Correlation between Adenoid Volume and Intratympanic Pressure Level and Degree of Mastiod Air Cell Pneumatization in Children at Pre-School Age

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Abstract: Objective: Studying correlation between adenoid volume and intratympanic pressure level and the degree of mastoid air cells pneumatization, clinically, audiologically and radiologically in children between (3-6th) years. **Background:** Adenoid Hypertrophy and Eustachian tube dysfunction are considered causal factor for intratymanic pressure level changes. There are many methods to measure the size of adenoid aslateral soft tissue X-ray of nasopharynx and measuring the adenoid volume physically. **Materials and method:** This study was made as a prospective study performed on 40 children with adenoid hyperatrophy, that was diagnosed clinically, radiologically by lateral soft tissue x-ray of neck and physically. Intratympanic pressure level was measured audiologcally. Mastoid air cells pneumatization was assessed radiologically by computerized tomography of temporal bone from May 2014 till September 2016. **Results:** 57.5 % males and 42.5 % females with adenoid volume were estimated in ranges between 4-7 ml in all cases with mean ±SD 5.47±0.96. We found that 35 cases with mean adenoid volume "5.48±0.94" have well mastoid air cell pneumatization, and 5 cases with adenoid volume "5.40±1.19" have poorely air cell pneumatization, also we found 42 ears with mean adenoid volume "5.80±0.87" their tympanogram was type B and, 10 ears with mean adenoid volume "6.05±0.85" their tympanogram type c, 24 ears with mean adenoid volume "4.69±o.69" with tympanogram type A and 4 ears with mean adenoid volume "5.18±0.35" with tympanogram type As. p value was < 0.001. **Conclusion:** There is a significant correlation between increasing adenoid volume and changes in intratympanic pressure level, and there is no significant relation between mastoid air cells pneumatization and Adenoid volume.

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1. Introduction

Adenoid hypertrophy is a common childhood disorder*(1, 2). It plays a significant role in the pathogenesis of intratympanic pressure variations. which is the commonest cause of hearing impairment in children (2). Thus, it predisposes to delayed speech, poor academic and language development(3). also, An untreated adenoid hypertrophy may lead to obstructive sleep apnea, ear problems, failure to thrive, pulmonary hypertension, and craniofacial anomalies (4).

Due to its location, adenoid tissue may have several negative effects on physiological development, such as hyponasal speech, open mouth breathing, snoring, and middle ear infections (5).

Adenoid may become chronically infected and act as a reservoir in upper respiratory infections with resultant oedema and obstruction of the nasopharyngeal end of the Eustachian tube (ET)*(6,7) leading to absorption of air and negative intratympanic pressure. Chronic infection of the adenoid tissue can cause epithelial metaplasia and connective tissue fibrosis which impede the function of the cilia and adenoid tissue in clearing infection*(8).

Studies have shown that there is an increase in number of mast cells and allergic mediators in adenoid tissues which are capable of binding immunoglobulin E (IgE) and releasing histamines and other inflammatory mediators following exposure to allergens(9). The mediators released influence the mucociliary transport time, modify the ciliary function and structure, and increase the secretory activity of the mucosal cells of the middle ear(10).

Recent guidelines from otologists, pediatricians, and allergists based on clinical evidence supportthe role of atopy in changes of intratympanic pressure level (11,12).

In our setting there is paucity of information on tympanometric findings of children with adenoid tissue volume. Therefore, we decided to evaluate the relation between adenoidal tissue volume and intratympanic pressure level and correlation with mastoid air pneumatization. Furthermore, OME produces a complex multifactorial process, that is why

the pneumatization of the mastoids and the variation in the gaseous diffusion in circulation has an important role in the negative pressure phenomenon in the affected middle ear.[13]

The mastoid air cell system is an air reservoir for the middle ear, and it has been suggested that it plays an important role as a protector of inner ear structures from external temperature changes and as a pressure regulator.*[14] Two hypotheses for the inter-individual variation of mastoid pneumatization have been proposed. The first is the genetic theory-that is, the degree of mastoid pneumatization is genetically determine and the environmental theory where the degree of mastoid pneumatization is determined by postnatal pathologic involvement of the middle ear. Up to date, there is considerable evidence to indicate that the genetically controlled normal mastoid pneumatization can be changed in varying degrees by postnatal environmental factors*[14].

Factors affecting the development of mastoid air cells include chronic otitis media, age, sex, and race. The development of this pneumatization system has been reported to be similar in different races [15].

During pneumatization, the only connection of the mastoid air system with the nasopharynx through the Eustachian tube*[16]. Therefore, it is not known whether nasopharyngeal tonsil have any effects on mastoid aeration.

