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# Correlation between tympanometric findings and adenoid hypertrophy among children without hearing loss in tertiary care hospital

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## Abstract

Adenoid hyperplasia is a common cause of nasal obstruction in children. Chronic infection and hypertrophy result in mouth breathing, snoring, sleep apnoea, hyponasality, sinusitis, and otitis media with effusion (OME). Some children with adenoid hypertrophy have OME in spite of having no complaints of hearing loss. Untreated OME may adversely affect the speech and intellectual development of the child.

**Aim** To determine whether there is a correlation between tympanometric findings and various radiological and endoscopic grades of adenoid hypertrophy.

To propose a combination of radiological and/or endoscopic assessment of adenoids and tympanometry as a screening program in patients with suspicion of adenoid hypertrophy.

**Materials and methods** One hundred children, presenting with one or more complaints of upper airway obstruction (UAO), suggestive of adenoid hypertrophy, without a history of hearing loss, to the OPD, were chosen for the study. X-ray nasopharynx soft tissue lateral view was done for all patients. Rigid diagnostic nasal endoscopy with 0° endoscope was conducted in only children who were cooperative and with parental consent. Tympanometry was carried out for all patients and plotted on tympanograms.

**Results** In our study, the mean age of children is 9.43 ± 2.430 years with gender distribution being 57% males and 43% females. The majority of children tend to present with nasal obstruction (100%), mouth breathing (83%), and snoring (56%). On both radiological and endoscopic evaluation of adenoids and correlation with tympanogram, a significantly higher number of patients with Grade 1 adenoids have a type A curve, while a significantly higher number of grade 3 adenoids patients have a type B curve and type C is significantly more prevalent in grade 2 and grade 4 adenoids ($p < 0.05$).

**Conclusion** In our study, adenoid size as measured from both adenoid X-ray and adenoid endoscopy, showed a significant association with the presence of middle ear effusion and also with eustachian tube dysfunction. This helps in early detection, prior to the development of hearing loss, making it easy to plan early intervention, and curbing the possibility of aggravation of the condition and occurrence of complications.

**Keywords** Adenoid hyperplasia, Otitis media with effusion, X-ray nasopharynx, Rigid Diagnostic nasal endoscopy, Tympanometry, Eustachian tube dysfunction

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## Background

Adenoid hyperplasia is a common cause of nasal obstruction in children [1]. Chronic infection and hypertrophy result in mouth breathing, snoring, sleep apnoea, hyponasality, sinusitis, and otitis media with effusion (OME) [2]. The study of the association of adenoid hypertrophy and otitis media with effusion is well known.

Adenoids can act as a predisposing factor for otitis media with effusion via tubal dysfunction by the following mechanisms:

i. Mechanical obstruction of the tubal opening.
ii. Acting as a reservoir for pathogenic organisms.
iii. In cases of allergy, mast cells of the adenoid tissue release inflammatory mediators that cause tubal blockage [3–5].

Some children with adenoid hypertrophy have OME in spite of having no complaints of hearing loss [6]. Untreated OME may adversely affect the speech and intellectual development of the child.

There are various ways of imaging and visualizing the adenoids, such as lateral radiographs of the nasopharynx, diagnostic nasal endoscopy (DNE), and computed tomography (CT). Pure tone Audiometry (PTA) and tympanometry are commonly used investigations to assess hearing and middle ear pressure respectively. Correlating the above investigations might help in the early diagnosis of secretory otitis media (otitis media with effusion) or other ear complications of nasopharyngeal adenoids, which might help in the early management of adenoids and prevention of permanent hearing loss.

Thus this study aims to determine whether there is a correlation between tympanometric findings and various radiological and endoscopic grades of adenoid hypertrophy and to propose the possibility of using tympanometry in combination with radiological and/or endoscopic examination as a screening program in children with suspicion of adenoid hypertrophy.

## Methods

The study was started following Institutional Ethical Committee clearance dated 30 August 2021, Reference number: JJMMC/IEC-Syc-109–2021.

