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Relationship between radiographic adenoid-nasopharyngeal ratio and clinical symptoms of adenoid hypertrophy in a tertiary health institution in North West Nigeria

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ABSTRACT

Background: Adenoid hypertrophy is the most common cause of nasopharyngeal airway obstruction in children. The radiographic evaluation of the adenoid hypertrophy using the adenoid-nasopharyngeal ratio is a simple, economical, and reliable method in determination of the position, size, and shape of the adenoids. **Aims and Objectives:** The study was conducted to determine the relationship between radiographic adenoid-nasopharyngeal ratio and clinical symptoms of adenoid hypertrophy. **Materials and Methods:** This cross-sectional prospective study was carried out in the Department of Radiology, Usmanu Danfodiyo University Teaching Hospital, Sokoto, North West Nigeria. A total of 90 consecutive patients aged between 3 and 12 years with clinical symptoms of adenoid hypertrophy were included in the study. All the patients had plain radiography of the post-nasal space. The adenoid-nasopharyngeal ratio (ANR), which is the ratio of the adenoid thickness measured from the maximum convexity of the adenoid to the margin of the basiocciput and the nasopharyngeal depth measured from the posterior border of the hard palate to the anteroinferior aspect of the sphenobasioccipital synchondrosis (Fujioka method), was calculated and scores obtained for each patient were graded into mild (0.50–0.62), moderate (0.63–0.75), and severe (0.76–0.88). The clinical symptoms assessed included snoring, mouth breathing, sleep apnea, otitis media, and recurrent upper airway infections. Each symptom was scored on a 4-point scale and the sum of the scores was graded into mild (0–5), moderate (6–10), and severe (11–15). The data were collected using a structured questionnaire and analyzed using Statistical Package for the Social Sciences version 22. **Results:** A total of 90 patients were involved in the study, their age ranged between 3 and 12 years (mean = 6.11 ± 2.77); and male-to-female ratio was 2:1.5. The mean ANR score was 0.71 ± 0.11 and that of the clinical symptoms score was 8.67 ± 3.23. ANR correlated significantly with the clinical symptoms scores ($r = 0.901$; $P < 0.0001$). The association was significant at ANR grading for mild ($\chi^2 = 20.91$; $P = 0.003$) and severe ($\chi^2 = 11.39$; $P = 0.022$). **Conclusion:** This study shows that radiographic ANR can predict the degree of nasopharyngeal airway obstruction especially for mild and severe grading. A severe nasopharyngeal airway obstruction as determined by both ANR and symptom's severity was observed in the 3–5 years age group.

Key words: Adenoid hypertrophy; Adenoid-nasopharyngeal ratio; Post-nasal space radiograph; Symptomatology scores

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INTRODUCTION

The adenoid is a conglomerate of lymphatic tissue located on the upper posterior wall of the nasopharynx adjacent to the choanae and auditory tube ostium.[1-4] It becomes clinically apparent when it undergoes hyperplasia; it enlarges during early childhood reaching a maximum size during the first 6–8 years and involutes during puberty.[4-6] Adenoidal hypertrophy is a common cause of morbidity in the pediatric population worldwide, and this has made adenoidectomy the most common surgical procedure performed by otorhinolaryngologists.[1,5,7-9] The prevalence of adenoid hypertrophy tends to decrease with increasing age due to physiological atrophy and is rarely found in children above 15 years of age.[10] It has also been found to be low among children of high socioeconomic class.[11] In a study done in Sokoto, North West Nigeria by Amutta et al.,[12] to determine the pattern of otorhinolaryngeal and head-and-neck diseases, the prevalence of adenoidal hypertrophy was found to be 4.9%.[12]

Adenoid hypertrophy does not appear to have any gender or racial predilection.[11,13] When adenoids enlarged, they lead to a variety of symptoms and diseases, including mouth breathing, nasal obstruction, snoring, repeated upper airway infections, recurrent otitis media, hyponasal speech, nocturnal drooling of saliva, and sleep apnea.[10,14,15]

The clinical examination of the nasopharynx in children for the assessment of adenoidal hypertrophy poses a great challenge to the clinicians because it provides little information on the size of the adenoids.[16-19]