This current study was conducted to show the relation between Adenoid Volume and Intratympanic Pressure level changes and if there is a relation between Adenoid Volume and mastoid air cells pneumatization.

2. Patients and methods

This is a prospective study. After getting the approval of the institutional ethical committee from the Menoufia University Hospital's Review Board and a written consent from all enrolled patients' parents. This study was conducted on 40 patients (40 adenoids) 80 ears (mastoid) at preschool age (3-6 yrs) on patients who suffered from manifestation of adenoid hypertrophy.

This study last from May 2014 to Septembers 2016. All of these patients (male, female) were collected from outpatient clinic of the ENT department in menoufiagovernate. Patients had different degrees of adenoid hypertrophy diagnosed clinically by ENT surgeon and confirmed by radiological and endoscopic assessment.

All patients were subjected to the following assessments**:** Clinical assessment (full history and clinical examination), Radiological examination (Digital plain x-ray lateral view soft tissue-CT temporal bone), Audiological assessment (tympanometric study) and Adenoid volume assessment.

We included the Children with clinical and radiological features of hypertrophied adenoidaged from 3-6 years. Patients with any pathology affect Eustachian tube other than adenoid hypertrophy were excluded from study as Cleft palate and Active ear discharge. also, we were excluded Other causes of nasal airway obstruction, Genetic syndromes with craniofacialabnormalities. (e.g. Down syndrome) and Neurological abnormalities. (e.g. cerebral palsy).

Patient'sdata included age, sex, residence, special habits of the parents, Analysis of symptoms. Present and past history of ENT symptoms and disease or operation.

All the patients underwent tympanogram; the results were evaluated according to Fiellau-Nikolajsen's modification of Jerger's system [17]. The results were classified as Type A (+100 and -100daPa), Type B (no pressure peak), Type C1 (-101 and -200 daPa), Type C2 (-201 and -300 daPa). Radiological investigation, included plane x-ray of the neck in lateral views to assess adenoid size, were measured by A\N ratio, where N is the distance between the posterior superior edge of the hard palate and the anteroinferior edge of the sphenobasioccipital synchondrosis, and A is the distance between the maximum convexity of the adenoid and a line drawn along basocciput. A\N ratio below 25% was scored as 1+, those between 26% and 50% as 2+, those between 51% and 75% as 3+, and those between 76% and 100% as 4+ [18].

Also, the adenoid volume were assessed by dunking the adenoid tissue after surgery in physiological fluid (saline.9%) in glass beaker 50 ml, then measure the increase in amount of fluid to evaluate the volume of adenoid. All patients were done Coronal C.T temporal bone to evaluate mastoid air cell pneumatization level.

Examined outcome parameters included correlation between adenoid volume and intratympanic pressurelevel changes and also, correlation between adenoid volume and matoid air pneumatization degree.

Statistical analysis of the data

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp) Qualitative data were described using number and percent. The Kolmogorov-Smirnov test was used to verify the normality of distribution Quantitative data were described using range (minimum and maximum), mean, standard deviation and median. Significance of the obtained results was judged at the 5% level.

The used tests were:

Chi-square test was used for categorical variables, to compare between different groups. Monte Carlo correction was used for Correction for chi-square when more than 20% of the cells have expected count less than 5. Student t-test was used for normally quantitative variables, to compare between two studied groups. F-test (ANOVA) was used to compare between more than two groups. Mann Whitney test was used for abnormally quantitative variables. Spearman coefficient was used to correlate between two abnormally quantitative variables. P value < 0.05 was considered statistically significant.

3. Results

This study included 40 patients with different degrees of adenoid hypertrophy and different intratympanic pressure levels, 23(57.5%) males with mean± SD adenoid volume =5.20 ± 0.92 and 17 (42.5%) females with mean± SD adenoid volume =5.84 ±0.91. Ratio of the age ranges from 3 - 6 years "preschool age" with mean range 4.87±0.87 years. There is a statistically significant difference between gender and increasing adenoid volume as pvalue = 0.036. as seen in **(Table 1).**

We measured adenoid volume for 40 cases in the range of (4-7 ml) with grade I-IV adenoid hyperatrophy by plain X-ray grade with spearman coefficient about 0.677 -in test pvalue 0.001.

There was increasing in adenoid volume with increase in grading in plain X-ray (direct proportional) as shown in **(Figure 1**) below. This confirmed that a significant correlation between adenoid volume and adenoid size by plain X-ray grading as p value<0.001. so we can consider adenoid volume and adenoid size the same as shown in figure 1below.

