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Significance of Adenoid Nasopharyngeal Ratio in the Assessment of Adenoid Hypertrophy in Children

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Abstract The aims of this study are to find out the significance of adenoid nasopharyngeal ratio obtained from lateral X-Ray of nasopharynx to decide on the option of surgical treatment of adenoid and to correlate the symptoms with the relative size of adenoid in the nasopharynx. This prospective study was done on 100 children who presented with bilateral nasal obstruction from 4- 12years of age. Radiological assessment of lateral radiograph of nasopharynx was done. Mean adenoidal depth and mean nasopharyngeal depth were calculated as per Yusuf et al method. Mean ANR was calculated by dividing adenoidal depth by nasopharyngeal depth. There was significant increase in adenoid size during 7-9 years and decrease in 10-12 years, the nasopharyngeal depth increased as age progressed. It was concluded that ANR > 0.7 are the candidates for adenoidectomy.

Keywords Adenoid Hypertrophy, ANR Ratio, Children

1. Introduction

The Adenoids, a group of lymphoid tissues in nasopharynx becomes apparent clinically when they undergo hyperplasia. In the past decades it was not unusual to therapeutically remove enlarged adenoids & tonsils. But, it is now recognized that lymphoid hyperplasia is not itself an indication for adenoidectomy. The nasopharyngeal tonsil was observed to become evident by six months to one year of life, increases rapidly in size during the first 6 to 8 years of life & generally atrophies by adolescence.[1]

An untreated adenoid hypertrophy may lead to obstructive sleep apnea, ear problems, failure to thrive, pulmonary hypertension, and craniofacial anomalies.[2] Therefore, adenoidectomy with or without tonsillectomy is one of the most frequent procedures in otorhinolaryngology. The absolute size of the adenoid and the available space in the nasopharynx are the major factors which determine the severity of symptoms.[3] In determining whether adenotonsillar enlargement is sufficient to be clinically significant, the physician typically relies on physical examination & history. However physical examination provides little information about the size of adenoid, although enlarged tonsils may be proved easily. Adenoidal hypertrophy and its measurement by clinical examination, imaging techniques, and endoscopic evaluation has been reported.[4] Lateral airway radiographs have long been used as a diagnostic tool in the assessment of adenoid size. They are simple, readily available, and reproducible.[5] In this study we have attempted to find the adenoid – nasopharyngeal ratio [ANR] from the lateral radiographs of the nasopharynx. We have selected 100 children between 4 – 12 years of age & analysed their lateral radiographs. We have tried to find out the significance of ANR, variation of ANR with relation to age & correlation between symptoms and adenoid size, clinically and radiologically. Our study is based on the guidelines provided by Yusuf KK et al.[6]

2. Materials and Methods

Our sample size is 100 children with 62 boys and 38 girls who presented with nasal obstruction due to adenoid hypertrophy. The age group of the study sample is between 4-12years. Analysis of adenoid size was made by soft tissue lateral radiograph of nasopharynx. All children from 4-12 years with bilateral nasal obstruction and mouth breathing were included in the study. Study sample was divided into 3 subgroups 4-6, 7-9 & 10-12 years. Children with nasal obstruction due to other causes like septal deviation, allergic rhinitis, nasal injury, acute infections and congenital nasal deformities were excluded. Symptoms were evaluated according to the presence of snoring, mouth breathing & sleep apnea in all children by taking the history from the parents. Lateral cephalographs were taken by the standard technique throughout the study. The x- ray beam was centered to external auditory meatus with the head in true lateral position and child breathing through nose with teeth occlusion. Head was fixed with cephalostat. The exposure was made at 70 kv

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with an exposure time of 0.6seconds. By using the reference points and lines on lateral radiographs of nasopharynx, adenoid size and nasopharyngeal depth was calculated in all x-rays (Table no.1). Using the measuring scale, three lines were drawn from the posterior nasal spine; first line to posterior superior sphenobasioccipital area (red line - U'1), second line to the nearest adenoidal point (green line -U'2) and third to basion of occipital bone (blue line –U'3). (Fig No.1) Mean adenoidal depth & mean nasopharyngeal depth was calculated.

ANR = Adenoid size/Nasopharyngeal depth.

