CORRELATION BETWEEN CLINICAL AND RADIOLOGICAL FINDINGS IN PEDIATRIC ADENOID HYPERTROPHY AT THE KENYATTA NATIONAL HOSPITAL.

A dissertation submitted in partial fulfillment for the degree of:

MASTER OF MEDICINE IN DIAGNOSTIC RADIOLOGY.

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DECLARATION

I, **Dr Cynthia Yiantet Sempele**, declare that contained herein is my original work and has not been presented in any other university or published anywhere to the best of my knowledge.

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APPROVAL BY SUPERVISOR:

This dissertation was submitted for evaluation with my approval as a University supervisor.

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LIST OF ACRONYMS

AA: **Antroadenoidal diameter**

AH: **Adenoid Hypertrophy**

ANOVA: **Analysis of Variance**

ANR: **Adenoid Nasopharyngeal Ratio**

AO: **Airway Occlusion**

ATH: **Adenotonsillar Hypertrophy**

ENT: **Ear Nose and Throat**

ERC: **Ethical Research Committee**

KNH: **Kenyatta National Hospital**

NpT: **Nasopharyngeal Tonsil**

NPV: **Negative Predictive Value**

PA: **Palatal airway**

PNS: **Post nasal space**

PPV: **Positive Predictive Value**

RV: **Right Ventricle**

UAO: **Upper Airway Obstruction**

VNP: **Video Nasopharyngoscopy**

DEFINITION OF TERMS

1. **Adenoid: lymphoid tissue in the nasopharynx**
2. **Adenotonsillectomy: surgical removal of adenoids and tonsils.**
3. **Atrophy: decrease in size.**
4. **Basiocciput: wedge like portion of the occipital bone that lies anterior to the foramen magnum and joins with the body of the sphenoid bone.**
5. **Cavum: the nasal cavity. Cavum radiograph is a postnasal space radiograph**
6. **Choanae: the paired openings between the nasal cavity and the nasopharynx**
7. **Cor pulmonale: disease of the heart characterized by hypertrophy and dilatation of the right ventricle and secondary to disease of the lungs or their blood vessels**
8. **Endoscopy: use of an illuminated usually fiber-optic flexible or rigid tubular instrument for visualizing the interior of a hollow organ or part for diagnostic or therapeutic purposes.**
9. **Hypertrophy: excessive development of an organ or part**
10. **Involute: to return to a former condition**
11. **Nasal septum: a wall or partition dividing the nasal cavity**
12. **Palatine tonsil: lymphoid tissue in the oropharynx**
13. **Pharynx: the part of the digestive and respiratory tracts situated between the cavity of the nose (nasopharynx), mouth (oropharynx) and the esophagus (hypopharynx).**
14. **Polysomnography: the technique or process of using a polygraph to make a continuous record during sleep of multiple physiological variables (as breathing, heart rate, and muscle activity)**
15. **Radiograph: an X-ray photograph**

16. **Sleep apnea: brief periods of recurrent cessation of breathing during sleep that is caused especially by obstruction of the airway**
17. **Synchondrosis: a type of cartilaginous joint in which the cartilage is usually converted into bone before adult life.**
18. **Tonsil hyperplasia: this is increase in tonsil size from increased immunologic activity. It is not a disease.**
19. **Video nasopharyngoscopy: Use of an endoscope to view the pharynx**

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ABSTRACT

INTRODUCTION / BACKGROUND

Adenotonsillectomy is one of the commonest ENT procedures at KNH . It is done in children with ATH to resolve obstructive symptoms and prevent complications like cor pulmonale. Children with ATH commonly present with mouth breathing and other obstructive symptoms such as: difficulty in breathing, sleep apnea and snoring. The post nasal space radiograph is used for evaluation of these children, and various methods are used for its assessment.

OBJECTIVE

The aim of this dissertation was to investigate the clinical and radiological assessment in adenoid hypertrophy, correlate them and obtain a simple, reproducible and accurate method that can be used for objective radiograph interpretation.

METHODOLOGY

A total of 55 children were enrolled into the study. Clinical assessment in this study utilized the assessment of the aforementioned symptoms and radiological assessment was performed using the Fujioka and Cohen methods.

Comparison of the clinical and radiological methods was performed using SPSS version 19.