Several radiologic and clinical methods for the diagnosis of adenoid hypertrophy have been recommended. These include post-nasal space radiographs (PNSRs), magnetic resonance imaging (MRI), computed tomography (CT), video fluoroscopy, flexible nasopharyngoscopy, transoral digital palpation, nasal resistance, and air flow test.[1,6,9] MRI can define the presence and size of the adenoid tissue with high accuracy. However, MRI seems not to be appropriate for a routine use in diagnosis of adenoid hypertrophy because of its high cost, non-availability, and prolonged imaging time.[1] Multi-row detector CT scans and video fluoroscopy are both very accurate, but require specialized equipment and expose patients to unjustifiably high levels of radiation.[20,21]

Post-nasal space radiography is perhaps the most frequent radiologic imaging modality used in the routine assessment of adenoid hypertrophy.[1,2,9] It is an affordable, readily available, and reliable way to diagnose adenoid hypertrophy.[6,7,9] The use of ionizing radiation and superimposition of surrounding structures because of its two-dimensional representation are some of its disadvantages or drawbacks.[6]

ANR is defined as the ratio between the distance measured from the maximal convexity of the adenoid to the anterior margin of the basiocciput (adenoid thickness) and the distance along a line from the posterosuperior edge of the hard palate to the spheno-occipital synchondrosis on the base of the skull.[7]

Several studies have reported that the adenoidal-nasopharyngeal ratio (ANR) obtained through PNSR is reliable for assessing the nasopharyngeal airways and correlates well with the findings obtained in other modalities of visualization of the nasopharyngeal airway, such as endoscopic examination.[5,7,21]

This study is aimed at determining the relationship between radiographic ANR and clinical symptoms of adenoid hypertrophy.

Aims and objectives

This study aims to determine the relationship between radiographic ANR and clinical symptoms of adenoid hypertrophy.

MATERIALS AND METHODS

This prospective cross-sectional study was carried out at the Department of Radiology, Usmanu Danfodiyo University Teaching Hospital Sokoto, North West Nigeria, on patients aged between 3 and 12 years whom were diagnosed with adenoid hypertrophy. Patients with congenital syndromes and head-and-neck malformations were excluded from the study. All patients were seen at the Ear, Nose, and Throat and Paediatric clinics of Usmanu Danfodiyo University Teaching Hospital, Sokoto, and referred to the Radiology Department of same hospital for plain radiography of the post-nasal space due to clinical suspicion of adenoid hypertrophy. Approval was obtained from the Institutional Ethics and Research Committee before the commencement of the study. Informed consent was obtained from the parents/guardians. The patients and/or their parents were interviewed with a structured questionnaire containing their sociodemographic status and clinical symptoms. Detailed clinical history of each patient was taken with special regards to presenting complaints such as snoring, mouth breathing, sleep apnea, otitis media, and recurrent upper airway infections. Each symptom (depending on the severity) was categorized into four groups according to patient's or their parent's statements. The sum of the clinical symptoms scores of each patient was graded into mild (0–5), moderate (6–10), and severe (11–15).

All subjects had a lateral view plain radiograph of the post-nasal space using Silhouette VR System GE diagnostic X-ray equipment (Model No: 2226680), manufactured in July 2007. Images were processed using either an automatic processor. The radiographs were reported by the investigators and cross-checked by other consultant radiologists in the department. ANR was calculated by dividing the distance from the outermost point of convexity of adenoid shadow to the anterior margin of the basiocciput to the distance between anterior inferior aspect of the sphenobasioccipital synchondrosis and posterior border of the hard palate (Fujioka Method); as shown in figure-1. The ANR scores of each patient were graded into mild (0.50–0.62), moderate (0.63–0.75), and severe (0.76–0.88). All the ANR and symptoms scores were analyzed using Statistical Package for the Social Sciences IBM version 22.

RESULTS

The study population consisted of 3–5 years (51.1%), 6–8 years (26.7%), and 9–12 years (22.2%) age groups. There were 52 (57.8%) males and 38 (42.2%) females (Table 1).

Twenty-two (24.4%), 29 (32.2%), and 39 (43.3%) had mild, moderate, and severe ANR scores, respectively (Table 2). Figure-2 shows post-nasal space radiographs with adenoidal hypertrophy and secondary airway obstruction. The minimum ANR was 0.50 and the maximum was 0.88. The overall mean ANR was 0.7. Male patients had a mean score of 0.72 while female patients had 0.69.

The mean ANR for the age groups was 0.79 (3–5 years), 0.67 (6–8 years), and 0.59 (9–12 years), as shown in Figure 3.