Mean adenoid size, nasopharyngeal depth & ANR was compared in different age.

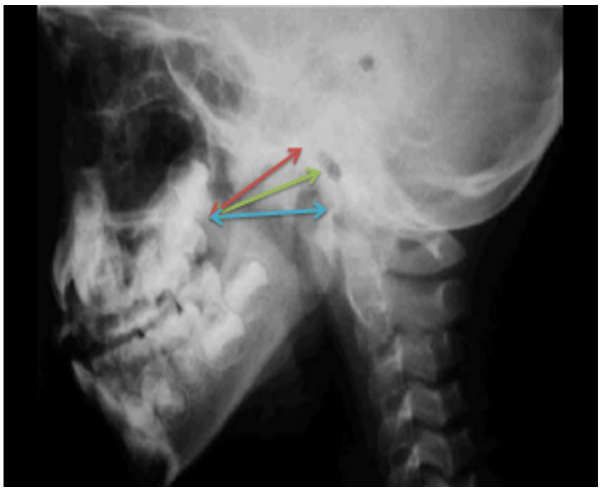


Figure 1. Showing the lines on lateral X-Ray of nasopharynx

Table 1. Reference points, lines and ratios used for radiological assessment6

Reference points	
U1	Intersection between adenoidal shadow and PSyL
U1	Intersection between nasopharyngeal surface of spheno-occipital bone and PSyL
U2	Nearest adenoidal point to P
U2	Intersection between nasopharyngeal surface of sphenooccipital bone and PU2L
U3	Intersection point between adenoidal shadow and PBaL
Ba	Basion; most posteroinferior point on anterior margin of foramen magnum
P	Posterior nasal spine; most posterior point of hard palate
Sy	Posterosuperior point of sphenobasioccipital synchondrosis
Reference lines	
PU2L	Line through P and U2
PBaL	PBaL-Line through P andBa
PSyL	PSyL - Line through P and Sy
Ratios	
ANR-Sy	Ratio of distance between U1 and U1' to distance between P and U1'
ANR-U2	Ratio of distance between U2 and U2' to distance between P and U2'
ANR-Ba	Ratio of distance between U3 and Ba to distance between P and Ba

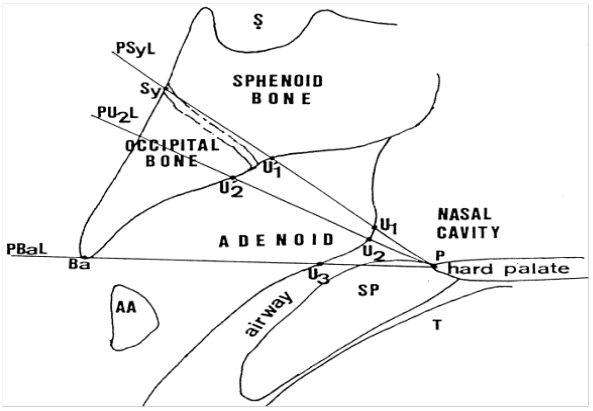


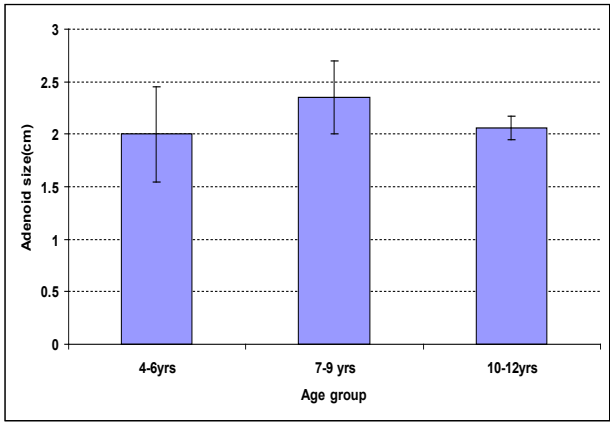
Figure 2. Reference points and lines on lateral cephalography (AA- most anterior point of atlas); U1, U2, and U3 - adenoidal points described in Table 2; U1', U2', Ba, and Sy - cranial base points described in Table 2; PSyL, PU2L, and PBaL - lines described in Table 2; S - sella; SP - soft palate; T - tongue). For calculation of adenoidal-nasopharyngeal ratios (ANRs): first, P-U1', P-U2', and P-Ba are measured as nasopharyngeal depths, and U1-U1', U2-U2', and U3-Ba, as adenoidal depths. Subsequently, each ANR is simply calculated as adenoidal depth divided by nasopharyngeal depth on same line.6

