
6 WEEKS	18.5784	5.93201	17.7353	4.66031

Table 4: Paired Samples PTA analysis

PTA	Mean (SD)		95% CI	t	P value
	Before	After			
PTA (R)	27.33 (9.73)	18.58 (5.93)	8.75 (6.76-10.74)	8.83	<0.001
PTA (L)	28.82 (10.24)	17.74 (4.66)	11.09 (8.64 – 13.54)	9.08	<0.001

Graph 2: PTA Threshold Decline Over Time



Discussion

This study highlights the significant impact of adenoid hypertrophy on middle ear function in children, particularly its role in causing Eustachian tube dysfunction and otitis media with effusion (OME). The majority of children presented with high-grade adenoid hypertrophy (Grades 3 and 4) and had symptoms such as mouth breathing, ear blockage, and hearing loss. These findings align with studies by Radhakrishnan et al. and Tawab and Tabook, which reported a higher prevalence of middle ear dysfunction in children with severe adenoid enlargement.[11,12] The association between adenoid

size and middle ear pathology is well-established, as enlarged adenoids can obstruct the Eustachian tube, causing negative middle ear pressure and effusion.

Postoperative improvements in tympanometry findings and hearing thresholds further affirm the therapeutic role of adenoidectomy. In our study, although little change was noted at one-week, significant improvement was observed by the sixth week: over 80% of tympanograms returned to Type A, and hearing thresholds improved significantly ($p < 0.001$). These outcomes are consistent with Radhakrishnan et al. and Durgut and Dikici, who also reported progressive normalization of tympanograms and hearing post-surgery.[11,13] However, variability in findings, such as those by Günel et al., who observed only subtle pressure normalization post-adenoidectomy without tympanogram type conversion, suggests that outcomes may depend on age, degree of hypertrophy, and baseline middle ear pathology.[14]

Overall, the present study supports the efficacy of adenoidectomy in managing middle ear effusion and improving hearing in children with adenoid hypertrophy. The data demonstrate that children with higher-grade hypertrophy benefit the most, with significant resolution of conductive hearing loss and normalization of tympanometry within six weeks. These findings underscore the importance of early identification and surgical intervention in appropriate cases to prevent long-term auditory and developmental consequences.

Limitations

The follow-up period was limited to six weeks, which may not capture long-term changes or potential recurrence of symptoms. Additionally, the study relied on tympanometry and PTA, without incorporating more detailed imaging or advanced audiological assessments. In our study, “the sample size, while sufficient for statistical significance, could be expanded for broader generalizability”.

Conclusion

Our study provides strong evidence that adenoidectomy significantly improves middle ear function in children with adenoid hypertrophy. A high prevalence of preoperative middle ear dysfunction—characterized by Type B tympanograms and elevated hearing thresholds—highlighted the impact of adenoidal obstruction on Eustachian tube function. Postoperatively, a progressive shift to normal tympanometry patterns and a significant bilateral improvement in hearing thresholds were observed, particularly by six weeks. These findings underscore the procedure’s effectiveness in resolving otitis media with effusion and preventing long-term auditory deficits, reinforcing adenoidectomy as a key intervention in managing conductive hearing loss in children with high-grade adenoid hypertrophy.[17,18]

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Conflict of Interest - The authors declare no conflict of interest whatsoever.

Funding - No financial support or funding was provided for the conduct of this study.

Ethical Approval - Before starting the study ethical clearance was taken from the Institutional Ethical Committee, AIMS, B.G. Nagara.

Consent for publication: Informed consent was taken by the patient’s parents or guardians before the adenoidectomy to enroll in the study.

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