ANR grading was found to be 89.7%, 7.7%, and 2.6% for the age groups 3–5 years, 6–8 years, and 9–12 years, respectively. The study showed that 68.2% of the 9–12 years group showed significant association with mild ANR grading (χ^2=20.91; P=0.003) while 89.7% of the 3–5 years group showed significant association with severe ANR grading (χ^2=11.39; P=0.022). However, no significant association was seen for moderate ANR grading in all the age groups (P>0.05); (Table 3).

All the patients presented with the complaints of more than clinical symptoms of adenoid hypertrophy with all of them presenting with snoring, mouth breathing, and recurrent upper airway infections. However, only 74 (82.2%) and 41 (54.6%) presented with sleep apnea and otitis media, respectively. There were 22 (24.4%), 25 (27.8%), and 43 (47.8%) with mild, moderate, and severe clinical symptoms grading, respectively (Table 4).

The lowest clinical symptom score was 3 and the highest score was 13. The mean clinical score was 8.67. Patients within the

Table 1: Age group and sex distribution of the study population

Variable	Frequency, N=90	Percentage
Age group (years)		
3–5	46	51.1
6–8	24	26.7
9–12	20	22.2
Sex		
Male	52	57.8
Female	38	42.2

Table 2: Radiological grading of adenoid-nasopharyngeal ratio scores

Grade	Frequency	Percentage
Mild	22	24.4
Moderate	29	32.2
Severe	39	43.3
Total	90	100

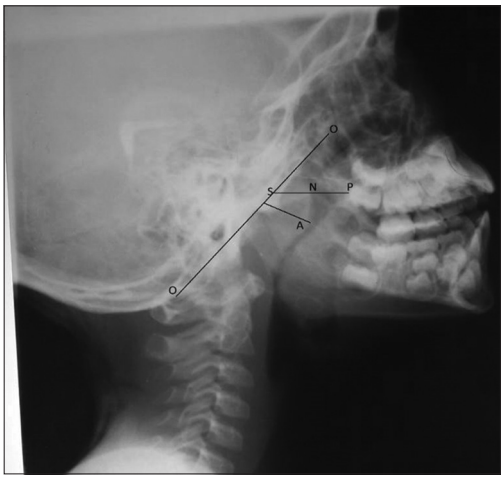

Figure 1: Post-nasal space radiograph illustrating the measurements for calculation of the ANR. Line O runs tangential to the basiocciput. The adenoidal measurement (A) is the distance from the maximum convexity of the adenoid tissue to the anterior margin of the basiocciput. The nasopharyngeal measurement (N) denotes the distance between the posterior border of the hard palate (P) and the anterior inferior aspect (S) of the sphenobasioccipital synchondrosis

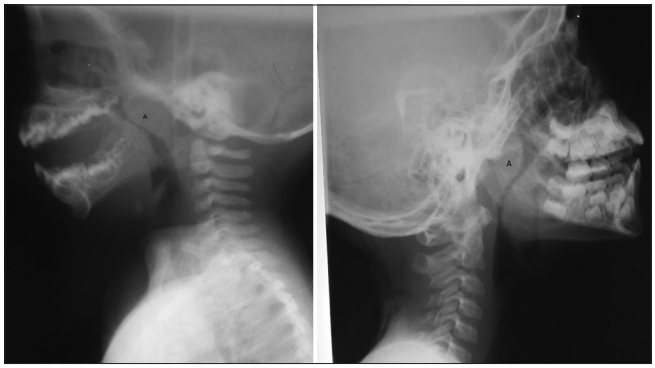

Figure 2: Post-nasal space radiographs showing enlarged adenoids (A) with nasopharyngeal airway obstruction

Table 3: Chi-square test showing the association between ANR grading and age group of patients

ANR	Age group			Totals
	3–5 (N=46) O (E) [%] [$\chi^{2(df)}$]; P value	6–8 (N=24) O (E) [%] [$\chi^{2(df)}$]; P value	9–12 (N=20) O (E) [%] [$\chi^{2(df)}$]; P value	
Mild	1 (11.2) [4.5] $\chi^{2\ (4df)}$=9.33; P=0.053	6 (5.8) [27.3]; $\chi^{2\ (4df)}$=0.01; P=0.990	15 (4.9) [68.2]; $\chi^{2\ (4df)}$=20.91; P=0.003*	22
Moderate	10 (14.8) [34.5]; $\chi^{2\ (4df)}$=1.57; P=0.814	15 (7.7) [51.7]; $\chi^{2\ (4df)}$=6.83; P=0.145	4 (6.4) [13.8]; $\chi^{2\ (4df)}$=0.93; P=0.920	29
Severe	35 (19.9) [89.7] $\chi^{2\ (4df)}$ =11.39; P=0.022*	3 (10.4) [7.7]; $\chi^{2\ (4df)}$=5.27; P=0.260	1 (8.7) [2.6]; $\chi^{2\ (4df)}$= 6.78; P=0.147	39
Totals	46	24	20	90

