A Case–Control Study on the Association Between Endoscopic ACE Grade of Adenoid Hypertrophy and Hearing Loss in Children and Its Impact on Speech and Language Development

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Abstract To establish an association between adenoid hypertrophy and hearing loss and its impact on speech and language in pediatric age group. A prospective case control study done in a tertiary hospital in South India. Twenty children with hearing loss were recruited in the study group and twenty-four children as controls. These groups underwent at detailed otorhinolaryngologic examination, hearing and speech evaluation. The size of the adenoids was graded endoscopically. Findings between the two groups were compared and analysed. Our study found statistically significant association between adenoid hypertrophy with choanal obstruction and abutment of eustachian tube opening seen on endoscopy with hearing loss ($p = 0.025$). The children with hearing loss also had speech and language delay ($p = 0.004$). Children with enlarged adenoids obstructing the $> 50\%$ of the choanae or abutting the eustachian tube opening are more likely to have hearing loss and may develop speech and language delay. The ACE endoscopic adenoid grading system is consistent and reliable in evaluation of adenoids.

Keywords Hearing loss · Adenoid hypertrophy · ‘ACE grading’ of adenoids · Endoscopic grading of adenoids · Speech delay

Introduction

Hearing impairment in children is a major health burden in India and other developing countries. Jacob et al. [1] reported the prevalence of hearing impairment in South Indian primary school children at 11.9%, the overwhelming majority were conductive type due to middle ear pathology. Enlarged pharyngeal tonsils or ‘the adenoids’ are a significant cause of causing eustachian tube dysfunction in the pediatric age group [2]. Eustachian tube obstruction causes negative pressure and impaired ventilation in the middle ear, leading to middle ear disease. Otitis media with effusion (OME) and Chronic otitis media (COM) have been identified as the most common causes for hearing loss in early childhood [3, 4]. Although opinions vary about the extent of impact on the learning ability of the child, most studies express concern. The problem is amplified in suboptimal listening situations where speech perception may be impaired by even a mild hearing loss [5]. The hearing loss is largely preventable and it adversely affects the learning capability and is a burden on both in individual and the nation [6, 7].

There is inadequate evidence in the literature on the role of adenoids on hearing loss in children. This study attempts to look for correlation between the endoscopic size of adenoids with hearing loss in children. The impact of hearing loss on the development of speech and language is the secondary objective of this study.

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Materials and methods

Study Design and Participants

This is a prospective case control study that was conducted in the department of Otorhinolaryngology of a tertiary hospital for duration of 11 months, between August 2012 and June 2013 after institutional review board approval. All children were recruited in the study after parental consent. In addition, an assent was obtained in children older than seven years of age. Children presenting with hearing loss to the outpatient clinic were evaluated and those with conductive hearing loss were invited to participate in the study. Twenty children with conductive hearing loss aged between 4 and 16 years were recruited in the study group. Syndromic children and children with sensorineural hearing loss were excluded. Twenty-four children in the similar age group presenting to pediatric otolaryngology outpatient clinic with no ear or nose complaints and volunteering to participate in the study were recruited as controls. The exposure factor studied was the presence of adenoid hypertrophy.

Evaluation

The participants in both the groups underwent a detailed clinical evaluation by a pediatric otolaryngologist. Presence of any significant nasal complaints and its severity was looked into and the parental awareness of any speech/articulation problems was also explored. Any debris or discharge in the ear canal was cleared and tympanic membrane was visualized. In children with an intact tympanic membrane, pneumatic otoscopy was performed. Speech evaluation was done by a speech and language pathologist for both the groups to look for any speech delay or misarticulations. Receptive and expressive emergent language scale 3 (REELS) and Extended REELS was used in children younger than 10 years. Linguistic profile test (LPT) was used in older children for the speech evaluation. An office based rigid nasal endoscopy under topical anesthesia was used to determine the endoscopic grade of adenoids. No sedation was used during or prior to the procedure. The nose was sprayed with Lignocaine 4% solution for 10 min prior to the procedure. Storz 2.7 mm diameter Hopkins's rod endoscope with a Karl Storz-TELECAM1 SL II single chip camera was used for the procedure and the images were recorded onto a computer. ACE endoscopic grading of adenoids was used to grade of adenoids [8] (Fig. 1).