### Sample size

Sample size $= Z\alpha^2 P (1\text{-}P) / d^2$

$Z\alpha^2$ = Std normal variate 1.96

$P$ = Expected proportion from population

$d$ = Absolute error

The prevalence of adenoid hypertrophy reported in a systematic review and meta-analysis study is 34.46%, considering a 10% error minimum sample needed to conduct this study is 87 cases. Thus, 90 or 100 cases were to be selected.

One hundred children, presenting with one or more complaints of upper airway obstruction (UAO), suggestive of adenoid hypertrophy, without a history of hearing loss as per their parents or guardians were chosen for the study.

Following inclusion and exclusion criteria were followed:

### Inclusion criteria

1. Children between the age group of 3–12 years presenting with a history suggestive of adenoid hypertrophy without hearing loss, without prior diagnosis of the same.
2. With parental or guardian consent and cooperation.

### Exclusion criteria

Children with presenting complaints of hearing loss or suggestive of the same such as communication difficulties, withdrawal and lack of attention, previous history of adenoidectomy, cerebral palsy, genetic syndrome, active sinonasal and throat infections, ear discharge, tympanic membrane perforation, cleft palate, congenital ear deformities, craniofacial anomalies, and those not willing or unable to get tympanometry done were all excluded from the study.

A complete history was taken. In addition, parents were questioned regarding suspicion of reduced hearing or hearing loss. Otorhinolaryngological examination was done in detail including otoscopy to check for tympanic membrane status.

X-ray nasopharynx soft tissue lateral view was done for all patients with the head in a slightly extended position with the mouth closed while breathing through the nose. Adenoid thickness (Johanneson method), adenoid to nasopharynx ratio (Fujioka method), and airway to soft palate ratio (Cohen and Konak method) were derived from this and used for grading of adenoids for further analyses.

Rigid nasal endoscopy was carried out using a 0° endoscope after prior local anesthesia by packing bilateral nasal cavities with pledgets soaked in 4% Lignocaine with Adrenaline solution with Xylometazoline drops for 15–20 min. Images recorded during endoscopy were evaluated and an obstruction ratio of adenoid tissue to choanal opening was calculated in percentage. This was conducted only on compliant children with prior parental consent.

Pure tone audiometry was performed and tympanometry was carried out for all patients using a probe tone

frequency of 226 Hz and plotted on tympanograms classified as per Jerger classification into A, As, Ad, B, and C curves.

IBM SPSS Version 22 for Windows was used for analyzing the data.

## Results

A total of 100 subjects were included in the study. The mean age group in the study was 9.43 ± 2.430 with a gender distribution of 57% males and 43% females.

Our study showed that the majority of children tend to present with nasal obstruction (100%), mouth breathing (83%), and snoring (56%). Clinically, no child had complaints of hearing loss.

On radiological examination of the nasopharynx, 30% of patients were seen to have grade 3, 29% had grade 4, 26% had grade 2, and 15% had grade 1 adenoid hypertrophy (AH), while on diagnostic nasal endoscopy, 28.33% patients had grade 3 and 26.67% had grade 2, 23.33% had grade 4, and 21.67% had grade 1 adenoid hypertrophy (Fig. 1a, b). There was no statistically significant difference in the grades of adenoid on DNE and X-ray grades of adenoid.

On otoscopy, 44 (42.7%) tympanic membranes (TM) examined of patients with grade 3 AH on radiograph showed retraction ($P=0.0000$), while, 22 (40.7%) TMs of children with grade 3 AH on DNE showed retraction ($P=0.0003$). These were found to be statistically significant.

A significantly higher number of patients with grade 1 AH have type A curve (30, 71.4%), while significantly higher number of grade 3 AH patients have type B curve (56, 57.1%), and type C is significantly more prevalent in grade 2 (28, 46.7%) and grade 4 (28, 46.7%) AH. A significant association was found between tympanometric curve and X-ray grade of the adenoid ($p<0.05$) (Fig. 2a).

