



ASSESSMENT OF THE MIDDLE EAR FUNCTION IN CHILDREN WITH ADENOID HYPERTROPHY BY NOTING FINDINGS IN TYMPANOMETRY & PURE TONE AUDIOMETRY (PTA) AND RECORD CHANGES POST ADENOTONSILLECTOMY

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ABSTRACT

Background: The effects of adenoid hypertrophy on the nasal airway obstruction is a well documented entity among otolaryngologist but the effects of adenoid hyperplasia on the middle ear, has long remained a challenging subject. **Aim:** To assess the middle ear function in children with adenoid hypertrophy pre-operatively and post operatively after adenotonsillectomy. **Materials And Methods:** This prospective study involves children reporting to the Department of ENT at CSSH, SVSU, Meerut. A total of 50 cases of clinically and radiologically diagnosed adenoid hypertrophy were studied and subjected to Adenotonsillectomy and changes in middle ear function and hearing were noted by tympanometry and pure tone audiometry (PTA) pre operatively and at six weeks follow up post operatively. **Results:** Our present study showed significant improvement in the type of graph, pressure, compliance and Air-Bone gap implying conductive hearing gain. Adenotonsillectomy has a positive effect on middle ear function. Six weeks postoperatively as healing occurs, inflammation & oedema resolve and middle ear function improves significantly.

KEYWORDS

Adenoid Hypertrophy, Eustachian tube dysfunction, Tympanometry, Pure Tone Audiometry, Middle Ear Function, Adenotonsillectomy.

INTRODUCTION:

The impact of both infection and obstruction from tonsil and adenoid on the child's health may not be localized just to the tonsil or adenoid alone. Major ill effects on the related anatomical structure like nose and Paranasal sinus, Eustachian tube, and middle ear cleft are well established.¹ Therefore it takes part in the pathogenesis of rhinosinusitis, recurrent otitis media, and otitis media with effusion.² Chronic infection of adenoids acts as a focus of infection adjacent to Eustachian tube orifice causing retrograde infection and tubal dysfunction.³ Tonsil as a potential source of infection is also implicated.⁴ Adenoids causes tubal obstruction at its pharyngeal opening. It causes reduction in middle ear pressure towards negative side due to absorption of gas leading to otitis media with effusion.⁵

Tympanometry provides an effective screening test for the detection of negative middle ear pressure.⁶ It has been demonstrated both by radiological techniques and middle ear pressure studies that adenoids do obstruct the Eustachian tube and adenoidectomy relieves obstruction.⁷

The effects of adenoid hypertrophy on the nasal airway obstruction is a well documented entity among otolaryngologist but the effects of adenoid hyperplasia on the middle ear, has long remained a challenging subject. Thus in our study, we aim to investigate the effects of adenoid hypertrophy on middle ear function by noting the tympanometry and Pure Tone Audiometry (PTA) findings, pre and post adenoidectomy, even in children without parental suspicion of hearing loss and to see the efficacy of adenoidectomy in improving middle ear function.

MATERIALS AND METHODS:

The study was conducted in the Department of Otorhinolaryngology and Head and Neck Surgery and Department of Radiology at Netaji Subhash Chandra Bose Subharti Medical College, Swami Vivekanand Subharti University, Meerut. The study was conducted between January 2017 to June 2018 (18 months). **Inclusion Criteria:** Subjects with symptoms and signs of enlarged adenoids in age group of 5 years to 15years.

Exclusion Criteria:

Subjects with perforation of tympanic membrane, patients with external auditory canal anomalies and disease, patients with cleft palate, patients with previous ear or palatal surgeries.

An informed consent was taken from all patients fulfilling the inclusion and exclusion criteria. A detailed history was taken. Special emphasis was laid on symptoms of enlarged adenoids including nasal obstruction (partial or complete) leading to mouth breathing or snoring and nasal discharge and symptoms of Eustachian tube obstruction like ear ache, blocked feeling ears, impaired hearing, tinnitus and throat complaints like sore throat and duration of said complaints.

A complete general physical and systemic and ENT examination was done. Soft tissue lateral digital radiograph of nasopharynx in erect position was done to confirm adenoid hypertrophy. Otoscopy was done to view the condition of the tympanic membrane. Audiological investigations like pure tone audiometry (PTA) and impedance audiometry were done for assessment of middle ear function.

