

## The effect of adenoid size on tympanometric finding in children

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### Abstract

**Background and objective:** There are controversial reports regarding the effect of adenoid size on middle ear conditions. Enlarged adenoid size may cause nasopharyngeal obstruction or may act as a reservoir for infection and cause tympanometric changes. This study aimed to determine the correlation between adenoid size and tympanometric findings in children.

**Methods:** This prospective study included 71 children aged 3-10 years old attending Rizgary Teaching Hospital for adenotonsillectomy between August 2013 to January 2014. Questions about upper airway obstruction symptoms were directed to parents and patients. Tympanometry and plane radiological study of lateral soft tissue of the neck were done for each case. Tympanometric type A and C1 were considered normal while B and C2 as abnormal. The adenoid size was measured by using adenoidal/nasopharyngeal ratio.

**Results:** Of 71 children (142 ears), 20 children (40 ears) had gross adenoid enlargement, of which tympanometry was found to be normal in 75% and abnormal in 25%. In 28 children (56 ears) with moderate adenoid enlargement, tympanometry was normal in 78.6% and abnormal in 21.4%. Twenty three children (46 ears) had minimal adenoid enlargement, in which tympanometry was normal in 91.3% and abnormal in 8.7%.

**Conclusion:** The study showed that adenoid size in children had an effect on tympanometric readings. Although the incidence of abnormal tympanometry was higher with the increased adenoid size but it was statistically non-significant.

**Keywords:** Adenoiditis; Adenoid hypertrophy; Nasopharyngeal tonsil; Tympanometry.

### Introduction

Adenoid is composed of lymph epithelial tissue and it is part of Waldyer's ring. The adenoids produce immunoglobulins through their B-cells which can be induced through antigen which leads to development of immunity during childhood.<sup>1-4</sup> Adenoid tissue is not radiographically visible until the age of one year. Adenoid enlargement can directly obstruct the pharyngeal orifice of Eustachian tube which can lead to otitis media with effusion (OME).<sup>5,6</sup> Its development can change the shape of the posterior pharyngeal wall and may obstruct the nasopharyngeal space.<sup>7,8</sup> Recurrent infections can cause functional, morphological and histological changes in

adenoid which sometime even needs surgical intervention to overcome the clinical manifestations induced by adenoid disorders.<sup>9-11</sup> Recurrent adenoid tissue infections without nasopharyngeal obstruction may also lead to acute OME which supports the theory of adenoids can act as a reservoir for pathogens.<sup>12,13</sup> Adenoid enlargement remains the most important cause of nasal obstruction which can lead to OME and Eustachian tube dysfunction.<sup>14-16</sup> Adenoid enlargement may cause chronic and recurrent sinusitis and OME in children. OME is the chronic accumulation of mucus in the middle ear and sometimes the air cells of mastoid bone for more than three months.<sup>5,14,17</sup> Middle ear diseases can occur in

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children, which is due to either infection or obstruction of the nasopharyngeal airway. Eustachian tube dysfunction is considered as one of the most common causes of middle ear diseases. Otitis media can affect one fourth of children around the age of 5 years. OME is usually due to dysfunction of the Eustachian tube. The abnormal Eustachian tube can lead to the development of negative intratympanic pressure. Not all children with Eustachian tube malformation or adenoid enlargement develop OME. The flexible nasal fiberscope is more accurate than the radiographic techniques because it can give a dynamic picture of both nasopharyngeal and oropharyngeal spaces and can visualize Eustachian tube orifices but Children are not easily tolerating nasopharyngoscopy.<sup>15</sup> Tympanometry is widely acceptable procedure to show changes in middle air pressure in children. It has been performed routinely in clinical settings since the early 1970s.<sup>5</sup> No risk are associated with this test and also does not require the child to do anything other than sit still and allow the audiologist to place a soft tip in their ear. Tympanometry can detect hidden or asymptomatic otitis media with effusion. Tympanogram findings classified as type A (normal), type B (flat, clearly abnormal), and type C (indicating a significantly negative pressure in the middle ear, possibly indicative of pathology).<sup>10,22</sup> The aim of this study was to show any significant correlation between adenoid size and tympanometric changes.