RESULTS

All 55 children underwent clinical and radiological evaluation. The ratio of male to female was 2:1 (67% were male and 33% were female). Patient age or sex and clinical symptoms had no statistically significant association. Sleep apnea was present in 87.5%. Majority (47.3%) of the

children had grade 2 difficulty in breathing, of these, 40% were equally likely to have grade 2 or grade 3 snoring. Majority (90.3%) of the children had moderate mouth breathing.

A strong positive correlation existed between the Fujioka method and clinical assessment. The Fujioka method showed high sensitivity and specificity in mild, moderate and severe AH. A strong negative correlation existed between the Cohen method and the clinical assessment. The Cohen method demonstrated a high sensitivity and specificity in mild and moderate AH. However, in severe AH, the specificity was high (96.7%) but the sensitivity was more modest at (52 – 56%).

CONCLUSION

Our study demonstrated two simple radiological assessment methods that are reproducible in every clinical setting. The Fujioka method showed better accuracy than the Cohen method in the classification of moderate and severe AH. In keeping with Naushaba's conclusion (1). The Cohen method on the other hand showed better specificity and NPV than the Fujioka method in the moderate and severe AH. Both methods were excellent for mild AH.

COMPARISON BETWEEN CLINICAL AND RADIOLOGICAL FINDINGS IN ADENOID HYPERTROPHY, AMONG CHILDREN AGED ONE TO SIX YEARS, AT THE KENYATTA NATIONAL HOSPITAL.

INTRODUCTION
NORMAL ANATOMY

Adenoids are a mass of lymphoid tissue found in the nasopharynx and are also referred to as nasopharyngeal tonsils.

Similarly, palatine tonsils are two small masses of lymphoid tissue found on either side of the throat, and are commonly simply referred to as tonsils.

Both adenoids and tonsils have an immune function and regress in size, with age, from childhood to adulthood.

The nasopharyngeal tonsils have been observed to become evident by six months to one year of life. They then rapidly increase in size during the first 6- 8 years of life. Thereafter, in adolescence, they atrophy (2).

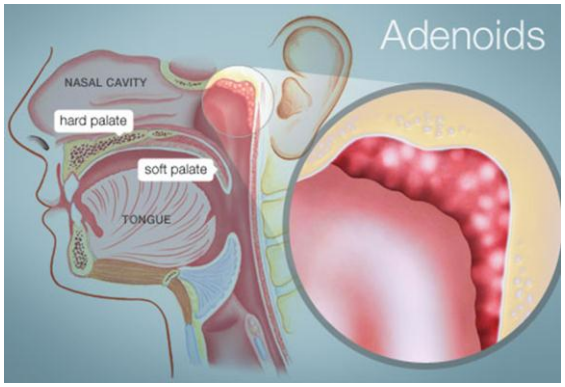


Figure 1. NORMAL ADENOID ANATOMY. COURTESY OF WEB MD

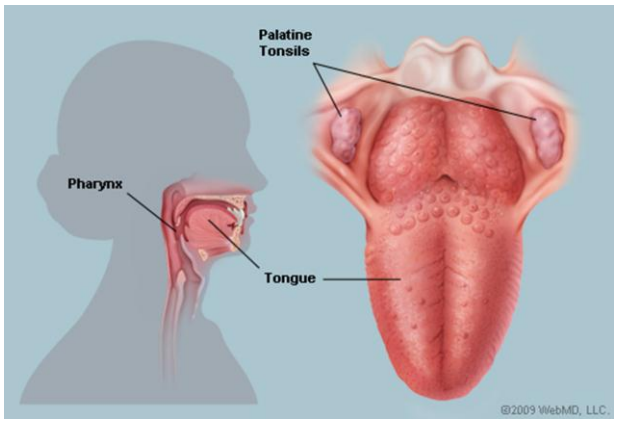


Figure 2. NORMAL ANATOMY OF PALATINE TONSILS. COURTESY OF WEB MD

ADENOID HYPERTROPHY AND ADENOTONSILLECTOMY

The term adenotonsillar hypertrophy refers to the unusual growth of the adenoids and palatine tonsils (3) . It was first described by Danish physician Wilhelm Meyer in Copenhagen in 1868 (4). He explained that chronic adenoid hypertrophy results in nasal airway obstruction, and that the nasal obstruction is a factor of the size of the adenoids and the size of the nasopharyngeal airway. Due to variation in adenoid enlargement among individual children, the compromise of the nasopharyngeal airway is required to describe the entity as adenoid hypertrophy. It is the size of the adenoids relative to the nasopharynx that may be important, rather than the actual size (5).This compromise in the airway results in symptoms such as obstructive sleep apnea, recurrent otitis and cor pulmonale, which may necessitate the surgical removal of the hypertrophied tissue in a surgical procedure termed adenoidectomy. Adenoidectomy is often carried out at the same time as tonsillectomy, the surgical removal of the palatine tonsils. Adenotonsillar Surgery is among the commonest pediatric surgical procedures undertaken by otolaryngologists in Kenya (6).