RESULTS:

A total of 50 cases of clinically and radiologically diagnosed adenoid hypertrophy were studied and subjected to PTA and tympanometry to assess middle ear function before adenotonsillectomy and 6 weeks post operatively on follow up to assess the improvement in hearing and the data thus collected were analyzed. Following observations were made:

Most of the patients belonged to the age group 5-10 years i.e 32 patients (64%) as compared to 18 patients (36%) in the age group 11-15 years. The male:female ratio was found to be 4:1. 98% of the cases presented with nasal obstruction, 92% with mouth breathing, 86% with snoring, 56% with sore throat and 56% with impaired hearing, and only 4% with ear ache. Obstructive sleep apnea was reported in 4% cases only. Most of the children were uncooperative for postnasal examination. Adenoids were visualized in only 26% cases. 98% of cases presented with either Hypertrophied tonsils or hypertrophied and congested tonsils.

All patients underwent Adenotonsillectomy and were followed up. Following is the data analysis collected pre-operatively and post-operatively on sixth week follow up :

Otoscopic examination revealed that pre-operatively 81 ears presented with abnormal tympanic membrane appearance and that 57 ears out of 81 ears improved post operatively. Table 1 shows that all 33 Type C tympanograms pre-operatively changed to Type A post-operatively. Out of 55 Type B pre-operative tympanograms, 39 showed change post-operatively (28 changed to Type A, 11 changed to Type C) and 16 showed no change. All 4 Type As tympanograms showed no change post-operatively.

Table 1 : Change In Type Of Tympanogram Pre And Post Operatively

No. Of Ears	Type Of Tympanogram (Pre Op)	Type Of Tympanogram (Post Op)
8	Type A	Type A
4	Type As	Type As
28	Type B	Type A
11	Type B	Type C
16	Type B	Type B
33	Type C	Type A

Post operatively Tympanogram showed considerable improvement in average middle ear compliance at 0.9145 ml from 0.495 ml pre-operatively (Table 2). There was significant decrease in average negative middle ear pressure from -204.91 daPa pre-operatively to -74.62 daPa post-operatively (Table 3).

Table 2 : Mean Compliance Pre And Post Operatively

Number Of Ears	Mean Compliance (ml)	Mean Compliance (ml)
	Pre Op	Post Op
Right Ears (50)	0.414	0.837
Left Ears (50)	0.545	0.992
All Ears (100)	0.4795	0.9145

Table 3 : Mean Pressure Pre And Post Operatively

Number Of Ears	Mean Pressure	Mean Pressure
	Pre Op	Post Op
Right Ears (50)	-191.00 daPa	-77.88 daPa
Left Ears (50)	-218.82 daPa	-71.36 daPa
All Ears (100)	-204.91 daPa	-74.62 daPa

Table 4 shows Pure Tone Audiometry (PTA) features pre and post operatively. Pure Tone Audiometry pre-operatively showed Mean Air-Bone Gap (Conductive gap) to be 25.81 dB in right ear and 21.68 dB in left ear ie; mean conductive hearing loss of 23.74 dB. Pure Tone Audiometry post operatively showed mean conductive hearing loss of 16.19 dB (Mean Air-Bone Gap was found to be 17.00 dB in Right Ear and 15.38 dB in Left Ear), a significant change from pre-operative mean conductive hearing loss of 23.74 dB.

Average Air-Bone (AB) Gap closure was 8.81 dB in right ear and 6.30 dB in left ear. Mean Air-Bone (AB) Gap closure in all 100 ears was 7.55 dB showing considerable amount of hearing gain.

Table 4 : Mean Values Of Pure Tone Audiometry Features Pre & Post Operatively

Number Of Ears	Mean AB Gap	Mean AB Gap	Mean AB Gap
	(AC-BC) Pre Op (dB)	(AC-BC) Post Op (dB)	Closure (Pre Op - Post Op) (dB)
Right Ears (50)	25.81	17.00	8.81
Left Ears (50)	21.68	15.38	6.30
All Ears (100)	23.74	16.19	7.55

DISCUSSION:

Clinical examination of children with nasal obstruction is notoriously unreliable. Radiographic evaluation of nasopharynx (soft tissue lateral view of neck) is established as a simple method for determination of the size and position of the adenoids.⁸ This will give the measure of the absolute size of the adenoids and also an assessment of the relation to the size of the airway.⁹ Tympanometry and Pure Tone Audiometry provide effective monitoring for middle ear function pre and post adenotonsillectomy.