3. Observations and Results

The adenoid nasopharyngeal ratio was calculated in 100 children aged 4- 12 yrs with nasopharyngeal obstruction due to the adenoid hypertrophy. All children were clinically and radiologically assessed. Data was statistically analysed using one way ANOVA and Chi-square test by using SPSS version17 & MS-Excel. P< 0.05 was considered to be statistically significant.

Table 2. Adenoid size between age group

Age group	N	Mean	Std. Deviation	Minimum	Maximum
4-6yrs	26	2.00	.450	1	3
7-9 yrs	31	2.35	.351	2	3
10-12yrs	43	2.06	.110	2	3
Total	100	2.14	.341	1	3

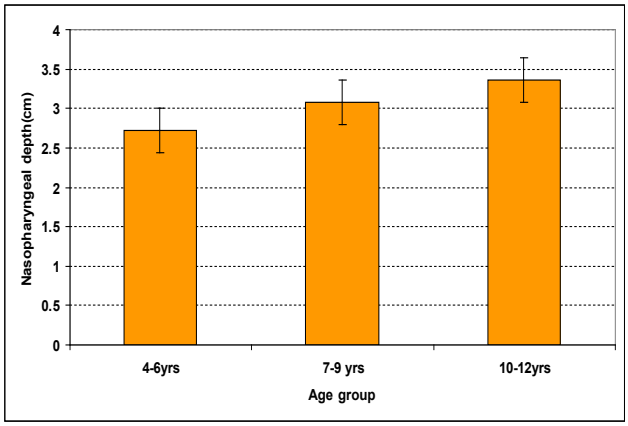


Mean adenoid size in 4-6 yrs is 2cm, there is statistically significant increase during 7- 9 yrs to 2.35cm, and later there is statistically significant decrease in 10-12 yrs to 2.06cm.

Table 3. Nasopharyngeal depth between age groups

Age group	N	Mean	Std. Deviation	Minimum	Maximum
4-6yrs	26	2.723	.2804	2.3	3.2
7-9 yrs	31	3.081	.2786	2.5	3.5
10-12yrs	43	3.358	.2788	3.0	4.0
Total	100	3.107	.3777	2.3	4.0

F=42.12
p=0.001 - Significant

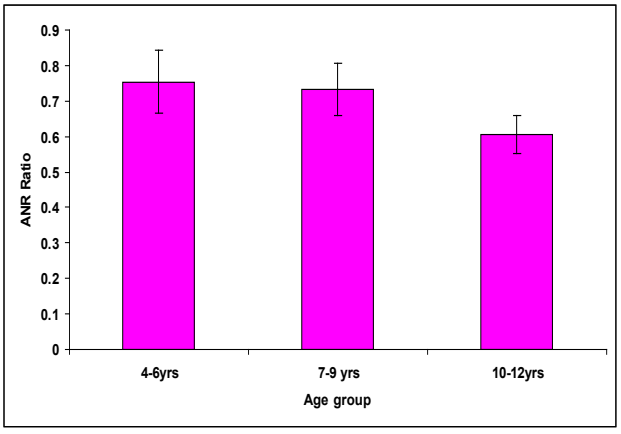


There is statistically significant increase in nasopharyngeal depth as the age increases. In 4-6 yrs it is 2.72cm, 7-9 yrs, it is 3.08cm and in 10-12 yrs, it reaches 3.35cm.