ANR: Adenoid-nasopharyngeal ratio, N: Number of subjects, O: Observed counts, E: Expected counts, %: Percentage frequency; χ^2: Chi-square test statistics, df: Degree of freedom. *Statistically significant at P<0.05. The overall Chi-square statistics was 63.008 and this was statistically significant (P<0.0001), likelihood ratio=64.880

age group of 3–5 years had the highest clinical symptoms score. A severe symptomatology score grading was seen 88.4%, 9.3%, and 2.3% within the age groups of 3–5 years, 6–8 years, and 9–12 years, respectively. The 9–12 years group (62.8%) showed significant association with mild clinical symptoms score grading (χ^2=20.91; P=0.003) while 88.4% of the 3–5 years group showed significant association with severe clinical symptom scores grading (χ^2=11.68; P=0.019). However, no significant association was seen in all the age groups (P>0.05).

There was statistically significant relationship between the ANR grading and the clinical symptoms grading of adenoid hypertrophy (P<0.0001); (Table 5).

Table 4: Grading of clinical symptoms scores

Grade	Frequency	Percentage
Mild (0–5)	22	24.4
Moderate (6–10)	25	27.8
Severe (11–15)	43	47.8
Total	90	100

Table 5: Cross-tabulation showing the relationship between ANR grading and clinical symptoms scores of the study population

ANR grading	Clinical symptoms score grading			Total	Test statistics
	Mild	Moderate	Severe		
Mild	21	1	0	22	χ^2=65.566 df=4 Likelihood ratio=137.140 P<0.0001
Moderate	1	23	5	29	
Severe	0	1	38	39	
Total	22	25	43	90	

There was a statistically significant relationship between the ANR grading and the clinical symptoms grading of the patients (P<0.0001). ANR: Adenoid-nasopharyngeal ratio, df: Degree of freedom, χ^2: Chi-square

DISCUSSION

Adenoid hypertrophy is the most common cause of nasopharyngeal airway obstruction in children, leading to a spectrum of clinical symptoms such as snoring, mouth breathing, recurrent airway infections, and sleep apnea.[14] In this study, the correlation between radiographic ANR and clinical symptoms of adenoid hypertrophy was evaluated. The highest frequency of adenoid hypertrophy was seen in children aged 3–5 years and the lowest was seen in the 9–12 years group. This is in agreement with the studies done by Osiatuma et al., in Ile-Ife and Adedeji et al., in Oshogbo South West Nigeria.[15,22] These findings of severe nasopharyngeal airway obstruction seen in the age group 3–5 years were probably due to the fact that adenoid size has a relatively higher growth rate than the nasopharynx in addition to the highest incidence of upper respiratory tract infection due to low immunity in this age group.[23] However, different results were reported by Gangadhara et al.,[5] in India who found significant increase in adenoid size in the 7–9 years age group. This difference may be due to regional variation.

There were more males (57.8%) in this study with a male-to-female ratio of 2:1.5. This is similar to the findings in studies done by Caylakli et al.,[1] Gangadhara et al.,[5] Kolo et al.,[9] and Ehab et al.,[24] with male preponderance of 61%, 62%, 64.7%, and 54%, respectively. Gill et al.,[6] however, in their study of comparative roles of X-ray nasopharynx and nasal endoscopy in diagnosis of adenoid hypertrophy of 40 patients in India got a higher number of females (70%) than males (30%). This variation may be due to the smaller sample size they studied compared to our own study.

