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Association Between Grade of Adenoid Hypertrophy and Middle Ear Function by Endoscopy (Clemens and McMurray Criteria) and Audiological Evaluation Pre and Post Adenoidectomy: An Observational Study.

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Abstract

Background: Adenoid hypertrophy (AH) is one of the most prevalent obstructive conditions in children and is strongyl implicated in middle ear dysfunction through mechanical obstruction of the Eustachian tube orifice, predisposing to otitis media with effusion (OME) and conductive hearing loss. The relationship between adenoid size and audiological parameters, as well as the impact of adenoidectomy on these parameters, remains an important clinical consideration. ***Aim:*** To determine the association between the grade of adenoid hypertrophy and middle ear function using endoscopy (Clemens and McMurray criteria) and audiological evaluation, and to assess the impact of adenoidectomy at 1st and 3rd month follow-up. ***Materials and Methods:*** This mixed-design observational study was conducted in the Department of Otorhinolaryngology, Mathuradas Mathur Hospital, Dr. S. N. Medical College, Jodhpur, from March 2024 to March 2025. Fifty children aged 5–15 years with adenoid hypertrophy who underwent adenoidectomy and/or adenotonsillectomy were included. Adenoid grading was performed using diagnostic nasal endoscopy (Clemens and McMurray criteria). Pure tone audiometry (PTA) and impedance audiometry were performed preoperatively and at 1st and 3rd month postoperatively. ***Results:*** The mean age was 9.24 years with male predominance (72%). The most common presenting complaints were mouth breathing and nasal obstruction (100%), followed by snoring (94%) and hearing loss (24%). Grade 3 adenoid hypertrophy was the most prevalent (80%). Preoperatively, 66% had Type A, 24% Type B, and 10% Type C tympanograms. Hearing loss was significantly associated with higher adenoid grades, with 80% of Grade 4 patients showing mild-to-moderate hearing loss. Postoperatively at 3 months, 49 of 50 patients achieved normal hearing bilaterally, and Type A tympanograms increased from 66% to 88%. ***Conclusion:*** Higher grades of adenoid hypertrophy are significantly associated with middle ear dysfunction and conductive hearing loss. Adenoidectomy results in significant improvement in middle ear function and hearing thresholds within 3 months of surgery, underscoring the importance of early diagnosis and intervention.

Keywords: Adenoid hypertrophy, otitis media with effusion, tympanometry, adenoidectomy, Clemens and McMurray criteria, pure tone audiometry.

INTRODUCTION

Adenoid hypertrophy is an obstructive disorder in which the adenoidal lymphoepithelial tissue found in the upper side of the nasopharynx, medial to the eustachian tube orifices, is abnormally enlarged. The adenoids or nasopharyngeal tonsils are part of Waldeyer's ring and the first line of immune defense against respiratory and digestive antigens encountered in the upper aero digestive tract [1]. Adenoid hypertrophy is one of the most common disorders in pediatric age group with an estimated frequency of roughly 34% [2]. The exact etiology is yet incompletely known although a complex origin has been hypothesized with abnormal immune responses, recurrent viral and bacterial infections, environmental, hormonal and genetic susceptibility [3,4].

The adenoids are tiny at birth and undergo gradual growth throughout the first four years of life related to increased immunological activity and reach their maximum relative size with respect to the nasopharyngeal cavity at around seven years of age [5]. After this stage the lymphoid tissue usually involutes and the nasopharyngeal cavity grows on under normal physiological circumstances. However, in some children persistent or progressive enlargement leads to mechanical obstruction of the upper airway and the Eustachian tube orifice, producing a constellation of clinical features including

nasal obstruction, mouth breathing, snoring, sleep apnoea, recurrent earache, hearing loss, anterior and posterior nasal discharge, abnormal craniofacial development and speech disturbances [6,7].

The association between adenoid enlargement and middle ear impairment is known for a long time but still under research. The middle ear is a transformer device that transmits sound waves from the external auditory canal to the inner ear. Normal middle ear pressure is between −100 mm H 2 O and +50 mm H 2 O. Normal compliance is between 0.39 and 1.30 mL. Hypertrophied adenoid tissue mechanically obstructs the Eustachian tube resulting in negative pressure in the middle ear. Consequently, there is vascular engorgement, increased capillary permeability, and transudation of fluid into the middle ear cleft. This negative pressure also retracts the tympanic membrane, which, coupled with fluid accumulation, changes middle ear mass effects, lowers compliance and in the end leads to conductive hearing loss [8,9]. The incidence of otitis media with effusion (OME) has been observed to be more than 7 times greater in children with adenoid hypertrophy than in those without [10].