### Methods

This is a prospective study conducted on 71 children in the otolaryngology outpatient department of Rizgary Teaching Hospital in Erbil between August 2013 and January 2014. Children with nasal obstruction and chronic tonsilloadenoid symptoms, aged between 3-10 years old and visited the hospital for adenotonsillectomy were included in this study. Children with craniofacial abnormalities, previous adenoidectomy, previous tympanotomy,

nasal septal deviations and sinonasal infection were excluded from the study. All children were inspected and examined for external ear canal using an otoscope to exclude ear canal obstruction, and anterior rhinoscopy was done to exclude any nasal abnormalities. After the patient being examined and included in this study, we directed questions to patients and their parents. The following data were obtained for each case: age, sex, nasopharyngeal obstruction symptoms including snoring, mouth breathing and sleep disturbance. After history taking and examination, children underwent tympanometry and lateral neck X-ray. Tympanometry was performed using Intra acoustics Audio Traveller AA220 device, Assens, Denmark, 2009 with a probe tone of 226Hz frequency and positive and negative pressures between -600 to +300 decapascal (daPa). The tympanometry curve results were classified into four types that included; (A) middle ear pressure of +200 to -99 mmH<sub>2</sub>O (the apex of the curve mmH<sub>2</sub>O lies near to zero on the pressure scale when the pressure in the meatus and the middle ear is equal, increase compliance), (C1) Middle ear pressure of -100 to -199 mmH<sub>2</sub>O (If the tympanic membrane is abnormally complaint for example in case of atrophy scars of the pars tensa or interruption of ossicular chain. The compliance is abnormally large and the apex of the curve appears to be abnormally high, decrease middle ear pressure), (C2) Middle ear pressure of -200 to -399 mmH<sub>2</sub>O (If the apex of the curve is displaced into the negative region below - 100 mmH<sub>2</sub>O) and (B) Flat curve between +200 to -600 in the case of OME. Both type A and C1 were considered as normal middle ear function while type C2 and B considered as predictive for middle ear disease (Images 1, 2 and 3).<sup>2, 23</sup> Lateral neck x-ray was obtained for each case by using (SIEMENS Optitop 150/40/80 HC- 100, Germany) machine while the child in erect position and her/his head fixed with a cephalostat and mouth

closed. For each x-ray film, the adenoid size was measured using the adenoidal/nasopharyngeal ratio (A/N ratio) which was computed using Fujioka method.<sup>8</sup> In this method, the (A) measurement represents a perpendicular line drawn from a maximal convexity point of adenoid tissue to a line along the anterior margin of basiocciput. It denotes the maximum thickness of adenoid tissue which is drawn perpendicularly to B. B is the line parallel to basiocciput. The (N) measurement is the distance between antero inferior edge of sphenoid S to the posterior aspect of hard palate P. Then, the A/N ratio was calculated and analyzed by dividing the A measurement over the N measurement. The A/N ratio was measured with a ruler in millimeters as shown in (Figure 4). The degree of

nasopharyngeal airway obstruction was classified into the following degrees; Minimal (0.5-0.62), Moderate (0.63- 0.75) and Gross or marked (0.76- 0.88)<sup>(18, 24)</sup>.

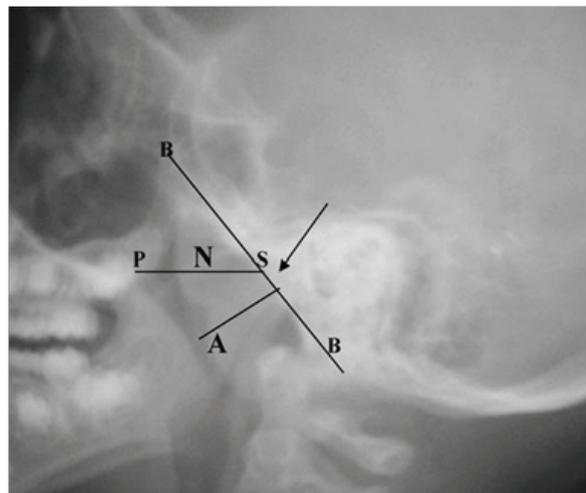
**Statistical analysis:-** Data were analyzed using the statistical package for the social sciences (version 19). Chi square test of associations was used to compare proportions. When the expected count of more than 20% of the cells of the table was less than 5, Fisher's exact test was used. *P* value of  $\leq 0.05$  was considered statistically significant.

**Results**

Among 71 children (41 boys and 30 girls) (142 ears), 63% of cases with upper airway obstruction symptoms were between 3-6 years old (Table1).