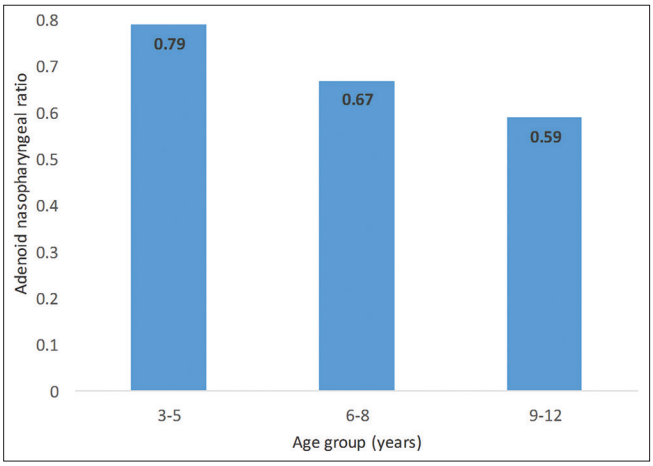

Figure 3: Bar chart showing mean adenoid-nasopharyngeal ratio between age groups

Majority of the patients studied; 39 (43.3%) had severe, 29 (32.2%) had moderate, and 22 (24.4%) had mild ANR scores. Severe ANR grading was found to be 89.7%, 7.7%, and 2.6% for the age groups 3–5 years, 6–8 years, and 9–12 years, respectively. Moderate ANR grading was higher in the age group of 6–8 years (51.7%) while mild ANR grading predominated within the 9–12 years group (68.2%). Our findings are comparable with the previous studies in the literature.[22,24,25]

In this study, 68.2% of the 9–12 years group showed significant association with mild ANR grading (χ^2=20.91; P=0.003) while 89.7% of the 3–5 years group showed significant association with severe ANR grading (χ^2=11.39; P=0.022). However, no significant association was seen for moderate ANR grading in all the age groups (P>0.05).

All the patients in our study presented with the complaints of more than 1 symptom with all of them presenting with snoring, mouth breathing, and recurrent upper airway infections. Seventy-four (82.2%) presented with sleep apnea while 41 (45.6%) had otitis media. This is similar to the findings by other researchers.[9,10,22,25,26]

The highest clinical symptoms score in our study was 13 and the lowest score was 3. Severe clinical symptoms scores were more frequent in the age group of 3–5 years (47.8%). The higher the age of the child, the less the clinical symptoms scores. This is in agreement with the previous studies done by Adedeji et al.,[22] and Orji et al.,[25] in Osogbo and Enugu, respectively.

A severe symptomatology score grading was found in 88.4%, 9.3%, and 2.3% within the age groups of 3–5 years, 6–8 years, and 9–12 years, respectively.

The 9–12 years age group (62.8%) showed significant association with mild clinical symptoms score grading (χ^2=20.91; P=0.003) while 88.4% of the 3–5 years age group showed significant association with severe clinical symptom scores grading (χ^2=11.68; P=0.019). However, no significant association was seen for moderate clinical symptoms scores grading in all the age groups (P>0.05).

Clinical symptoms score grading showed strong significant negative correlation with the child's age (r=−0.804; P≤.0001). Younger children were observed to have more severe symptoms. The symptoms became increasingly less severe as the child's age increases. The lowest scores were seen in the age group of 9–12 years. This is similar with the findings in the previous studies.[22,26]

There was a very strong positive significant correlation between the clinical symptoms scores and the ANR (r=0.901; P<0.0001). As the ANR increases, the clinical symptom scores of the patient also increase. This is consistent with the findings of Manzoor et al.,[27] in Lahore where they found a statistically significant correlation between clinical symptoms scores and the radiological assessment of nasopharyngeal airway obstruction.

This study shows statistically significant relationship between the ANR grading and grading of clinical symptoms of adenoid hypertrophy (χ^2=65.566; P<0.0001). This is similar with the findings of Orji et al., and Adedeji et al.,[22] but is contrast to that of Kolo et al.,[9] who found a very weak non-significant correlation between symptomatology assessment score and the radiographic findings of enlarged adenoid. This difference in the findings may be due to their small sample size and the variation in the age range of the patients compared to our study.

Limitations of the study

The sample size in the study is small and therefore not representative of the general population.

CONCLUSION

This study shows that radiographic ANR can predict the degree of nasopharyngeal airway obstruction, especially for mild and severe grading. A severe nasopharyngeal airway obstruction as determined by both ANR and symptom's severity was observed in the 3–5 years age group.

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MDR – Concept and design of study, literature review, designing methodology, statistical analysis, interpretation of results, and preparation of draft of discussion; **SAS** – Reviewed concept and study design, reviewed methodology, final result interpretation, and manuscript; **SMM** – Reviewed the statistical analysis, designed the framework for results and discussion; **MD** – Reviewed the statistical analysis, designed the framework for results and discussion; **GHY** – Image re-interpretation and documentation, discussion; **KRI** – Patient recruitment, referral, literature review, and methodology; **AOH** – Image re-interpretation and documentation, discussion; and **AA** – Data analysis, interpretation of results and discussion.

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