Table 4. ANR ratio between age groups

Age group	N	Mean	Std. Deviation	Minimum	Maximum
4-6yrs	26	.754	.0887	.5	.8
7-9 yrs	31	.733	.0734	.6	.8
10-12yrs	43	.605	.0544	.5	.8
Total	100	.683	.0980	.5	.8

F=46.97
p=0.001 – Significant



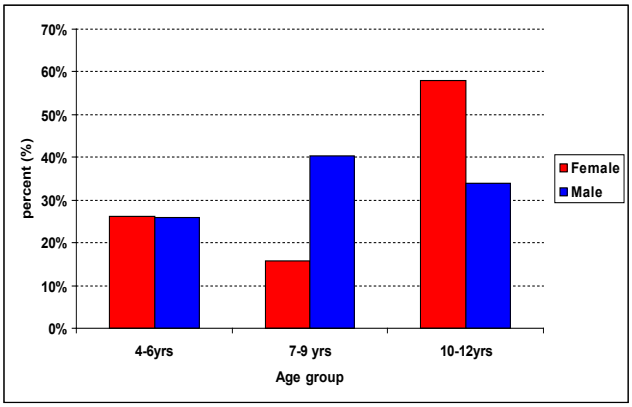
The mean ANR of 4-6 yrs is 0.75, 7-9 yrs is 0.73 and 10-12 yrs is 0.60.

There is no statistically significant difference between mean ANR of 4-6 yrs and 7-9 yrs age group. But there is statistically significant difference between mean ANR of age group 4-6 yrs and 7-9 yrs with 10-12 yrs.

Table 5. Sex Incidence

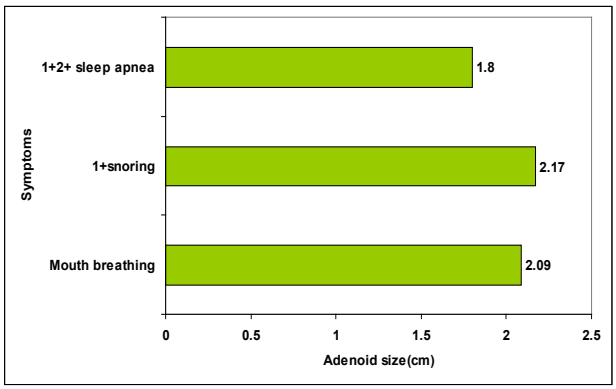
SEX		Age group			Total
		4-6yrs	7-9 yrs	10-12yrs	
F	Count	10	6	22	38
	% within SEX	26.3%	15.8%	57.9%	100.0%
M	Count	16	25	21	62
	% within SEX	25.8%	40.3%	33.9%	100.0%
Total	Count	26	31	43	100
	% within SEX	26.0%	31.0%	43.0%	100.0%

Chi-square=7.739 p=0.021



There was male predominance with 62: 38, male- female ratio.

Table 6. Symptoms



There is significant increase in adenoid size in children presenting with mouth breathing and snoring – 2.17 cm.

4. Discussion

Symptomatic adenoid hypertrophy is common in paediatric population. Adenoidectomy is one of the most commonly performed procedures in this age group. Due to its location in the posterior nasopharyngeal airway, assessment of the size and degree of adenoid hypertrophy is challenging. Multiple modalities to quantify adenoid tissue and its relationship to the nasopharyngeal airway have been devised. Lateral radiographs of nasopharynx and nasal endoscopy are used to assess the size of adenoids. However, there is currently no

clear standard to guide the treating physician.[5]This study was done to validate X-rays which is an important noninvasive diagnostic test. Our study was compared with those done by Yusuf K. Kemaloglu et al., Elwany et al., Soroosh Mahboubi et al. and Fujioka et al. We preferred to adopt the method of Yusuf KK et al as the landmarks used by them could be easily located on the X-ray. The average mean of all the three ratios is taken as the mean ANR.

From subjective longitudinal observation of serial lateral radiographs of nasopharynx, Subtelny et al. observed that adenoids grew rapidly in infants up to age of 2years, at which time they filled half of nasopharyngeal cavity[7].ANR was first described by Fujioka et al., in 1979 as a reliable method of expressing the size of adenoids and patency of nasopharyngeal airway wherein a comparison of the amount of lymphoid tissue in the nasopharynx to the size of nasopharyngeal compartment was made. He studied 1,398 children with lateral radiographs of nasopharynx and calculated ANRs. He stated that for practical purposes a value of ANR greater than 0.80 may be considered indicative of enlarged adenoids[3]. The landmark used was the anteroinferior edge of the sphenobasioccipital synchondrosis. Linder Arenson used a similar ratio of adenoidal and nasopharyngeal depths as a parameter in the symptomatic adenoid hypertrophy before Fujioka et al.[8]

Yusuf K Kemaloglu et al. studied 150 children from 4-10years in 1999. They used two bony reference points (the posterosuperior edge of spheno basioccipital synchondrosis and the basion) and one adenoidal point (the nearest point of the adenoidal shadow to the posterior nasal spine).The ratio of adenoidal depth to nasopharyngeal depth which was both measured on the same line was taken as the ANR. Our study followed the same method of calculation as his. The data in his study clearly demonstrated that ANRs was a reliable objective criterion for evaluation of adenoidal hypertrophy[6].