Otitis medium with effusion is characterized by the presence of fluid in the middle ear cleft without signs of acute infection and with an intact tympanic membrane. It is one of the most prevalent causes of acquired hearing loss in infancy, usually affecting children between the ages of 1 and 6 years [11]. About 80% of children have at least one episode of OME by the time they are three years old and 40% have three or more episodes [12]. Persistent OME may result in permanent sequelae such as atelectasis of the tympanic membrane, retraction pockets, tympanosclerosis and cholesteatoma. These can lead to delayed speech and language development, learning problems and decreased academic performance.

Various techniques are available to measure adenoid size, including lateral nasopharyngeal radiography and the adenoid–nasopharyngeal ratio. Diagnostic nasal endoscopy, however, has been shown to be a very reliable, non-invasive and repeatable approach in assessing adenoid status in the outpatient context. The Clemens and McMurray endoscopic grading method ranks adenoid hypertrophy based on percentage of choanal blockage into four classes, serving as a benchmark for clinical correlation [13]. Pure tone audiometry (PTA) and impedance audiometry (tympanometry) are the objective methods for the measurement of hearing thresholds and middle ear pressure in audiological assessment.

Adenoidectomy remains the mainstay of surgical therapy of symptomatic adenoid hypertrophy, especially when coupled with OME or recurrent acute otitis media. The technique relieves obstructive lymphoid tissue, normalizes middle ear pressure, and promotes Eustachian tube ventilation. The present study was undertaken to determine the association between the grade of adenoid hypertrophy (using Clemens and McMurray criteria) and middle ear function, as assessed by tympanometry and PTA and to evaluate the impact of adenoidectomy on middle ear function at 1st and 3rd month postoperative follow up.

MATERIALS AND METHODS

The present mixed design observational research was performed at the Department of Otorhinolaryngology, Mathuradas Mathur Hospital attached to Dr. S. N. Medical College, Jodhpur, Rajasthan from March 2024 to March 2025 with minimal follow up time of 3 months. The research was approved by the Institutional Ethics Committee. Written informed permission was taken from the parents/guardians of all the participants and assent was taken from children in the age group of 7–12 years.

Children of either gender, aged 5–15 years, diagnosed with adenoid hypertrophy based on clinical features, lateral nasopharyngeal X-ray and diagnostic nasal endoscopy (graded by the Clemens and McMurray endoscopic scoring method) who underwent adenoidectomy and/or adenotonsillectomy were included. Patients with recent upper respiratory tract infection, prior adenoidectomy, cerebral palsy, genetic disorders, ear discharge, perforated tympanic membrane, cleft palate or congenital maxillofacial/ear abnormalities were excluded.

Consecutive sampling was used. The sample size was determined by hypothesis testing of two independent population proportions with $\alpha = 0.05$ and research power of 80%. The minimum needed sample was 40 individuals. Finally, 50 patients were enrolled.

Methodology: A structured assessment was done in all children including detailed history, ENT examination (otoendoscopy and anterior rhinoscopy) and preoperative investigations including PTA, impedance audiometry, diagnostic nasal endoscopy with Clemens and McMurray grading and lateral nasopharyngeal X-ray. The surgical therapy was adenoidectomy with or without tonsillectomy. PTA and impedance audiometry were performed at 1st and 3rd months postoperatively. Hearing loss was graded according to Clark's criteria (Normal: −10 to 15 dB; Minimal: 16–25 dB; Mild: 26–40 dB; Moderate: 41–55 dB).

Data were entered into Microsoft Excel and analyzed using SPSS version 22.0 software. Categorical variables were described as numbers and percentages while continuous variables were described as mean ± SD. Differences in proportions were evaluated using chi-square and unpaired t-test. A p-value < 0.05 was recognized as statistically significant.

RESULTS

A total of 50 children with adenoid hypertrophy who underwent adenoidectomy were analyzed. The mean age was 9.24 years, with the majority (56%) belonging to the 5–10 year age group. There was a clear male predominance (72%). On otoscopic examination, 68% had bilaterally normal tympanic membranes, while 18% showed retraction (bilateral or unilateral) and 10% demonstrated air bubbles behind the tympanic membrane.

The most common presenting complaints were mouth breathing and nasal obstruction (100% each), followed by snoring (94%), hearing loss (24%), sleep disturbance (12%), voice changes (10%), and headache (6%).