RADIOGRAPHIC ASSESMENT OF ATH

Imaging is important in the assessment of children with suspected AH since these children are often difficult to examine. In addition, symptoms described by the patient's parents are often very subjective and vary based on the parent emotions or understanding of the child's condition. A postnasal space radiograph demonstrates the hypertrophic tonsils, adenoids and the narrowed nasopharyngeal and oropharyngeal airway(7). Consequently, it is a more objective assessment method for adenoid hypertrophy than clinical assessment. However, interpretation of the PNS

radiograph can also be quite subjective and vary from one radiologist to another. Several methods to objectively assess and standardize interpretation of these radiographs have been developed. This study will evaluate two such methods and how they compare to the clinical assessment of these patients, with the hope of finding the best method for use in our local KNH setting.

The two radiographic assessment methods that will be compared are:

i. The adenoid nasopharyngeal ratio: Developed by Fujioka et al
ii. The air column soft palate ratio: Developed by Cohen et al

Other assessment methods for ATH include nasal endoscopy and polysomnography. This study will assess and compare the clinical and radiological findings in children with adenoid hypertrophy who require adenotonsillectomy at The Kenyatta National Hospital.

LITERATURE REVIEW

The adenoids and tonsils are usually present at birth but only become visible around the age of 6 months. They grow rapidly until age 6 years and then involute through adulthood. Enlargement is described as pathological when they encroach on the nasopharyngeal airway and this usually does not occur until the ages of 1 to 2 years (8). Absence of adenoidal tissue after 6 months on the PNS radiograph should raise the suspicion of immune deficiency. Inversely, if enlarged adenoids are seen well after childhood, lymphoma should be suspected (8).

Adenoid hyperplasia usually follows upper respiratory tract infection with multiplication of lymphoid follicles (5).

Diseases of the tonsils and adenoids are the commonest pediatric ENT diagnosis, while adenotonsillectomy is among the top ten pediatric surgical procedures performed (6,9). Adenotonsillar hypertrophy (ATH) is the most common cause of upper airway obstruction (UAO) in children(10) and has become the most frequent indication for adenotonsillectomy in children (9,11). Wong Yee Hang Birgitta and Hui Yau of the University of Hong Kong, department of Surgery, compiled the percentage number of admissions from obstructive tonsillar disease over a three-year period in Queen Mary Hospital, Hong Kong. They observed that the trend was increasing, similar to the obstructive sleep apnea trend; sleep apnea is an indicator of ATH (9,11) .

	1995	1996	1997	1998
OBSTRUCTIVE TONSILLAR DISEASE(% OF TOTAL PEADIATRIC ADMISSION)	**19%**	**39%**	**28%**	**68%**

TABLE 1: TREND OF TONSILLAR DISEASE IN QUEEN MARY HOSPITAL HONG KONG

At the KNH, trends for the number of adenotosillectomies have shown a steady annual increase from January 2012 to May 2015(12).

TABLE 2: STATISTICAL REPORT ON ADENOTONSILLECTOMY SURGERY IN CHILDREN AT KNH

YEAR	NUMBER OF SURGERIES
2012	301
2013	373
2014	492
JAN- MAY 2015	187

SOURCE: HEALTH INFORMATION DEPARTMENT KNH 12/6/2015

Worldwide, the accepted methods for the assessment of adenotonsillar hypertrophy include: Clinical scoring system, lateral neck radiography and videonasopharyngoscopy: which is considered the gold standard (13).

A. CLINICAL ASSESMENT

Clinical signs and symptoms of adenotonsillar hypertrophy (ATH) include (14,8): Mouth breathing, hyponasal speech, sleep apnea, snoring, rhinorrhea, nasal congestion, adenoid facies and chronic or recurrent otitis media due to proximity to the Eustachian tubes.