On pure tone audiometry done to assess hearing, mean right ear hearing loss was 17.1050 ± 8.09455 db, and mean left ear hearing loss was 16.4175 ± 8.55848 db (Table 1).

Among subjects with type A tympanic curve, the majority, that is, 24 (57.1%) showed grade 1 adenoid on DNE. Among subjects with type B tympanic curve, the majority, that is, 29 (29.6%) showed grade 3 adenoid. Among subjects with type C tympanic curve, the majority, that is, 17 (28.3%) showed grade 4 adenoid on DNE. A significant association was found between the type of curve and grade on DNE ($p<0.05$) (Fig. 2b).

## Discussion

Adenoid hypertrophy can result in upper airway obstruction, either partially, or, completely. This in turn narrows the airway lumen which might cause eustachian tube dysfunction due to negative air pressure. On the other hand, the pharyngeal end of the auditory tube might be obstructed directly by the hypertrophied adenoid tissue, thus predisposing to OME [4, 7, 8].

Over the years, various modalities of treatment for adenoid hypertrophy with or without otitis media with effusion have been developed starting from, conservative management by medical therapy via topical steroid spray [9], to various surgical means such as conventional adenoidectomy, endoscopic adenoidectomy via laser, microdebriders, or coblation adenoidectomy [10, 11]. Even adenoidectomy at times is combined with myringotomy with or without grommet insertion [12].