Fig. 1 Adenoids visualized from the posterior part of left nasal cavity, just proximal to the choanal and posterior end of inferior turbinate in view (Adenoids: *; Nasal septum: X)

Statistical Analysis

Analysis was done using SPSS software-version 21. Chi square test was used to analyze the association between quantitative variables such as Endoscopic grade of adenoids (A), Choanal Obstruction (C) and Eustachian tube obstruction (E) with hearing loss in both the case and control groups. The speech delay was compared in both the groups using Fisher's exact test.

Results

Demographic Data and Symptomatology

Both the groups were comparable to each other in terms of age and gender distribution. Fourteen of the twenty subjects in the study group presented with ear discharge along with hearing loss. The symptoms of nasal obstruction, snoring and mouth-breathing are clinically suggestive of adenoid hypertrophy and were predominant in the study group (Table 1).

Severity of Hearing Loss

Hearing loss being the outcome in the study, the severity of hearing loss was looked at. Majority of children in the study group had mild hearing loss i.e., 25–40 dB. Only one child had a hearing loss above 55 dB (Table 2).

Table 1 Case and control group compared in terms of gender, age and symptoms

	Cases (n = 20)	Controls (n = 24)
Gender		
Male	12	14
Female	8	10
Age distribution		
≤ 5 years	3	3
6–10 years	13	12
> 11 years	4	9
Ear discharge		
Absent	6	24
Present	14	0
Obstructive symptoms		
Nasal obstruction	12	3
Snoring	10	3
Mouth breathing	8	2

Table 2 Severity of hearing loss- 8 cases had hearing loss exceeding 40 db (7 moderate and 1 moderately severe)

Severity of hearing loss	No.
Mild	12
Moderate	7
Moderately severe	1

Endoscopic ACE Grading

Airway grading was from 0 to grade 4. Majority of the subjects in the control group were grade 2 and below. In the study group, nine were grade 2 and six were grade 3 (Table 3). The airway grading ‘A’ was, not statistically

Table 3 The ACE grading of adenoids—the A or airway of adenoids shows a trend towards larger adenoids in cases in comparison to the control group

ACE grading components	Grade	Cases (n = 20)	Controls (n = 24)
Airway obstruction	0	0	1
	1	5	6
	2	9	15
	3	6	2
	4	0	0
Choanal obstruction	0	8	16
	1	8	8
	2	4	0
Abutment of eustachian tube opening	0	12	21
	1	8	3

The choanal obstruction and eustachian tube obstruction are predominantly in the cases

significant but numerically larger in the case group. There was a strong association between adenoids hypertrophy with > 50% of the choanal obstruction i.e. C2 grade and hearing loss ($p = 0.025$; odds ratio = 13.36). Similarly, adenoids abutting the eustachian tube opening i.e. E1 grade and hearing loss showed a strong association ($p = 0.025$; odds ratio = 4.66).

Speech and Language

Speech and Language delay and misarticulations were identified in seven children in the case group. There was no speech and language delay or misarticulations in children from the control group. These findings were statistically significant ($p = 0.004$; odds ratio = 27.22).

Discussion

Hearing plays a significant role in speech and language development. Acute otitis media, otitis media with effusion and chronic otitis media are part of the same pathogenesis with varied outcome. The etiology is multifactorial and not yet fully understood to why some develop only a single episode while others develop otitis media with effusion or chronic otitis media [9, 10]. Jacob et al. [1] in 1997 in a study conducted in a school in rural district of Tamil Nadu, diagnosed 10.9% of the children in the school with conductive hearing loss and 5.3% with a chronic otitis media mucosal disease. In the present study, fifteen subjects in the case group were diagnosed with chronic otitis media and presented with history of hearing loss associated with ear discharge. Ten subjects were diagnosed as otitis media with effusion based on pneumatic otoscopy, audiometry and tympanometry findings.