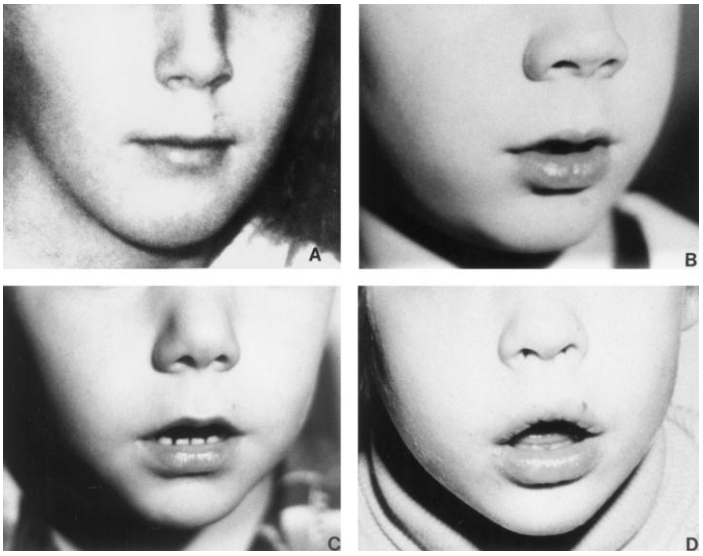


Figure 3. PICTURES DEMONSTRATING DIFFERENT GRADES OF MOUTH BREATHING

Mouth breathing is prevalent amongst children of all ages but is frequently caused by obstructive hypertrophied adenoids (13). A clinical grading of AH, using the clinical symptom of mouth breathing is employed by some pediatricians.

Figure 3 demonstrates the grades of mouth breathing (15): images A ,B, C and D represent no mouth breathing, slight, moderate and marked mouth breathing respectively.

Another clinical method was developed by Brouilete et al in 1984 for the diagnosis of obstructive sleep apnea in children (14). This method assessed the symptoms of difficulty in breathing during sleep (D), sleep apnea (A) and snoring (S).

The Brouilete method then scored the symptoms as; Never (0), Occasionally (1), Frequently (2) and Always (3). For sleep apnea, a score of zero if absent or one if present was given.

The final clinical score was calculated as follows:

- 1.42D + 1.41A + 0.71S – 3.83

The final scores were categorized as; mild if less than -1, moderate if between -1 and 3.5, and severe if greater than 3.5.

Naushaba et al concluded that clinical assessment scores have better sensitivity and specificity in mild to moderate adenoid hypertrophy compared to radiological assessment. In addition, the clinical assessment score maintained respectable values in all grades of AH, this is demonstrated in table 3 (1).

TABLE 3 : COMPARISON OF CLINICAL AND RADIOLOGICAL ASSESMENT IN AH

INTENSITY OF AH	**AN RATIO SPECIFICITY**	**AN RATIO SENSITIVITY**	**CLINICALLY ASSESSED SCORE SPECIFICITY**	**CLINICALLY ASSESSED SCORE SENSITIVITY**
MILD	53%	36.3%	72%	66%
MODERATE	51%	43%	71%	70%
MODERATELY SEVERE	89.4%	91.6%	85%	87%%
SEVERE	90%	94.8%	86%	89%

B. RADIOGRAPHIC ASSESMENT

In the Brazil public health system, the postnasal space radiograph is the most frequently required otolaryngologic complementary exam in the diagnosis of adenotonsillar hypertrophy (16). These statistics are replicated in the Kenyan set up. According to the KNH clinicians and Health Information statistics, the PNS radiograph is the more likely requested complementary examination in pediatric ATH than VNP (12).

In KNH, symptom assessment only has predominantly been utilized as the likely predictor of ATH and the need for adenotonsillectomy. Patient finances also play a major role in this decision since many of the patients served at KNH are from financially deprived backgrounds. Another reason could be the lack of clinician confidence in the radiographic diagnosis offered, which tend to vary from the observed clinical condition of the patient. The contradictory nature of radiographic interpretation in KNH stems from a lack of a standardized objective method of reporting the films. Another factor that leads to clinician bias against the radiograph is that previously reported studies that involved roentgenographic assessments have given mixed results (15) . Major and Feres suggest that this uncertainty might be related to the absence of comprehensive studies that simultaneously investigate a considerable number of radiographic parameters. (17,18)

Radiographic evaluation has been proposed as a method of not only predicting the need for adenotonsillectomy, but also predicting the likelihood of complications of ATH such as cor pulmonale (19). Therefore, it is justifiable to investigate the usefulness of cavum X-ray on adenoid assessment (13).