50 patients, diagnosed as having enlarged adenoids, aged 5 years to 15 years were considered in our present study. Majority of the children were male (80%) and in the age group 5-10 years (64%). 98% of the cases presented with nasal obstruction, 92% with mouth breathing, 86% with snoring, 56% with sore throat and 56% with impaired hearing, and only 4% with ear ache. Number of patients that presented with nasal complaints were much more as compared to ear and throat complaint indicating that the parents identify nasal symptoms easily as compared to aural symptoms. Obstructive sleep apnea was reported in 2 cases which is in accordance with the study of Redline S et al¹⁰ which reported that Pediatric Obstructive Sleep Apnea (OSA) affects 2-3% of children. Adenotonsillar hypertrophy is the most commonly recognized anatomic risk factor for pediatric obstructive sleep apnea. Adenoid hypertrophy can partially or completely obstruct the nasal airway. Jeans W.D et al¹¹ in their study have confirmed that enlarged adenoid led to mouth breathing. Study of Fujioka M et al⁸ showed that the size of the adenoid varies from child to child and also in the same individual as he/she grows. The adenoids attain their maximum size between 4-8 years and gradually decrease afterwards. Our study correlates with the study of Sarwar et al¹², who in a prospective study of 60 patients (children) diagnosed as having enlarged adenoids found that majority of them were male (62.85%) and 53.33% were in the 5-10 years age group. They also found that most of the patients presented with multiple symptoms, the commonest was the hearing impairment (58.33%). Other common symptoms were mouth breathing (50%), Nasal obstruction (50%), snoring (46.67%).

In our present study, adenoids were visualized in only 26% cases. Most of the children were uncooperative for postnasal examination leading to difficult clinical evaluation of adenoid size by postnasal examination. Concomitant involvement of tonsil was seen in 98% of cases which indicated a common etiological factors acting on both adenoids and tonsils. Soft tissue lateral digital radiograph of nasopharynx in erect position was done to confirm adenoid hypertrophy. All patients were subjected to adenotonsillectomy.

Pre and post operative findings of our present study of 50 patients :

Six weeks post op, during follow up, the Otoscopic examination, Tympanogram and Pure Tone Audiometry results showed that there were significant changes in the appearance of Tympanic membrane, Tympanogram types and improvement in conductive hearing loss.

Tympanic membrane: 81 ears presented with abnormal tympanic membrane appearance pre-operatively whereas 19 ears presented with normal tympanic membrane appearance. Post operatively, on Otoscopic examination, significant changes were seen in 57 out of 81 ears. In 55 ears, tympanic membrane appearance changed from retracted pre-operatively to normal post-operatively. 2 ears showed change in tympanic membrane appearance from air fluid level behind TM pre-operatively to retracted post operatively. Hence, 70.37 % (ie; 57/81) ears showed changes in the tympanic membrane appearance post adenotonsillectomy.

Tympanogram: 92 ears showed abnormal type of graph pre-operatively. Post operatively, 72 out of 92 ears showed change in type of graph. All 33 Type C tympanograms pre-operatively changed to Type A post-operatively. Out of 55 Type B pre-operative tympanograms, 39 showed change post-operatively (28 changed to Type A, 11 changed to Type C) and 16 showed no change. All 4 Type As tympanograms showed no change post-operatively. Hence, 78.26 % (72/92) ears showed improvement in type of graph which implies significant change post adenotonsillectomy. **Compliance:** Mean compliance of middle ear changed from 0.4795 ml pre-operatively to 0.9145 ml post-operatively. All ears that showed abnormally low compliance pre-operatively showed improved compliance post operatively after six weeks. **Pressure:** Average negative middle ear pressure changed from abnormally low (-204.91 daPa) pre-operatively to normal (-74.62 daPa) post-operatively. There was significant decrease in mean negative middle ear pressure 6 weeks post adenotonsillectomy.

Pure Tone Audiometry (PTA): Post-operatively, average Air-Bone gap (Conductive gap) in right ear decreased from 25.81 dB to 17.00 dB and in left ear from 21.68 dB to 15.38 dB. Mean conductive hearing loss in all 100 ears changed from 23.74 dB pre-operatively to 16.19 dB post-operatively, thereby showing significant improvement in conductive hearing loss. **Air-Bone gap closure** was 8.81 dB in right ear and 6.30 dB in left ear (ie; average 7.55 dB in both ears) which

points to considerable hearing gain.

Post operative results of our present study showed significant improvement in middle ear function evaluated by Tympanogram and Pure Tone Audiometry post adenotonsillectomy.

Our present study is in concurrence with that of Sandooja D et al¹³ about the effect of adenotonsillectomy on hearing threshold and middle ear pressure which concluded that it improves Eustachian tube function. Gunel C et al¹⁴ studied fifty-six children. They found that the negative middle ear pressure before the adenoidectomy was significantly higher from after adenoidectomy. In their study they concluded that it is pertinent to perform middle ear pressure assessment and tympanometry in children before adenoidectomy even without parental suspicion of hearing loss. In Febin James et al¹⁵ study, hearing evaluation was performed by pure tone audiometry (PTA) and tympanometry preoperatively at time of diagnosis and postoperatively at 6 weeks and 3 months after adenotonsillectomy. They found that pre-operatively most of the subjects were having moderate conductive hearing loss (between 26dB to 40dB) with a mean hearing loss of 34.2dB. At 6 weeks postoperatively, hearing loss of children were within 16-25dB with a mean loss of 21.6dB. Concluding that Adenoidectomy can improve the middle ear function and the hearing profile of child and can be considered as a practical management option in children with chronic adenotonsillar hypertrophy.