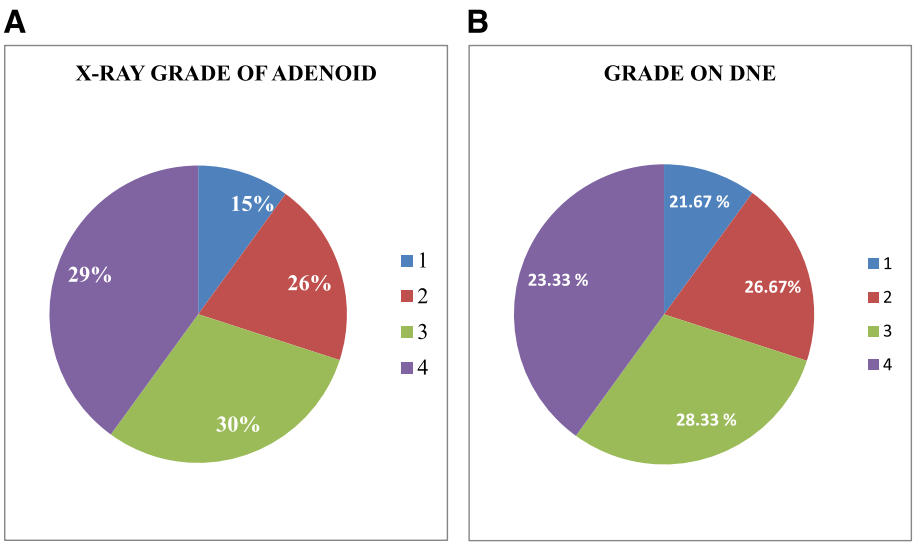


**Fig. 1** **a**, **b** Grades of adenoid hypertrophy as seen on X-ray and DNE

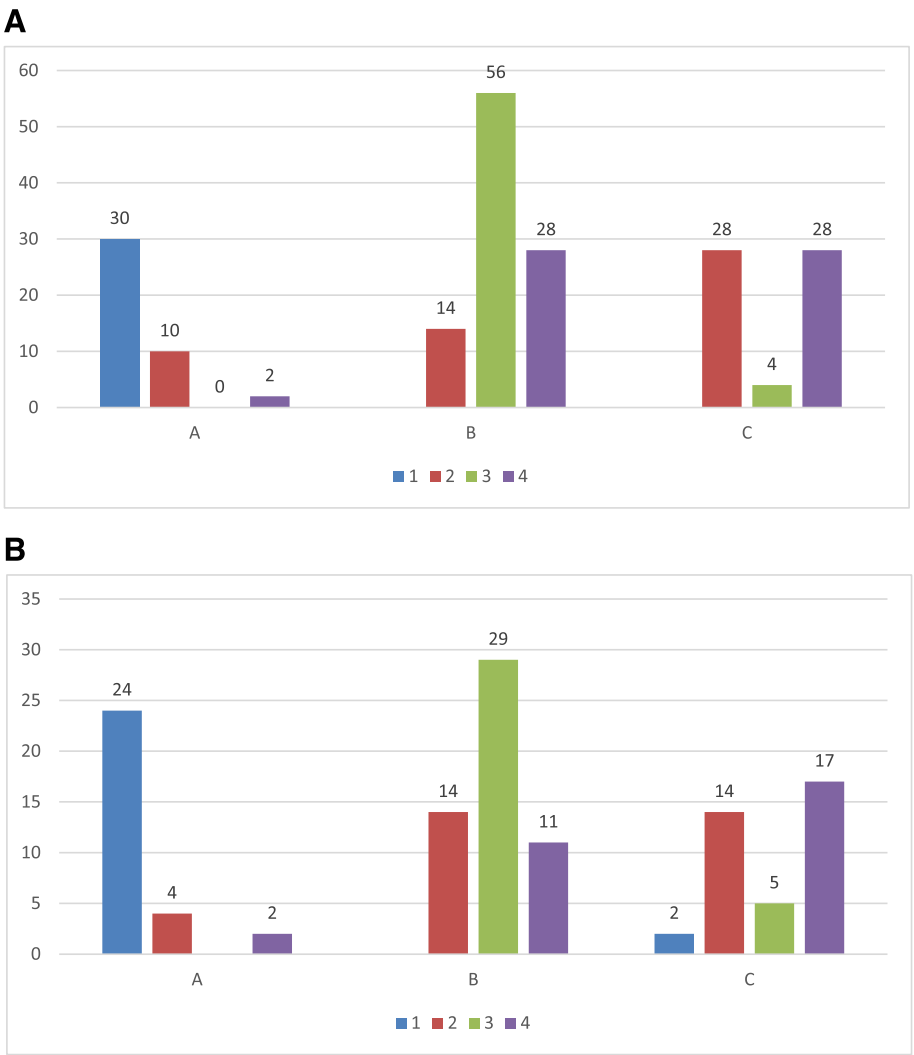


**Fig. 2** **a** Association of tympanometric curve with X-ray grade of adenoid. **b** Association of type of tympanometric curve with grade on DNE

**Table 1** Mean hearing loss among study subjects

| | Minimum | Maximum | Mean | SD |
|---|---|---|---|---|
| Right hearing loss (dBhl) | 10.00 | 55.00 | 17.1050 | 8.09455 |
| Left hearing loss (dBhl) | 10.00 | 60.00 | 16.4175 | 8.55848 |

*Inference*: Mean right hearing loss was 17.1050 ± 8.09455 db and mean left hearing loss was 16.4175 ± 8.55848 db

In our study, we aimed to study the relationship between tympanometric findings and various radiological and endoscopic grades of adenoid hypertrophy. This study was intended to potentially help in early detection through a screening program, a combination of radiological and/ or endoscopic assessment of adenoids and tympanometry, which could be followed with an early, adequate, suitable intervention that may lessen the chances of progression of disease and complications, thus effectively combating against the disease.

Conductive hearing loss may be associated with loss of speech in otitis media with effusion, which may have gone unnoticed. A study by Vadisha Bhat et al. [13] showed that on pure tone audiometry performed even when patients had no complaints of hearing loss, a total of 12.5% showed significant hearing loss of more than 25 dB. In our study, the mean right ear hearing loss was 17.1050 ± 8.09455 db, and the mean left ear hearing loss was 16.4175 ± 8.55848 db.

The study by Chibuike Nwosu et al. [14] showed the incidence of OME among patients with adenoid hypertrophy was 55.9% with more type B (29.4%) than type C (26.5%). This study showed a significant association between grade 3 AH and OME when compared with other grades of AH. In the study by Hamza SB et al. [15],

the most common tympanogram found was type B (96 ears, 48%) and the least common was type A (40 ears, 20%).