The lateral skull radiograph is a noninvasive procedure that is well tolerated by children (20), as opposed to invasive techniques like VNP, which is considered the gold standard in assessment (13). Some studies have compared radiographic assessment of the adenoids and nasal endoscopy and concluded that radiography may serve as a better planning tool (21). Moreover, Mlynarek et al concluded that airway occlusion estimated by video rhinoscopy is better correlated to symptom severity than lateral neck radiography, but radiography was still quite favorable. (13,21)

To the contrary, a study by Sharifkashani, et al published in January 2015, found that there was significant correlation between the nasopharyngeal airway obstruction evaluated by nasal endoscopy and the clinical symptom score. The correlation between the lateral neck radiographic findings and the clinical score was weak. (22)

Naushaba Malik et al in his study on the radiographic estimation of adenoidal weight concluded that there was a good agreement between radiographic AN ratio (Fujioka method) and endoscopic findings especially in children with moderately severe to severe adenoid hypertrophy (1). He also stated that lateral x-ray had a great ability in diagnosis of adenoid hypertrophy but it has little effectiveness in determination of intensity. (1)

Worm and Prescott compared the methods most used when using the cavum radiograph, which are the Johanneson, Fujioka and Crepeau, and Cohen and Konak, and they found that the method of Cohen and Konak had the best results and the best efficiency, although the lack of standardization of the cavum radiograph may compromise the measurements.(23) . Murilo on the other hand gave the Cohen method a modest performance (24)

The controversies could arise from inclusion of a wide range of the pediatric age group. Many studies employed children from 4 years to 14 years. Recalling the physiological development of

the adenotonsillar tissue, this sample group left room for adenoid hyperplasia as a cause of obstruction and not AH only. Although, the studies attempted to exclude confounders like allergic rhinitis and septal deviation. In addition, for better comparison between the methods, similar categories should be compared. For example, if clinical grading is in three groups of mild, moderate and severe, it follows that radiological and VNP grading should be classified in a similar way. This avoids overlap in results that may lead to an erroneous conclusion.

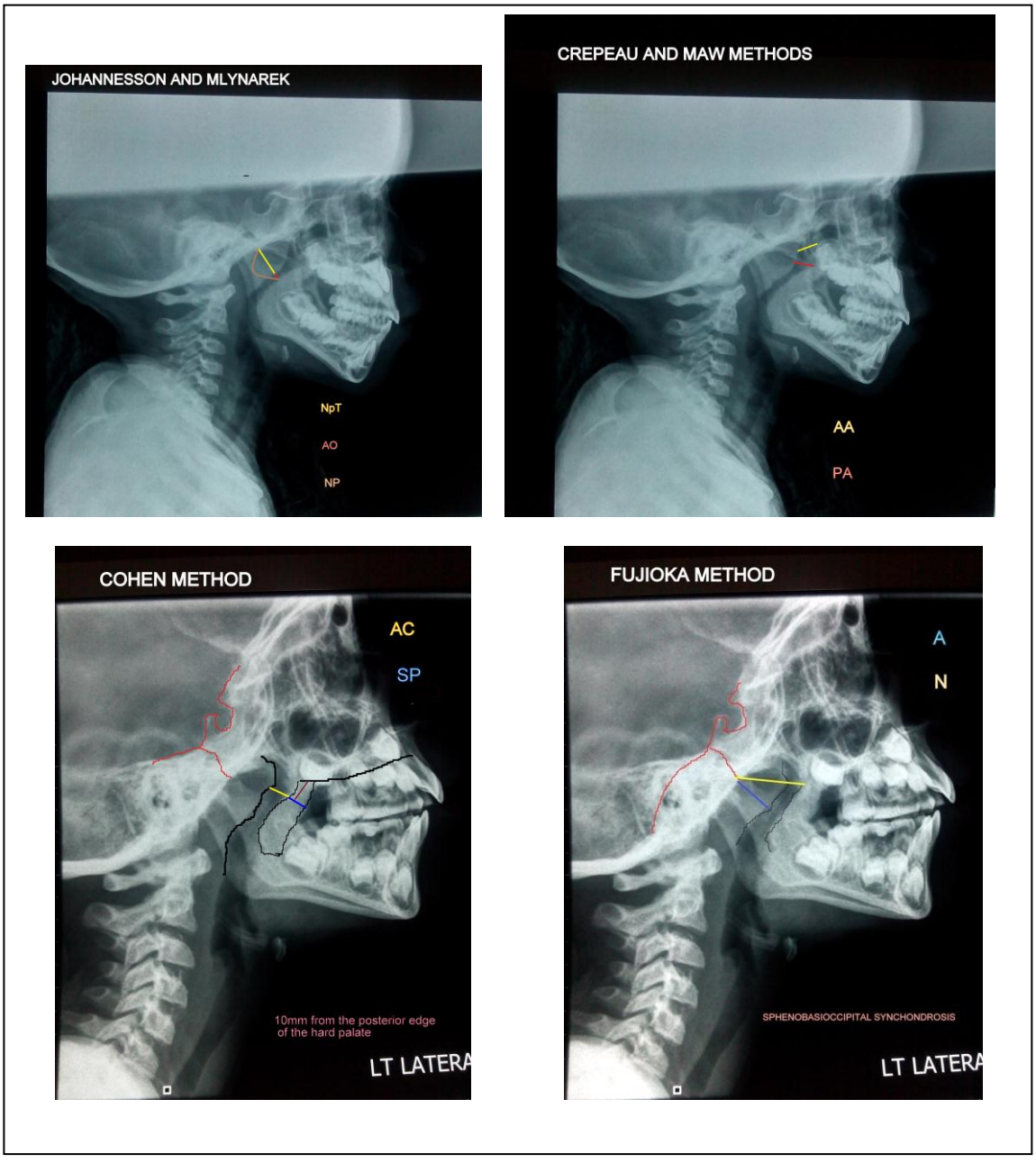
Table 4 shows the various techniques for the radiographic assessment of AH on PNS radiographs.

