RELATIONSHIP BETWEEN SYMPTOMS OF ADENOID HYPERTROPHY AND ADENOIDAL NASOPHARYNGEAL RATIO IN CHILDREN AT A TERTIARY HOSPITAL

Anupama Shah Rijal,[1] Abhushan Siddhi Tuladhar,[2] Rupesh Raj Joshi,[1] Kundan Kumar Shrestha,[1] Anup Dhungana,[1] Rupak Khadka[1]

[1]Department of Otorhinolaryngology, [2]Department of Radiology, Nepal Medical College Teaching Hospital, Attarkhel, Gokarneshwor-8, Kathmandu, Nepal

ABSTRACT

Adenoid hypertrophy (AH) is a common problem in the paediatric age group causing nasal obstruction, snoring, waking up at night, nasal discharge, mouth breathing and decrease in hearing. This causes considerable morbidity in children along with various sequalae. The adenoidal nasopharyngeal ratio (ANR) is an objective method to assess AH and is calculated using a lateral nasopharynx x-ray. The study assessed the relationship between symptoms of AH and ANR. A cross-sectional, hospital-based study was conducted in children between the ages of 2 to 14 years. History of the symptoms was obtained and ANR was calculated using a lateral nasopharynx x-ray. There was a male preponderance of 1.3:1, with the majority of children between 6 to 10 years of age (67.3%). The common symptoms were nasal discharge (81.1%), mouth breathing (79.8%), snoring (76%) and decrease in hearing (66.3%). The largest mean adenoid size was 18.20 ± 2.63 mm in the 6-10 years, while the greatest mean nasopharyngeal depth was in the 11-14 years old age group (34.50 ± 2.88 mm). The maximum mean ANR of 0.71 ± 0.11 was in the 2-5 years old. All the symptoms of AH showed statistically significanct relationship with high ANR; snoring (p=0.003), waking up at night (p=0.001), nasal discharge (p=0.001), mouth breathing (p=0.034), decrease in hearing (p=0.030). It was seen that the highest number of children affected was in the younger age group where ANR was higher. ANR on nasopharyngeal x-ray (lateral view) correlated well and showed significant relationship with symptoms of AH.

KEYWORDS

Adenoid, adenoidal nasopharyngeal ratio, children, symptoms

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CORRESPONDING AUTHOR

Dr. Anupama Shah Rijal
Associate Professor,
Department of Otorhinolaryngology,
Nepal Medical College Teaching Hospital, Attarkhel,
Gokarneshwor-8, Kathmandu, Nepal
Email: asrijal@gmail.com
Orcid No: https://orcid.org/0000-0002-4956-4769
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INTRODUCTION

The adenoid is lymphoid tissue that forms part of Waldeyer's ring at the portal of the upper respiratory tract. The adenoid grows rapidly during infancy and plateaus between 2 and 14 years of age, then regresses rapidly after 15 years of age in most children.[1] The adenoid grows more rapidly than the bony structure in the nasopharynx, reaching its relative largest in relation to the volume of the nasopharynx in the 7 years age group, which may predispose children to obstructive symptoms.[2,3] Clinical symptoms are commoner in younger age groups, owing to a combination of a relatively small volume nasopharynx and increased frequency of upper respiratory tract infections.[1] Frequent clinical symptoms of adenoid hypertrophy (AH) are upper air way obstruction, recurrent otitis media, obstructive sleep apnoea, paediatric chronic rhinosinusitis, failure to thrive and craniofacial developmental anomalies. Other documented symptoms of AH are mouth breathing, snoring, cough, speech disturbance, lethargy and poor academic or scholastic performances. Children with AH are also found to have increased association with nocturnal enuresis, attention deficit hyperactivity disorder, pulmonary hypertension and right heart failure.[4-7]

In spite of all the symptoms that may be associated with AH an objective method to calculate the adenoidal nasopharyngeal ratio (ANR) was introduced by Fujioka, which is an easy non-invasive procedure for measurement of adenoid hypertrophy. ANR is the ratio of adenoid size (A) to nasopharyngeal depth (N), where A is the distance between the maximum convexity of the adenoid and a line drawn along the basiocciput and N is the distance between the posterosuperior edge of the hard palate and the anteroinferior edge of the sphenobasioccipital synchondrosis.[8] Assessment of adenoid hypertrophy may be challenging because of its anatomical location, moreover, the history about the presenting symptoms is narrated mostly by the parents/care takers and children do not generally cooperate during examination. The adenoid appears to have an important role in the development of 'immunological memory' in younger children, hence any decision regarding surgical intervention needs careful evaluation of the patient before adenoidectomy.[9] Therefore careful documentation of symptoms along with the ANR could provide a useful guide in the management of adenoid hypertrophy. Hence, this study aims to assess the relationship between the symptoms of adenoid hypertrophy and ANR in children at a tertiary hospital.