According to the Clemens and McMurray endoscopic grading, Grade 3 hypertrophy was most common (80%), followed by Grade 2 and Grade 4 (10% each). Tympanometric evaluation revealed Type A in 66%, Type B in 24%, and Type C in 10% of patients.

Table 1: Demographic and Baseline Clinical Profile (n=50)

Parameter	Category	Number	Percentage
Age (years)	≤5	5	10.00
	5–10	28	56.00
	11–15	17	34.00
Gender	Male	36	72.00
	Female	14	28.00
Adenoid Grade (Clemens & McMurray)	Grade 2	5	10.00
	Grade 3	40	80.00
	Grade 4	5	10.00
Tympanogram type	Type A	33	66.00
	Type B	12	24.00
	Type C	5	10.00

Table 2: Association of Adenoid Grade with Hearing Loss (Right and Left Ear)

Adenoid Grade	Total	Normal (R/L)	Minimal (R/L)	Mild (R/L)	Moderate (R/L)
Grade 2	5	5/5 (100%)	0/0	0/0	0/0
Grade 3	40	27/25 (67.5%/62.5%)	5/6 (12.5%/15%)	7/8 (17.5%/20%)	1/1 (2.5%)
Grade 4	5	1/1 (20%)	0/0	3/3 (60%)	1/1 (20%)
Total	**50**	**33/31**	**5/6**	**10/11**	**2/2**

The proportion of hearing loss increased substantially with rising adenoid grade. All Grade 2 patients had normal hearing bilaterally, whereas 80% of Grade 4 patients exhibited mild-to-moderate hearing loss.

Table 3: Association of Tympanogram Type with Hearing Loss

Tympanogram	Right Ear				Left Ear			
	Normal	Minimal	Mild	Moderate	Normal	Minimal	Mild	Moderate
Type A (n=33)	32 (96.97%)	0	1 (3.03%)	0	31 (93.94%)	1 (3.03%)	1 (3.03%)	0
Type B (n=12)	1 (8.33%)	0	9 (75%)	2 (16.67%)	0	0	10 (83.33%)	2 (16.67%)
Type C (n=5)	0	5 (100%)	0	0	0	5 (100%)	0	0

Type A tympanograms were strongly associated with normal hearing, while Type B was associated with mild-to-moderate conductive hearing loss, and Type C with minimal hearing loss.

Table 4: Pre- and Postoperative Tympanogram and Hearing Status

Parameter	Preoperative	1st Month Post-op	3rd Month Post-op
Type A (Bilateral)	30	42	44
Type A (Unilateral)	3	3	5
Type B (Bilateral)	10	3	1
Type B (Unilateral)	2	2	0
Type C (Bilateral)	5	0	0
Right ear normal hearing	33	–	49
Left ear normal hearing	31	–	49

A marked shift toward Type A tympanograms was observed postoperatively, with 88% achieving bilateral Type A by 3 months. Hearing thresholds normalized in 49 of 50 patients (98%) at 3-month follow-up, with only one patient retaining mild hearing loss.

DISCUSSION

Adenoid hypertrophy and its relationship to middle ear dysfunction is a clinically relevant item in pediatric otolaryngology with consequences beyond ear disease to speech, language, and academic development. Objectives: To determine the correlation between the size of adenoids and middle ear function using objective audiological assessment and a standardized endoscopic grading system (Clemens and McMurray) in children aged 5-15 years. Materials and Methods: Fifty children aged 5-15 years who underwent endoscopic assessment of adenoids and audiological assessment of middle ear function both pre- and postoperatively were included in the study. Results: The study revealed a significant correlation between the increasing size of adenoids and the worsening of middle ear function. There was a significant improvement in middle ear function postoperatively.

The mean age in our cohort was 9.24 years with 56% of the cases between 5 and 10 years of age which was close to Radhakrishnan et al. who reported an average age of 7.65 years with 80% in the 5–10 year age range [14]. Savery et al. [15] also found a similar peak prevalence in this age group for adenoid involution after the age of seven years, coinciding with the expansion of the nasopharynx. The male majority (72%) found is consistent with the findings of Radhakrishnan et al. (60% males) and Savery et al. (61% males) and further substantiates the well known male preponderance of adenoid pathology in the pediatric population.

Otoscopic results in our investigation revealed 68% bilaterally normal tympanic membranes,18% retraction and 10% air bubbles. Augustian et al. found comparable results, 72% normal, 14% retracted and 4% with air-fluid levels [16]. The results illustrate the range of subclinical middle ear disease that is often present in children with adenoid hypertrophy, may be overlooked on standard screening, and is related to long-term auditory and developmental consequences.