Similar to the above results, in our study, a significant association was found between the Tympanometric curve and X-ray grade of the adenoid ($p < 0.05$). That is, a significantly higher number of patients with grade 1 adenoids have type A curve (30, 71.4%), while a significantly higher number of grade 3 adenoid patients have type B curve (56, 57.1%) and type C is significantly more prevalent in grade 2 (28, 46.7%) and grade 4 (28, 46.7%) adenoids. This clearly indicates an association between ET dysfunction and OME in the population who present with clinical features of adenoid hypertrophy.

Contrary to the above-mentioned studies and our study, in the study done by Sema Zer Toros et al. [16], there was no statistically significant difference in radiologic measurement values according to tympanogram types.

In the study done by Nishanth Savery et al. [17], which used DNE to assess adenoid hypertrophy, most children had B type (58%), 35% had A type curve on tympanometry, but there was no significant statistical association between adenoid size and the distribution of tympanometry curve ($p$ value $> 0.05$).

Contrary to the above, in our study, a significant association was found between the type of curve and grade on DNE ($p < 0.05$), wherein, a significantly higher number of patients with grade 1 adenoids had type A curve (24, 57.1%), while a significantly higher number of grade 3 adenoids patients had type B curve (29, 29.6%) and type C was significantly more prevalent in grade 2 (14, 23.3%) and grade 4 adenoids (17, 28.3%). This again correlates with the above statement of the association of ET dysfunction and OME in the population who present adenoid hypertrophy.

Studies by Islam MA et al. [18], Kumar A et al. [19], Sogebi OA et al. [20], and Sherin Maria Augustian et al. [21] had results similar to our study and studies as mentioned above, being, an association between adenoid size, and occurrence of OME and hearing loss.

A study by Günel C et al. [22] involved a comparison of tympanometric findings before and after adenoidectomy and showed that the median negative middle ear pressure prior to the surgery was significantly higher as compared to that after surgery ($p = 0.045$). Preoperatively, the tympanogram showed a type B curve in 13 of the 112 ears, while, close to 17.9% ($n = 20$) of the ears with otitis media with effusion was confirmed by myringotomy procedure. Unlike this study, our study was restricted to radiological, endoscopic, and tympanometric findings in suspected adenoid hypertrophy prior to any sort of medical or surgical involvement.

## Conclusion

Children with adenoid hypertrophy have a higher incidence of otitis media with effusion. Specifically, higher grades of adenoid hypertrophy may result in otitis media with effusion, even when the child may have no ear complaints or complaints of reduced hearing.

The tympanometry test is an objective test that can easily be performed to detect OME. Adenoid size, as measured from both X-ray nasopharynx soft tissue lateral view and diagnostic nasal endoscopy, showed a significant association with the presence of middle ear effusion. As the X-ray grade of the adenoid and that of DNE, had no statistical difference, either one of them in combination with tympanometry can be used for screening in the pediatric age group on suspicion of adenoid hypertrophy. This helps in early detection (prior to the development of hearing loss), making it easy to plan early intervention, thus, curbing the possibility of aggravation of the condition and occurrence of complications.

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#### Authors' contributions
All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by Dr. K. P. Basavaraju, Dr. S. K. Ranjani, Dr. Sri Vaibhava V, and Dr. Sushmita Sulhyan. The first draft of the manuscript was written by Dr. S. K. Ranjani and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

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#### Availability of data and materials
The data used in this study was not used/published in any other publications.

## Declarations

#### Ethics approval and consent to participate
The study was done after approval from the Institutional Ethics committee from JJM Medical College, Davangere, Karnataka, India, dated 30/08/21, Reference number: JJMMC/IEC-Syc-109-2021, in accordance with ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Written informed consent was taken from all the parents of the patients.

#### Consent for publication
Not applicable.

#### Competing interests
The authors declare that they have no competing interests.

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