MATERIALS AND METHODS

A cross-sectional, hospital-based study was conducted from April 2022 to November 2022 in the Outpatient Department of Otorhinolaryngology at Nepal Medical College Teaching Hospital (NMCTH). Permission for the study was obtained from the Institutional Review Committee (IRC) of Nepal Medical College Teaching Hospital. Consent was taken from the children's parents/caretaker. All children between the ages of 2 to 14 years, of both genders, with bilateral nasal obstruction were included in the study. Previous history of adenoidectomy, congenital anomalies of head and neck, traumatic craniofacial abnormalities and ear diseases like acute otitis externa, chronic otitis media with perforation and cholesteatoma were excluded from the study. Children fulfilling the inclusion criteria and parents/caretaker who were willing for their children to participate in the study were included. A detailed history of the related symptoms was taken by the investigating doctor from the child's parents or caretaker. The symptoms included were snoring, waking up at night, nasal discharge, mouth breathing and decrease in hearing. Clinical examination of the ear, nose, throat and head and neck was carried out, along with otoscopic examination of both ears. The patient was then referred to the radiology department and plain x-ray of the nasopharynx (lateral view) with the mouth closed was taken. The size of the adenoids and nasopharyngeal depth were measured according to Fujioka, Adenoid size (A) was determined by drawing a perpendicular line from a line drawn along the straight part of the anterior margin of basiocciput to a point of maximal convexity of adenoid. Nasopharyngeal depth (N) was determined by drawing a line from the anterior inferior edge of sphenobasioccipital synchondrosis to the posterior superior margin of the hard palate. (Fig. 1) The adenoid sizes and the nasopharyngeal depth was measured in millimetres. Adenonasopharyngeal ratio (ANR) was then determined by dividing adenoidal size with nasopharyngeal depth. The children were divided into three groups age 2 to 5 years, 6 to 10 years and 11 to 14 years according to the pre-school, primary and upper primary and mean ANR was calculated. The data was coded, entered into SPSS version 16 and analysed. The relationship between the symptoms of AH and ANR was determined using Fisher's exact test. A value of $p < 0.05$ was considered statistically significant.

RESULTS

One hundred and four children were included in the study, the age ranged from 3 years to 14 years, with the mean age 7.06 ± 2.30 years. There were 59 (56.7%) male and 45 (43.3%) female children with the ratio being 1.3:1. There were 70 (67.3%) children between 6 and 10 years followed by 28 (26.9%) who were 2 to 5 years. Among the 104 children, nasal discharge was seen in 85 (81.1%), mouth breathing in 83 (79.8%), snoring in 79 (76.0%) and waking up at night in 32 (30.8%) children. According to the parents and caretakers decrease in hearing was seen in 69 (66.3%) children (Table 1).

The mean adenoid size in 2 to 5 years children was 17.39 ± 2.26 mm, ranging from 14 to 22 mm. In the 6-10 years age group the mean adenoid size was 18.20 ± 2.63 mm ranging from 10 to 24 mm, whereas in the 11 to 14 years old it was 17.00 ± 1.54 mm ranging from 14 to 18 mm. The mean adenoid size was 17.91 ± 2.50 mm ranging from 10 to 24 mm (Table 2).