TABLE 4: Techniques For The Assessment of AH on PNS Radiographs

FUJIOKA METHOD et al	**ANR : measures the distance of the adenoid at its greatest diameter, against the size of the nasopharyngeal space**
COHEN METHOD et al	**AC:SP measures the size of the air column in the nasopharynx, 10mm from the hard palate, against the soft palate thickness at this level**
JOHANNESSON	**NpT (mm): measures the greatest width of the adenoid tissue perpendicular to the bony roof of the nasopharynx.**
CREPEAU et al	**AA: measures the shortest width between the adenoid tissue and the posterior maxillary wall**

MAW et al	**PA: measures the shortest width from anterior adenoid to the soft palate**
MLYNAREK et al	**AO: measures the Johannesson dimension against the width of the nasopharynx.**

Figure 4. ASSESSMENT DIMENSIONS DEMONSTRATED ON LOCAL(KNH) RADIOGRAPHS (13)



The Fujioka and Cohen methods were chosen for this assessment. The Fujioka method, also known as the adenoid nasopharyngeal ratio (ANR), was first described by Fujioka et al., in 1979 as a reliable method of expressing adenoidal size and nasopharyngeal airway patency. He compared the amount of lymphoid tissue in the nasopharynx to the size of nasopharyngeal compartment in 1,398 children using the 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. The landmark was the anteroinferior edge of the sphenobasioccipital synchondrosis (25). Gangadhara et al. concluded in a study they conducted on 100 children in India, that ANR > 0.7 are the candidates for adenoidectomy (26). His landmarks differed from those of Fujioka, wherein he used two bony reference points: the posterosuperior edge of sphenobasioccipital synchondrosis and the basion, and the nearest point of the adenoidal shadow to the posterior nasal spine. The reason for this change in landmarks was ease of localization (26). The Fujioka method correlated well with the clinical assessment score and the weight of adenoids removed at the operation in a study carried out by Feres et al. However, when compared to video nasopharyngoscopy, it demonstrated poor sensitivity and negative predictive value for certain parameters (13).

The Cohen and Konak method was developed later in 1985. It compared the nasopharyngeal air column to the distance between the soft palate and anterior edge of the adenoid. Thus, it could be said that this method is more reliable for determining whether the ATH is clinically significant or not, rather than the size of the adenoid or nasopharynx. Hwan Lee et al carried out their study in Korea and included the Brodsky scale for tonsillar hypertrophy to assessment of PNS radiographs using the Cohen method. This was done to enroll patients into his study on the

effects of ATH on RV function in children. He only wanted a sample population with grade three and four ATH enrolled. This combination enabled him to better define grades of ATH.(10,27,28)