According to adenoid volume 5.48±0.94appeard that35 cases have well mastoid air cell pneumatization (70ears) and 5 cases have adenoid volume 5.40±1.19 poorly mastoid air cell pneumatization 5 cases (10ears). In **(table 1)** there is no significant correlation between adenoid volume and mastoid air cells pneumatization as p value=0.864**.**

According to table 2 there are 3 cases (6ears) in grade 1 plain X-ray. There are 2 cases (4ears) 66.7% well pneumatized, 1case (2ears) poorly pneumatized,15 cases (30 ears) grade II,14 cases (28ears) of them are well pneumatized as 93.3% and 1 case (2ears) poor pneumatized as 6.7%. In grade III adenoid hypertrophy plain X-ray 19 cases (38ears) there are16 cases (32ears) well pneumatization 84.2% and 3 cases (6ears) only poorly pneumatization 15.8%.. In grade IV adenoid hypertrophy plain X-ray 3 cases (6ears) there are 3 cases (6ears) well pneumatization 100% as montecarlo for chi square test =2.393 and p value 0.472**.** In this table. there is no significant correlation between size of adenoid by plain X ray and mastoid air cells pneumatizationas pvalue=0.472 as shown by **(Table 2)**.

The middle ear pressure level changes with adenoid grading. Asit's summerized in table 2. Total result from this table evidenced that we had 80 ears,6 ears are in grade I plain X- ray, and all of them are type A (100%). Inadenoid hypertrophy grade II (60ears), type A was noticedin11 ears (36.7%), type As in 3ears (10%), type B in 13 ears (43.3%) and type C3 ears (10%). In adenoid hypertrophy Grade III (38ears) type A recorded 7ears (18.4%), type As recorded1ear (2.6%), type Brecorded 24 ears (63.2%) and type Crecorded6 ears (15.8%). finally grade IV adenoid hypertrophy (6 ears) were divided into type B 5 ears (83.3%) and type C1 ear (16.7%).

We concluded from **(table 2)**, that there is a significant relation between increasing plain x-ray grade of adenoid and changes in tympanic pressure levels as p value=0.006**.**

Table 3 shows that larger mean adenoid volume is associated with changes in the tympanic pressure level, As An evedance for this, that patients with type B had mean adenoid volume 5.80 ± 0.87, patients with type C had a mean adenoid volume6.05 ± 0.85 and patients with type As had mean adenoid volume5.18 ± 0.35, while patients with type A had mean adenoid volume 4.69 ± 0.69

We concluded from this **(Table 3)** there is a significant relation between increasing adenoid volume and changes in tympanic pressure levels as pvalue <0.001.

Table (1): Relation between adenoid volume ML with sex and mastoid air cell pneumatization level

	N	Adenoid volume ML			t	p
		Min. – Max.	Mean ± SD.	Median		
Sex						
Male	**23**	3.70 – 7.0	5.20 ± 0.92	5.0	2.169*	0.036*
Female	**17**	4.0 – 7.30	5.84 ± 0.91	6.0		
Mastoid air cell pneumatization level						
Well mastoid air cell pneumatization	**35**	3.70 – 7.30	5.48 ± 0.94	5.20	0.172	0.864
Poorly pneumatization	**5**	4.0 – 7.0	5.40 ± 1.19	5.50		

t: Student t-test; *: Statistically significant at $p \leq 0.05$

Table (2): Relation between PXR grad of adenoid and different parameters

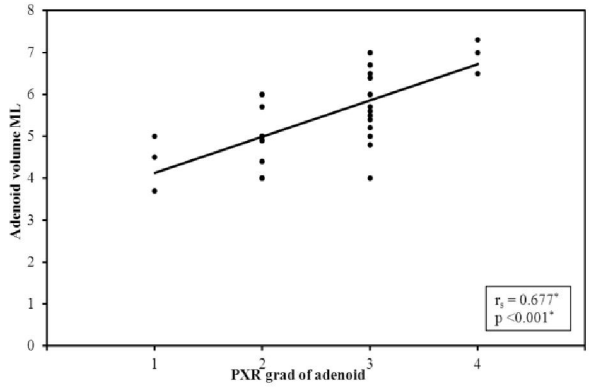
	PXR grad of adenoid									
	I		II		III		IV			^{MC}p
	No.	%	No.	%	No.	%	No.	%		
Mastoid air cell pneumatization level	**(n=3)**		**(n=15)**		**(n=19)**		**(n=3)**			
Well mastoid air cell pneumatization	2	66.7	14	93.3	6	84.2	3	100.0	2.393	0.472
Poorly pneumatization	1	33.3	1	6.7	3	15.8	0	0.0		
Tympanic pressure level by type in tympangram										
Left	**(n=3)**		**(n=15)**		**(n=19)**		**(n=3)**			
A	3	100.0	4	26.7	2	10.5	0	0.0	11.508	0.151
AS	0	0.0	1	6.7	1	5.3	0	0.0		
B	0	0.0	7	46.7	3	68.4	2	66.7		
C	0	0.0	3	20.0	3	15.8	1	33.3		
Right	**(n=3)**		**(n=15)**		**(n=19)**		**(n=3)**			
A	3	100.0	7	46.7	5	26.3	0	0.0	13.238	0.068
AS	0	0.0	2	13.3	0	0.0	0	0.0		
B	0	0.0	6	40.0	11	57.9	3	100.0		
C	0	0.0	0	0.0	3	15.8	0	0.0		
Total	**(n=6)**		**(n=30)**		**(n=38)**		**(n=6)**			
A	6	100.0	11	36.7	7	18.4	0	0.0	19.395*	19.395*
AS	0	0.0	3	0.0	1	2.6	0	0.0		
B	0	0.0	13	43.3	24	63.2	5	83.3		
C	0	0.0	3	0.0	6	15.8	1	16.7		