The mean adenoid nasopharyngeal depth in 2 to 5 years was 24.64 ± 5.10 mm ranging from 16 to 35mm. The mean adenoid size in 6 to 10 years was 27.85 ± 4.18 mm ranging from 22 to 40 mm, whereas in 11 to 14 years was 34.50 ±

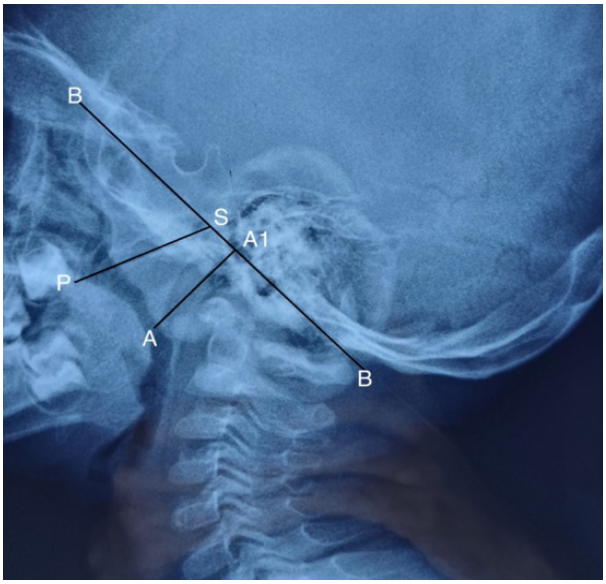

Fig. 1: Plain x-ray of the nasopharynx (lateral view): **B-B:** Line drawn along straight part of anterior margin of basiocciput; S: Sphenobasioccipital synchondrosis; **S-P:** Nasopharyngeal depth (line from the anterior inferior edge of sphenobasioccipital synchondrosis to the posterior superior margin of the hard palate); **A-A1:** Adenoid size (perpendicular line from maximum convexity of adenoid intersecting the B-B line)

Table 1: Frequency of symptoms

Symptoms	Snoring n (%)	Waking up at night n (%)	Nasal discharge n (%)	Mouth breathing n (%)	Decrease in hearing n (%)
Absent	25 (24.0)	72 (69.2)	19 (18.3)	21 (20.2)	35 (33.7)
Present	79 (76.0)	32 (30.8)	85 (81.7)	83 (79.8)	69 (66.3)
Total	**104 (100)**	**104 (100)**	**104(100)**	**104 (100)**	**104 (100)**

Table 2: Adenoid size in different age groups

Age group (years)	n (%)	Mean	Standard Deviation	Minimum	Maximum
2 - 5	28 (26.9)	17.39	± 2.26	14.0	22.0
6 - 10	70 (67.3)	18.20	± 2.63	10.0	24.0
11 - 14	6 (5.8)	17.00	± 1.54	14.0	18.0
Total	**104 (100)**	**17.91**	**± 2.50**	**10.0**	**24.0**

Table 3: Nasopharyngeal depth in different age groups

Age group (years)	n (%)	Mean	Standard Deviation	Minimum	Maximum
2 - 5	28 (26.9)	24.64	± 5.10	16.0	35.0
6 - 10	70 (67.3)	27.85	± 4.18	22.0	40.0
11 - 14	6 (5.8)	34.50	± 2.88	29.0	37.0
Total	**104 (100)**	**27.37**	**± 4.91**	**16.0**	**40.0**

Table 4: Adenoidal nasopharyngeal ratio in different age group					
Age group (years)	**n (%)**	**Mean**	**Standard Deviation**	**Minimum**	**Maximum**
2 - 5	28 (26.9)	0.71	± 0.11	0.48	0.90
6 - 10	70 (67.3)	0.66	± 0.13	0.25	0.91
11 - 14	6 (5.8)	0.49	± 0.01	0.48	0.50
Total	**104 (100)**	**0.67**	**± 0.13**	**0.25**	**0.91**