TABLE 5: ATH GRADING

GRADE	**ADENOID HYPERTROPHY (COHEN AND KONAK)**	**TONSILLAR HYPERTROPHY (BRODSKY SCALE)**
I	0-25% NASOPHARYNGEAL AIRWAY OBSTRUCTED	TONSILS JUST OUTSIDE THE TONSILLAR FOSSA AND OCCUPY 0-25% OF OROPHARYNGEAL WIDTH
II	25=50% NASOPHARYNGEAL AIRWAY OBSTRUCTED	TONSILS OCCUPY 25-50% OF THE OROPHARYNGEAL WIDTH
III	50-75% NASOPHARYNGEAL AIRWAY OBSTRUCTED	TONSILS OCCUPY 50-75% OF THE OROPHARYNGEAL WIDTH
IV	75-100% NASOPHARYNGEAL AIRWAY OBSTRUCTED	TONSILS OCCUPY 75- 100% OF THE OROPHARYNGEAL WIDTH

In conclusion, in the third world, radiographic assessment is advantageous to nasal endoscopy because of issues related to cost and availability. In Kenya, all 47 counties have at least one

radiography machine, regardless of how remote the area is. To the contrary, nasal endoscopes are rare and in some cases limited to facilities and some level six public facilities. At the Kenyatta National Hospital, only rigid nasal endoscopy is readily available. The procedure itself is charged at 1500 Kenya Shillings. However, it requires to be done under general anesthesia, which raises the cost to approximately 40000 Kenya Shillings. Furthermore, in children, flexible endoscopy is best. A lateral radiograph of the neck would cost at most 1500 Kenya Shillings. For this reason, the gold standard of VNP shall not be utilized for correlation.

STUDY RATIONALE AND JUSTIFICATION

The adenoid forms part of the Waldeyer ring and is located in the posterior choanae. This is a difficult area to view directly during routine clinical examination. Untreated AH can result in various complications in childhood that include obstructive sleep apnea, recurrent otitis, failure to thrive, cor pulmonale and craniofacial abnormalities. Therefore, ATH requires prompt management.

Despite being the gold standard, VNP is expensive and not available to majority of the population; radiography remains the most widely available imaging method in Kenya and the KNH is a representation of this national population. Moreover, there is no standardized method employed in reporting postnasal radiographs and, no study correlating the clinical and radiological assessment of adenoids has been conducted at KNH. This study is aimed at developing a standardized method that can be utilized by KNH radiologists in assessing the postnasal radiographs and thus improving patient care in the clinical management of ATH. No comparison will be done with rigid VNP, because such a method will only be of academic benefit and offer no additional benefit to the patient. It will also increase patient management costs and is poorly tolerated by the child. Thus, VNP is not ethical for this study.

GENERAL OBJECTIVE

To determine the correlation of clinical assessment and grading of AH with the PNS radiographic findings, in children diagnosed to have AH at the Kenyatta National Hospital.

SPECIFIC OBJECTIVES

i. To determine the sensitivity, specificity, positive predictive value and negative predictive value of radiographic assessment of adenoid hypertrophy in The Kenyatta National Hospital.

ii. To assess the two proposed methods for evaluating the postnasal space radiograph at the Kenyatta National Hospital.

iii. To determine which method best correlates with clinical assessment of the patient.

STUDY QUESTION:

How does the radiographic assessment of AH in symptomatic children at KNH compare with the clinical symptom assessment?

METHODOLOGY

STUDY DESIGN

An analytical cross sectional study

STUDY DURATION

September 2015 to February 2016.

STUDY SETTING

The study was carried out at the Kenyatta National Hospital ENT Clinic/ Ward and the Department of Diagnostic Radiology (X ray) at The Kenyatta National Hospital

STUDY POPULATION

Children aged 1 to 6 years, with AH who required adenotonsillectomy at the Kenyatta National Hospital.

SAMPLE SIZE

The sample size calculation was based on the formula for calculating sample size required for sensitivity (29).

$$\text{TP+FN} = Z^2_{\alpha/2} \frac{SN(1-SN)}{W^2}$$

Where $Z_{\alpha/2}$ is standard normal deviate for 95% CI = 1.96 with α being type I error rate

SN = expected sensitivity of radiographic assessment of adenoid hypertrophy set at 85%

W = the maximum acceptable width of 95% CI set at 10%

TP = true positive rate of radiograph for adenoid hypertrophy

FN = false negative rate of radiograph for adenoid hypertrophy

$$\text{TP + FN} = 1.96^2 \times \frac{0.85(1-0.85)}{0.1^2}$$

Sample size required for sensitivity (N) = $\frac{TP+FN}{P}$

Where P is prevalence of adenoid hypertrophy among children with clinical features of disease = 90%

$N = \frac{49}{0.9}$

N = 55 children

SAMPLING METHOD

- Consecutive purposive sampling method was used to recruit study subjects who met the criteria and for whom consent was obtained from the guardians.