Nasal blockage and mouth breathing were universal (100%) in our group followed by snoring (94%) and hearing loss (24%). These results are consistent with Augustian et al., who reported mouth breathing in all the patients and snoring in 98% and with Radhakrishnan et al., where nasal obstruction and snoring were common complaints [14,16]. The significantly lower reported rate of subjective hearing loss likely reflects parental under-recognition of mild conductive losses, especially when unilateral, highlighting the utility of objective audiological screening in this group.

The most frequent finding was Grade 3 adenoid hypertrophy (80%) according to the criteria of Clemens and McMurray, followed by Grades 2 and 4 (10% each). This pattern is similar to Augustian et al. who reported 82% Grade III and 12% Grade IV, but different from Radhakrishnan et al. who reported preponderance of Grade 2 (50%) and Grade 3 (45%) hypertrophy and no Grade 4 instances [14,16]. These disparities may be due to referral patterns, threshold for surgical intervention and geographical variances in illness presentation.

Tympanometric distribution in our research (Type A: 66%, Type B: 24%, Type C: 10%) was in agreement with Augustian et al. (Type A: 60%, Type B: 30%) [16]. In contrast, Savery et al. observed Type B tympanograms in 58% and Type A in 35%, perhaps due to a greater number of children with established OME in their sample [15]. Bhat et al. observed that 36% of children with adenoid hypertrophy had asymptomatic OME, emphasizing the need for frequent tympanometric monitoring even in clinically asymptomatic individuals [17].

Our investigation showed that the severity of hearing loss increased significantly with the increase in adenoid grade. All Grade 2 patients had normal hearing, whereas 80% of Grade 4 patients had mild-to-moderate bilateral hearing loss. This dose–response association is consistent with the pathophysiologic hypothesis of progressive Eustachian tube blockage with increased adenoid size leading to negative middle ear pressure, effusion, and subsequent conductive impairment. Similar

statistically significant connection between Grade III adenoids and bilateral mild hearing loss was found by Augustian et al. [16] and majority of mild and moderate hearing loss were reported by Savery et al. to occur in Grades II and III [15]. Tympanogram type was a significant predictor of hearing status. 96.97% of Type A ears had normal hearing, whereas 91.67% of Type B ears had mild-to-moderate hearing loss, and all Type C ears had minor hearing loss. These results closely paralleled those of Augustian et al. [16] and Bhat et al. [17].

The most clinically significant result was the remarkable improvement after adenoidectomy in the postoperative period. At 3 months, 88% of patients had bilateral Type A tympanograms (60% preoperatively) and 98% had bilateral normal hearing thresholds (one patient still had slight hearing loss). Augustin et al. observed that 93% of preoperatively bilateral Type B tympanograms converted to Type A after 3 months and all Type C tympanograms normalized [16]. Giri et al. observed comparable audiological recovery after microdebrider-assisted adenoidectomy, especially when the tissue overlaying the Eustachian tube opening was completely cleared [18]. Sano et al. stressed that urgent surgical intervention should be performed to avoid irreversible tympanic membrane damage due to persistent undetected OME mediated by inflammatory mediators such as prostaglandins [19].

Our results confirm that adenoid hypertrophy leads to middle ear dysfunction along a spectrum that worsens with increasing adenoid size, and that adenoidectomy restores these alterations in most patients within 3 months. The clinical implications are obvious; all children presenting with symptomatic adenoid hypertrophy must be screened audiologically and tympanometrically as a large proportion may have unrecognized conductive hearing loss that may otherwise adversely affect speech, language and educational outcomes [20].

Limitations: The relatively small sample size, single-center design, and short follow-up period (3 months) are notable limitations. Longer-term studies are warranted to assess the durability of postoperative gains and any late recurrence of OME.

CONCLUSION

This study demonstrates that the grade of adenoid hypertrophy is significantly associated with middle ear dysfunction and conductive hearing loss in children. Higher adenoid grades (3 and 4) correlate with increased prevalence of abnormal tympanograms (Types B and C) and progressively severe hearing impairment. Adenoidectomy produces marked improvement in middle ear function and hearing thresholds within 3 months in the vast majority of patients. Routine audiological and tympanometric assessment should therefore be considered an integral component of the workup in every child with adenoid hypertrophy, enabling early detection of subclinical OME and timely surgical intervention to safeguard speech, language, and academic development.

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