Table 5: Relationship between symptoms of adenoid hypertrophy and ANR ratio				
	Symptoms			
ANR ratio	**Snoring**		**Total (n = 104)**	**P value**
	Absent n (%)	**Present n (%)**		
0.25 – 0.49	4 (40)	6 (60.0)	10 (100.0)	
0.50 – 0.74	20 (30.8)	45 (69.2)	65 (100.0)	0.003
0.75 - 0.99	1 (3.4)	28 (96.6)	29 (100.0)	
ANR ratio	**Waking up at night**		**Total (n =104)**	**P value**
	Absent n (%)	**Present n (%)**		
0.25 – 0.49	10 (100.0)	0 (0.0)	10 (100.0)	
0.50 – 0.74	49 (75.4)	16 (24.6)	65 (100.0)	0.001
0.75 - 0.99	13 (44.8)	16 (55.2)	29 (100.0)	
ANR ratio	**Nasal discharge**		**Total (n = 104)**	**P value**
	Absent n (%)	**Present n (%)**		
0.25 – 0.49	6 (31.6)	4 (4.7)	10 (100.0)	
0.50 – 0.74	12 (63.2)	53 (62.4)	65 (100.0)	0.001
0.75 - 0.99	1 (3.4)	28 (96.6)	29 (100.0)	
ANR ratio	**Mouth breathing**		**Total (n = 104)**	**P value**
	Absent n (%)	**Present n (%)**		
0.25 – 0.49	4 (40.0)	6 (60.0)	10 (100.0)	
0.50 – 0.74	15 (18.5)	50 (81.5)	65 (100.0)	0.034
0.75 – 0.99	2 (6.1)	27 (93.1)	29 (100.0)	
ANR ratio	**Decrease in hearing**		**Total (n = 104)**	**P value**
	Absent n (%)	**Present n (%)**		
0.25 – 0.49	6 (60.0)	4 (40.0)	10 (100.0)	
0.50 – 0.74	24 (36.9.6)	41 (63.1)	65 (100.0)	0.030
0.75 – 0.99	5 (17.2)	24 (82.8)	29 (100.0)	

2.88 mm ranging from 29 to 37 mm. The mean nasopharyngeal depth was 27.37 ± 4.9 mm ranging from 16 to 40 mm (Table 3).

ANR was calculated by dividing adenoid size with nasopharyngeal depth. The mean ANR between 2 to 5 years was 0.71 ± 0.11 ranging from 0.48 to 0.90. Similarly, the mean ANR in age group 6 to 10 years was 0.66 ± 0.13 ranging from 0.25 to 0.91 and the mean ANR in age group 11 to 14 years was 0.49 ± 0.01 ranging from 0.48 to 0.50. The mean ANR was 0.67 ± 0.13 ranging from 0.25 to 0.91 (Table 4).

The minimum ANR was 0.25, maximum ANR 0.91 and the mean ANR was 0.67 in our study. All the children with bilateral chronic nasal obstruction were included in the study and relationship between the symptoms like snoring, waking up at night, nasal discharge, mouth breathing and decrease in hearing were studied individually. The ANR was divided into 3 subgroups and relationship with symptoms were tabulated according to these groups. Among the 104 children snoring was noted in 79 (76%) children with 96.6% presenting with this symptom in the 0.75 to 0.99 ANR group and the relationship between this symptom and the ANR was statistically significant (p=0.003). There were 32 (30.8%) children who woke up at night that represented 55.2% of the total presentations of this symptom in the 0.75 to 0.99 ANR group, which was statistically significant (p= 0.001). Among the symptoms nasal discharge had the highest presentation with 85 (81.7%) children having this symptom and 96.6% within the 0.75 to 0.99 ANR group presented with it, which was showed a significant relationship (p = 0.001). There were 83 (79.8%) children with mouth breathing with 81.5% in the 0.50 to 0.74 and 93.1% in the 0.75 to 0.99 ANR group. The relationship between mouth breathing and ANR was significant (p = 0.34). Parents/caretakers of 69 (66.3%) children complained of decrease in hearing and this symptom was present in 82.8% who were in the 0.75 to 0.99 ANR group, which was also statistically significant. Overall, the study showed that with the increase in ANR there was increase in presenting symptoms that were statistically significant.

DISCUSSION

Nasal obstruction due to adenoid hypertrophy is a common problem in the paediatric age group, with these children presenting in both the Otorhinolaryngology and Paediatric Departments. Early recognition of the symptoms of adenoid hypertrophy is important to prevent the pathological manifestations. It has been considered that nasopharyngoscopy examination is the gold standard for the diagnosis of AH. However, since it is an invasive procedure, children are not ideal candidates for this diagnostic modality. Moreover, endoscopic facilities may not be available in all centres and the cost of this procedure is high, hence, limiting the use of nasopharyngoscopy examination.[4] Likewise, lateral nasopharynx x-rays are considered another method to estimate adenoid size. In contrast to endoscopy, x-rays are cheap, non-invasive, well tolerated by children and readily available, although they can cause exposure to radiation and the image is two-dimensional.[4,10-12] Despite these limitations it has been seen that calculation of adenoido-nasopharynx ratio using these x-rays shows significant correlation with endoscopic examination.[13] A study suggested correlation between symptomatology assessment and roentgenographic assessment was significant for roentgenographic ratings of minimal obstruction and gross obstruction.[14] The symptoms of this condition are also characteristic but choosing the appropriate diagnostic modality is essential. In this regard it is our feeling that a detailed history of the presenting symptoms along with a plain x-ray of the nasopharynx (lateral view) and calculating the ANR will help in making a diagnosis of adenoid hypertrophy.