**Table 1:** Distribution of sample by gender according to age groups

Age groups	Gender				Total No.	Total (%)
	Male No.	(%)	Female No.	(%)		
3-6 years	25/41	(61%)	20/30	(66%)	45/71	(63.4%)
7-10 years	16/41	(39%)	10/30	(34%)	26/71	(36.4%)



**Figure 1:** Post nasal X-ray showing calculation of A/N ratio<sup>18</sup>

(A) denotes the maximum thickness of adenoid tissue which is drawn perpendicularly to the (B). (B) Is the line parallel to basiocciput. (N) Is the distance between the anterior-inferior edge of sphenoid (S) to the posterior aspect of hard palate (P).

Among the study cases with abnormal tympanometry findings, 61.5% (8/13) were male and 38.5% (5/13) females cases (Table 2). Among 71 cases with adenoid enlargement, 25% showed to have abnormal tympanometry (C2 and B) while 75% had normal tympanometry (Table 3).

Of 142 ears who had tympanometry, 72% were type A, 11.2% type C1, 7.7% type C2 and 9.1% were type B. (Table 4). Among those 13 cases with abnormal tympanometry types, 23% had sleep disturbance and 77% had snoring and mouth breathes.

**Table 2:** Abnormal tympanometric type by gender.

Abnormal Tympanometry Types	Male		Female		Total	
	No.	(%)	No.	(%)	No.	(%)
C2	4/8	(50%)	1/5	(20%)	5/13	38.4
B	4/8	(50%)	4/5	(80%)	8/13	61.6

**Table 3:** Abnormal tympanometric finding according to adenoid size.

Adenoid Size	Tympanometry				P value
	Normal (Type A and C1)		Abnormal (Type C2 and B)		
	No.	(%)	No.	(%)	
Gross	15	(75%)	5	(25%)	0.342
Moderate	22	(78.6%)	6	(21.4%)	
Minimal	21	(91.3%)	2	(8.7%)	

**Table 4:** Patient distribution according to tympanogram findings.

Tympanometry Types	Age 3-6 years	Age 7-10 years	Total Ears	P value
A	60 (59%)	42 (41%)	102	0.346
C1	10 (63%)	6 (37%)	16	
C2	8 (72%)	3 (28%)	11	
B	12 (92.5%)	1 (7.5%)	13	
Total ears	90 (63%)	52 (37%)	142	

## Discussion

In this study 71 patients aged between 3-10 years old with adenoid enlargement, 13 (18.3%) children had abnormal tympanometry findings (Type C2 and B). The literature review also revealed that incidence of abnormal tympanometry and otitis media with effusion fall between 1.3%-20%.<sup>21,26,27</sup> In our study, most common age group with abnormal tympanometry was 3-6 years old (84.6%). The mean age for patients with abnormal tympanometry was 5.4 years old. The mean age obtained in our study was close to findings in studies like Abdulbaqi 2001 was 5.8 and Cengel and Akyol 2006 was 6.<sup>28-29</sup> The reason for this is that adenoid size reaches its maximal size at age seven years old and will gradually decrease afterward. With regard to gender distribution in this study, it revealed that 61.5% of patients with abnormal tympanometry were male and 38.5% were female. This finding was similar to previous studies that showed male predominance for abnormal tympanometry over females. Both Yassan 2003 and Agidir 2006 showed that 60% of cases with abnormal tympanometry were males and the rest were females.<sup>30-31</sup> Khayat 2008 also found that 55% male patients had abnormal tympanometry and OME and 45% of females had OME.<sup>14</sup> While in other studies like Tong 2005 did not find any significant difference between both genders in the prevalence of OME.<sup>32</sup> Abnormal tympanometry was found only in 18.3% of patients with adenoid enlargement who participated in this study and aged between 3-10 years old. Tanpowpong 2007 also showed that among the 23 children with adenoid enlargement between ages 4-11 years old, 21.7% had OME.<sup>33</sup> While Yassan 2003 and Khayat 2008 both demonstrated that OME incidence among children (3-13 years old) with adenoid enlargement was near 35%.<sup>14,30</sup> The difference in the incidence between our study and the other studies could be due higher incidence of upper respiratory tract infections among children