A detailed clinical evaluation can give a good estimation of severity of symptoms due to upper airway obstruction [11]. Nasal obstruction, snoring and mouth breathing are important symptoms indicating upper airway obstruction with adenoid hypertrophy being a common cause of upper airway obstruction in children [12]. In the present study, the study group had significantly higher number of children with nasal obstruction, snoring and mouth breathing. Kindermann et al. found adenoid hypertrophy as the commonest cause of nasal obstruction in children. They reported adenoid hypertrophy in 53% of children with nasal obstruction [13].

Nasal endoscopy is an indispensable tool in the evaluation of adenoids. Wormald evaluated adenoids endoscopically and proposed a grading system analogous to the Brodsky grading of adenoids and tonsils [11, 14]. But the relationship to the eustachian tube opening and the choanae was not looked into. Various authors replicated similar

studies. Acharya and colleagues found statistically significant correlation between grade 4 adenoid enlargement and otitis media with effusion [15]. Saedi et al. [16] found adenoid size assessed endoscopically co-relating with number of episodes of acute otitis media and concluded that endoscopic and radiologic findings complementary to each other. Parikh et al. [17] proposed modification to the endoscopic grading and introduced the relationship of adenoids to the torus tubaris, the vomer and the soft palate. The grading system proposed was adenoid tissue not in contact with any structure was considered grade 1 and if in contact with the torus tubaris as grade 2. If adenoid tissue is in contact with vomer, as grade 3 and touching soft palate as grade 4. This system was an improvement on the earlier methods. It addressed the relationship of adenoids to adjoining structures which was not seen in Wormald's endoscopic grading. However, in practice, there are can be a lot of variations in size and relationship of adenoids to the various structures in nasopharynx. For example, adenoid tissue may be in contact with vomer but not torus tubaris. Or as in a case of revision adenoidectomy, adenoid may be in contact with vomer and soft palate and not the torus tubaris. These anatomic variations cannot be accommodated in this system. Hence these structures need to be addressed individually.

Varghese et al. [8] proposed the ACE endoscopic grading of adenoids which was used in the present study has three components- the airway obstruction, the choanal obstruction and abutment of eustachian tube opening. Any anatomic variations can easily be accommodated in the ACE endoscopic grading system. Each side can be graded separately, if asymmetric. The present study found no statistically significant association with the size of the adenoids, i.e., A of the ACE grading, though numerically larger grade in study group than the control group. However, there was a strong and statistically significant association of hearing loss with both choanal obstruction $> 50\%$ ($p = 0.025$) and abutment of eustachian tube opening ($p = 0.025$) i.e., 'C' and 'E' of the ACE grading. This strong association endorses the view for evaluation and grading the adenoidal relationships to choanae and eustachian tube separately as these can be more reliable predictors than just the size of adenoids.

Hearing loss during early childhood can adversely affect the speech perception abilities and language development. Zumach et al. [18] reported that both speech perception and articulation are affected in children with OME. Maw et al. [19] suggested that OME lessened the child's learning potential and auditory deficit hampers the child's listening skills, which in turn cause problems in reading and spelling. They found that if it is left untreated, child may develop expressive language delay in the long run. They suggested myringotomy and grommet insertion may benefit

such children. On the contrary, Roberts and colleagues found no statistically significant association between OME and later speech and language development [20]. In the present study, we found as strong association between hearing loss and speech delay. Seven of twenty children in study group had mild speech and language delay which was statistically significant ($p = 0.004$). The speech delays were both receptive and expressive. Also, two of these seven children had additional misarticulations.

Limitations of the study The major limitation of the study was that the study and control groups were not age and gender matched, but the trends in both the groups were similar and unlikely to affect the outcome of the study.

Conclusion

Our study found an association between adenoid hypertrophy and hearing loss. We found a strong association between endoscopic grading of adenoids—both choanal obstruction of $> 50\%$ and abutment of the eustachian tube opening with hearing loss ($p = 0.025$). The children with hearing loss had speech and language delay in comparison to the control group ($p = 0.004$).

Thus, we can conclude that children with adenoid hypertrophy obstructing the choanae or abutting the eustachian tube opening are more likely to have hearing loss and may develop speech and language delay. The proposed endoscopic adenoid grading system is consistent and reliable in evaluation of adenoids.

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