The most common age group in our study was 6-10 years (67.3%), followed by 2-5 years (26.9%) with the least being between 11-14 years (5.8%). The age distribution in the study done by Sarma and Khaund[15] showed majority of the children were between 6-10 years(76%) and another study showed children with chronic adenoiditis were from 5-7 years (45.83%) and 8-10 years (29.17%). Like our study male preponderance was shown by other studies when gender was analysed.[4,16] Among the symptoms nasal discharge was the most common, which was similar to the study done by Sathe and Mahajan,[17] who showed 88.89% of samples had nasal discharge. However, unlike our study, Adedeji *et al*[4] noted mouth breathing as the predominant symptom, that was present in 100%, followed by snoring in 97.8% of the children, compared to 76.0% of children who snored and 79.8% mouth breathers in his study.

The mean adenoid size increased with age from 2 to 5 years to 6 to 10 years (1.82 cm) and decreased thereafter from 11 to 14 years. This is similar to a study that suggested the adenoid size was the most in the 7-9 years age group (2.3 cm), with a slight decrease beyond this group, and the results were statistically significant.[18] Likewise, the same study suggested a significant increase in nasopharyngeal depth with greater age, as was the case in our study.

Fujioka *et al*[8] ascertained that the ANR reached a high value of 0.59 at age 54 months and then gradually decreased to 0.55 at 90 months and 0.51 at 126 months; these values are similar to the mean ANRs of our age groups, with the highest value in the 2-5 years group that became lesser by 11 to 14 years of age. The pattern of the ANR values is different from both the adenoid size and nasopharyngeal depth but the observation lends credence to the assumption that the ANR is a more convenient radiological parameter for determining whether adenoidal hyperplasia is clinically significant or not, rather than the size of the adenoid or the size of the nasopharynx, because it demonstrates the established state between the size of the nasopharynx and that of the adenoid.[19]

In our study the maximum mean ANR was in the 2-5 years age group, which also corresponds with the greatest number of symptoms. In the study conducted by Hamza and Ranjith[16] the maximum ANR was seen at an average of 0.7364 in the 5–7-year-olds and they also presented with the greatest number of symptoms and signs. Fujioka proposed that a value of ANR above 0.80 was indicative of enlarged adenoids. However, it is seen that in our study a value of 0.71 was associated with the maximum number of symptoms of adenoid hypertrophy. Similar results have been shown by Hamza and Ranjith.[16] It has been mentioned that obstruction of the nasopharynx by the adenoid could be caused by two separate processes: an enlarged adenoid or a small nasopharynx, or both.[19] Similarly, in a study it was seen that if the ANR ratio was more than 0.70 then the chances of children resolving from otitis media with effusion was lesser and they had to undergo surgical intervention.[20]

The classical presentation of chronic adenoiditis is mouth breathing, snoring, nasal obstruction and nasal discharge.[17] Our study also looked at these classical symptoms; nasal discharge being the most common symptom, followed by mouth breathing and decrease in hearing. All these symptoms showed statistical significance in the higher ANR group (0.75 to 0.99) as was to be expected. Moreover, the highest number of children affected by the symptoms was in the younger age group where the ANR was higher.

The relationship between the ANR that has been derived using lateral nasopharynx x-rays and the symptoms suggests that this mode of diagnosis is effective. As mentioned previously although nasopharyngoscopy is considered the gold standard, calculation of ANR from lateral nasopharynx x-rays was found to significant correlation with endoscopic examination. Taking symptoms of the child and ANR into consideration the child and parents can be reassured, treated conservatively or advised further investigations and surgical intervention. Our study confirms this point and we would suggest that this method be used when facilities of endoscopy is not available.

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