participated in their studies through cold seasons. Regarding the main finding in this study about the relation between adenoid enlargement and tympanometry types, among the 71 patients with adenoid enlargement, 20 cases had grossly enlarged adenoid in which 75% had normal tympanometry findings while 25% showed abnormal tympanometry. Twenty eight cases with moderately enlarged adenoid showed normal tympanometry findings in 78.6% and abnormal tympanometry in 21.4%. Among 23 patients with minimal adenoid enlargement, only 8.7% showed to have abnormal tympanometry while the rest had normal findings. Although we noticed that with increasing of adenoid size from minimal, moderate to gross, the abnormal tympanometry was increased. The correlation between adenoid enlargement and tympanometry was statistically found to be non-significant. In Alhady et al. study, among 40 cases (2-6 years old) with adenoid enlargement, 23 cases showed abnormal tympanometry including five ears with type B and 27 ears type C2. Similarly, in Khayat 2008 study, among 120 children with adenoid size enlargement, 44 (36.7%) had abnormal tympanometry. They found that the changes in middle ear pressure due to adenoid enlargement were significant.<sup>14,34</sup> It might be due to encroached adenoid laterally even small size adenoid to obstruct the Eustachian tube of the involved ear, it was reported to be significant in producing abnormal tympanometry. While in Toros et al. 2010 study, among 95 patients aged 2-12 years old with adenoid enlargement, the tympanometry types were (21.4% A, 20.4% B and 33.9% C) in patients with severe enlargement (63.3% A, 59.2% B and 53.2% C) in cases with moderate enlargement and in mild enlargement, tympanometry types were (12.7% A, 20.4% B and 12.9% C). They found this correlation was not significant because they supposed that the role of adenoid infection rather than obstruction.<sup>35</sup>

The reasons for the discrepancy in the correlation between adenoid enlargement and tympanometric changes or OME might be due to recurrent adenoid infection or mechanical obstruction. There are researchers that support the mechanical obstruction theory of adenoid including Wright et al., 1998 who stated that adenoid might compress the lumen of Eustachian tube thereby causing middle ear negative pressure and subsequently OME.<sup>36</sup> DiFransesco et al, 2008 mentioned that enlarged adenoid is an important factor for OME once it obstructs the pharyngeal ostia of the auditory tube.<sup>11</sup> Abdulbaqi et al., 2001 also mentioned that removal of adenoid could eliminate the obstructive effect of adenoid and/or the source of nasopharyngeal infection.<sup>28</sup> Kindermann et al. 2008 revealed that Eustachian tube orifice compression by adenoid enlargement is associated with middle ear pressure changes and OME. They showed that children with Eustachian tube obstruction by adenoid tissue, 87% of cases had tympanogram changes while when the Eustachian tube orifice was not obstructed, in 86% of cases, tympanogram was normal.<sup>2</sup> While there are other studies supporting that adenoid infection could lead to OME. Abdul Latif et al., 2007 showed that the role of adenoid in middle ear diseases is not well understood. They showed that removal of adenoid results in resolution of OME. However, recurrent or chronic infection in adenoid without Eustachian tube lumen obstruction may cause acute otitis media and OME supporting the adenoid can be a reservoir for pathogens that can lead to Eustachian tube edema and dysfunction.<sup>37</sup> Both Stewart et al, 1999 and Takahashi et al 2003, mentioned that adenoidectomy benefits relate to removal of infection source rather than mechanical obstruction and found same infection pathogens in the nasopharynx of children with OME.<sup>38-39</sup> Balram et al 2001 revealed that adenoid acts as a focus of infection, the position of adenoid in posterior nasopharyngeal wall

serves as an area of contact between inhaled pathogen and the adenoid lymphoid tissue. Adenoid proximity to Eustachian tube orifice can ease colonization of Eustachian tube by adenoid bacterial or viral pathogens.<sup>40</sup>

### Conclusion

The incidence of abnormal tympanometric changes was higher in grossly enlarged adenoid or big size radiological but statistically was non-significant, yet we believe that there is an intimate relation between the size of the adenoid and abnormal tympanometric finding and because of a small number of the patient the result was non-significant. Larger sample size studies are required to confirm the exact role of how adenoid affects middle ear conditions and abnormal tympanometric finding. Comparison research between lateral neck x-ray and flexible fiberoptic nasopharyngoscopy of adenoid size, and correlation with tympanometric finding is needed.

### Conflicts of interest

The authors report no conflicts of interest.

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