Elwany et al. studied 200 children from 3-7years in 1987. He reported ANR of 0.58 and 0.71 for normal and adenoidectomy children respectively in the age group of 2-12 years[9]. Mahboubi et al. studied lateral radiographs [both supine and erect] of 27 children. His ANR values were 0.79 in erect and 0.69 in supine position[10].

Linder – Aronson S and Woodside DG reported that the sagittal depth of nasopharynx increased in both the sexes until about 18 years of age.[8] However, our patients had no significant differences in the nasopharyngeal depth across various age groups. It is said that enlarged adenoids may delay the growth of the nasopharyngeal depth.[6]

Our ANRs are similar to study done by Fujioka et al., Yusuf K Kemaloglu., Elwany et al., Mahboubi et al.

Table 7. Comparison of different studies

Yusuf et al	0.73 / 0.68 / 0.69	4-6 / 6-8 / 8-10years
Fujioka et al	0.8	
Elwany et al	0.71	
Mahboubi et al	0.71 / 0.69	Erect / supine
Our study	0.75 / 0.73 / 0.60	4-6 / 7-9 / 10-12years
Average	0.68	4-12 years

Results were statistically analyzed:

- Significant increase in adenoid size during 7- 9 yrs & decrease during 10 -12yrs.
- Significant increase in nasopharyngeal depth as age progresses.
- No significant difference between mean ANR of 4-6 & 7-9yrs.
- Significant difference between mean ANR of 4-6 with 10-12yrs & 7-9 with 10-12yrs.
- Significant increase in adenoid size in children presenting with mouth breathing & snoring
- ANR > 0.7 are the candidates for adenoidectomy

Limitations of this method of assessment of adenoid hypertrophy include anatomical alterations based on rotation, respiratory cycle, lack of co-operation of the child and exposure to radiation. [5]

Wang DY et al considered direct visualization of the nasopharynx by endoscopy as a superior method of assessment of adenoid size.[11] However; the procedure is subjective and may be difficult to perform in younger children. It is said that radiological methods seemed to overestimate adenoid size with smaller adenoids, and seemed to underestimate size with the much larger adenoids.[5] K. Lertsburapa et al. notes that radiologist's accuracy in the assessing the ratios could be variable and believes that mirror examination of the nasopharynx at the time of the surgery would be a better assessment of adenoid size.[5] Babak Saedi et al in their research article state that despite the popularity of nasal endoscopy, radiography can serve as a better planning tool for adenoidectomy.[2]

5. Summary and Conclusions

- Hundred children with nasopharyngeal obstruction due to adenoid were included in our study.
- All children in our study are between 4- 12years. Nasal breathing was evaluated according to presence of snoring, mouth breathing and sleep apnea. Depending upon the age, all children were divided into 3 subgroups, 4-6, 7-9 and 10-12years. We took lateral radiographs of nasopharynx of all children and calculated adenoid – nasopharyngeal ratio from the mean adenoidal depth and mean nasopharyngeal depth which was measured separately.
- All ANRs were statistically analyzed and the results are 0.75, 0.73 & 0.60 for age groups of 4-6, 7-9 & 10-12 respectively. We found that adenoid size increase during 7-9 years and decreased during 10-12years. There was significant increase in nasopharyngeal depth as the age progresses from 4-12years. There was significant difference between ANR of age group 4-6 and 7-9 with 10-12 years group. Adenoid size was found to be maximum when children presented with mouth breathing and snoring.
- Our study gives support to the assumption that the ANR is a more convenient radiologic parameter for determining whether adenoid hyperplasia is clinically significant or not, rather than the size of adenoid or the size of nasopharynx.

- To conclude, ANR > 0.7 are considered to be the candidates for adenoidectomy

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