CONCLUSION:

The inferences drawn from our present study were:

- Tympanometry and Pure Tone Audiometry are sensitive OPD investigative procedures to assess middle ear function.
- Children with adenoid hypertrophy, confirmed by soft tissue lateral digital radiograph of nasopharynx,
- should be subjected to Tympanometry and Pure Tone Audiometry at the earliest to diagnose effects of adenoid hypertrophy over the middle ear function.
- Adenotonsillectomy has a positive effect on middle ear function and hearing profile of a child diagnosed with adenoid hypertrophy. This is confirmed by comparing the results of pre and post operative (after 6 weeks) Tympanometry and Pure Tone Audiometry.
- Six weeks postoperatively as healing occurs, inflammation & oedema resolve and middle ear function improves significantly.
- Surgical intervention is important to remove the focus of infection.

REFERENCES

1. Brodsky L. Adenotonsillar diseases in children, chapter 2, practical pediatric otolaryngology, Robin T., Cotton M.D., Charles Myer, 111 M.D., New York, Lippincott-Raven, 1997:237. In.
2. El-Badrawy A, Abdel-Aziz M. Transoral endoscopic adenoidectomy. *Int J Otolaryngol* 2009;2009:949315.
3. Sinha V, Patel BH, Sinha S. Incidence of uncomplained secretory otitis media in patients undergoing adenotonsillectomy. *Indian J Otolaryngol Head Neck Surg.* 2005;57(2):110.
4. Cengel S, Akyol MU. The role of topical nasal steroids in the treatment of children with otitis media with effusion and/or adenoid hypertrophy. *Int J Pediatr Otorhinolaryngol.* 2006;70(4):639-45.
5. Buchman CA. Functional-anatomical correlation of eustachian tube obstruction related to the adenoid in a patient with otitis media with effusion: a case report. *Ear-Nose-Throat-J* 1994 Nov; 73(11): 835-838.
6. Maw AM. Otitis Media. In: Scott-Brown's (Pediatric) Otolaryngology. 6th ed. Otitis Media : Adams DH, Cinnamon MJ (eds), Butterworth Heinemann, London; 1997:1-23.
7. George Browning. Otitis media with effusion; Scott-Brown Otorhinolaryngology, Head & Neck Surgery 7th Edition; Chapter 72: Volume 1:877-906.
8. Fujioka M., Young L.W., Girdany B.R. Radiographic evaluation of adenoidal size in children: adenoidal- nasopharyngeal ratio, *American journal of roentgenol* 1979; 133:401-404.
9. Cowan DL, Hibbert J. Tonsils and adenoids. In: Scott-Brown's (Pediatric) Otolaryngology. 6th ed. Adams DH, Cinnamon MJ (eds), Butterworth Heinemann, London; 1997:3-10.
10. Redline S, Amin R, Beebe D, Chervin RD, Garett SL, Giordani B, et al. The Childhood Adenotonsillectomy Trial (CHAT): rationale, design, and challenges of a randomized controlled trial evaluating a standard surgical procedure in a pediatric population. *Sleep* 2011;34:1509-17.
11. Jeans W.D., Fernando, D.C.J., Maw A.R. and Leighton K.C., A longitudinal study of growth of nasopharynx and its contents in normal children, *British Journal of Radiology* 1981;54:117-121.
12. S M Sarwar, Masroor Rahman, Mohammad Idrish Ali, Md. Morshed Alam, Md Anwar Hossain, Narayan Prosad Sanyal. Correlation of Enlarged Adenoids with conductive hearing impairment in children under twelve. *Bangladesh J Otorhinolaryngol* 2015; 21(2): 62-68.
13. Sandooja D, Sachdeva OP, Gulati SP, Kakkar V, Sachdeva A. Effect of adenotonsillectomy on hearing threshold and middle ear pressure. *Indian J Pediatr.* 1995;62(5):583-5.
14. Günel C, Ermişler B, Başak HS. The effect of adenoid hypertrophy on tympanometric findings in children without hearing loss. *Kulak Burun Bogaz İhtis Derg KBB J Ear Nose Throat.* 2014;24:334-8.
15. James F, George J, Regina M. Impact of adenotonsillectomy on hearing profile of children with chronic middle ear effusion. *Int J Contemp Pediatr* 2018;5:1377-81.