^{2}: Chi square test MC: Monte Carlo test
*: Statistically significant at $p \leq 0.05$

Table (3): Relation between adenoid volume ML and tympanic pressure level by type in tympangram

Tympanic pressure level by type in tympangram	N	Adenoid volume ML			F	p
		Min. – Max.	Mean ± SD.	Median		
Left						
A	9	3.70 – 6.0	4.58 ± 0.74	4.50	5.012*	0.005*
AS	2	5.0 ± 5.0	5.0 ± 0.0	5.0		
B	22	4.0 – 7.30	5.74 ± 0.85	5.65		
C	7	4.40 – 7.0	5.91 ± 0.98	6.0		
Right						
A	15	3.70 – 6.0	4.76 ± 0.68	5.0	7.147*	0.001*
AS	2	5.0 – 5.70	5.35 ± 0.49	5.35		
B	20	4.0 – 7.30	5.88 ± 0.90	5.85		
C	3	6.0 – 6.70	6.37 ± 0.35	6.40		
Total						
A	24	3.70 – 6.0	4.69 ± 0.69	4.90	11.955*	<0.001*
AS	4	5.0 – 5.70	5.18 ± 0.35	5.0		
B	42	4.0 – 7.30	5.80 ± 0.87	5.70		
C	10	4.40 – 7.0	6.05 ± 0.85	6.20		

F: F value for ANOVA test
*: Statistically significant at $p \leq 0.05$



I = 1 – II = 2 – III = 3 – IV = 4

Figure (1): Correlation between adenoid volume ML and PXR grade of adenoid
rs: Spearman coefficient
*: Statistically significant at $p \leq 0.05$

4. Discussion

In our study, we planned to examine children from 3 to 6 years, because of adenoid enlargement outstrips growth of nasopharynxfrom3 to5 years with resultant reduction of nasopharyngeal air way. [19]

In this study the intratympanic pressure level increases with increasing the adenoid volume, where as type C recorded12.5%, type B 52.5%and As 5% with total70%in cases of adenoid hypertrophy similar to results in a study held in Kenya on children aged (1-4 years) using both types Band C as indicators with total 67.3%. Also reported in Nugu Orgi et al and Obukoucha et al with similar results. [20]

In our study type B tympanogram was 4 folds more than type C, so intratympanic pressure level changed with adenoid hypertrophy empacted Eustachian tube function leading to hearing impairment. Sointratympanic pressure level was required with adenoid hypertrophy. This results similar to findings reported in Nigerian study Chibuike et al. [21]

The adenoid volume was measured in all children with mean volume±SD 5.47=0.96 and also ANR was measured, where there is an increase in the adenoid volume with an increase in ANR (grading of adenoid hypertrophy). there is a direct proportional relation.

In a current study most of children had grade 3 adenoid hypertrophy 47.5%, so there is a significant association between grade 3 ANR and adenoid volume with the intratympanic pressure level changes, when they are compared with other grades. This is similar to a study of Hibbett, Stella and Enqu et al, which also reported positive correlation between the degree of adenoid hypertrophy and intratympanic pressure level changes, this shows that increasing grades of adenoid hypertrophy and adenoid volume are an important prediction in intratympanic pressure changes in patients with adenoid hypertrophy. [22]

Also in our study degree of mastoid pneumatization was measured by C.T temporal bone to evaluate the correlation with adenoid hypertrophy which estimated by measuring size and volume. The mastoid air cells were well pneumatized in 35 cases as 87.5% with mean adenoid volume 5.48+0.94 in all grades measured by plain x-rayand the rest of cases 12.5% were poorly pneumatized. So, in our study there is no correlation between mastoid pneumatization and adenoid volume.

Conclusion

Our study findings suggest that there is a significant correlation between increasing adenoid volume and changes in intratympanic pressure level and no significant relation with mastoid air cells pneumatization.

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