INCLUSION CRITERIA

- Children, both male and female, aged between 1 - 6 years. This age was chosen because it reduces the likelihood of the hypertrophy being normal physiological that occurs from age 6 years to 8 years. (2)
- Symptomatic i.e. severe enough to require adenotonsillectomy
- Adenotonsillectomy to be performed at the Kenyatta National Hospital.

EXCLUSION CRITERIA

- Age above 6 years
- Age below 1 year
- Adenotonsillectomy not carried out at the Kenyatta National Hospital
- Asymptomatic children

STUDY PROCEDURES

EQUIPMENT

- PNS Radiographs were performed using X-ray machines at the Kenyatta National Hospital.
- Questionnaires

METHODS: CLINICAL TECHNIQUE

Clinical assessment was in two forms. A questionnaire was administered by the principal investigator to the patient's primary care giver citing the degree to which the indicated symptoms were present and the answers were then evaluated by the clinical scoring system 1: (14,15)

The symptoms assessed were difficulty in breathing during sleep (D), sleep apnea (A) and snoring (S). these symptoms were then scored as; Never (score 0), Occasionally (score 1), Frequently (score 2) and Always (score 3). For sleep apnea, a score of zero if absent or one if present was given.

The final clinical score was calculated as follows:

- $1.42D + 1.41A + 0.71S – 3.83$

The final scores were categorized as; mild if less than -1, moderate if between -1 and 3.5, and severe if greater than 3.5.

The second form of clinical symptom evaluation involved the assessment of the extent of mouth breathing. This was documented in the questionnaire as assessed by the principal investigator in the presence of the examining ENT registrar and/or consultant. A tick on the image that best corresponded to the child was put:

Image A signified no mouth breathing, while images B, C and D signified slight , moderate and severe mouth breathing respectively.

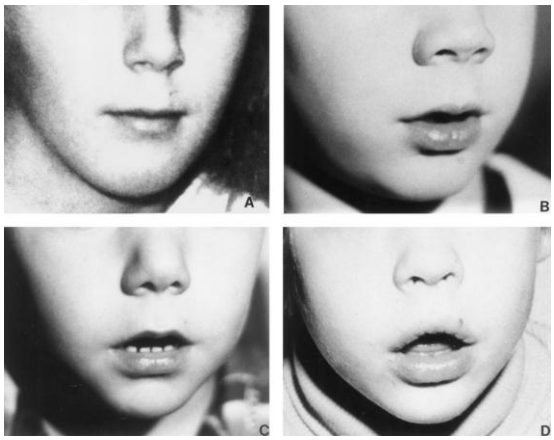


Figure 4. PICTURES DEMONSTRATING DIFFERENT GRADES OF MOUTH BREATHING

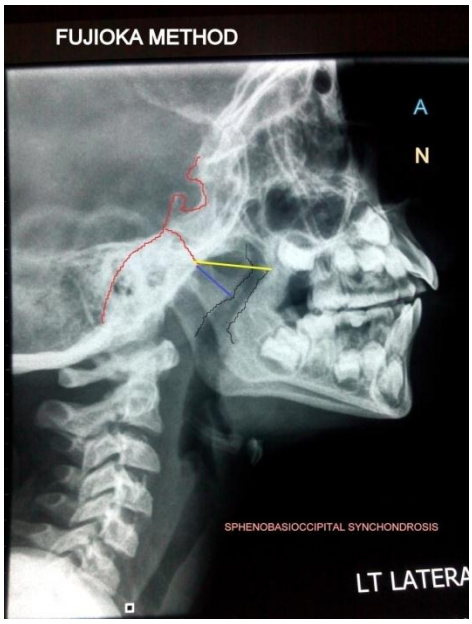
METHODS: RADIOGRAPHIC TECHNIQUE

Left lateral closed mouth radiograph with slight neck extension was taken of the sample population in the Xray department of KNH.

The radiological assessment was performed using the Cohen and Fujioka methods. The PNS radiographs of each participant was analyzed by the principal investigator and the AH graded using the aforementioned methods. A senior attending consultant radiologist reviewed and confirmed the radiological grading before inclusion of the data into the study.

IMAGE REVIEW

The images were reviewed by the principal investigator and a senior attending consultant radiologist and interpreted using the Cohen method and the Fujioka method. A radiological assessment score was given for each film.



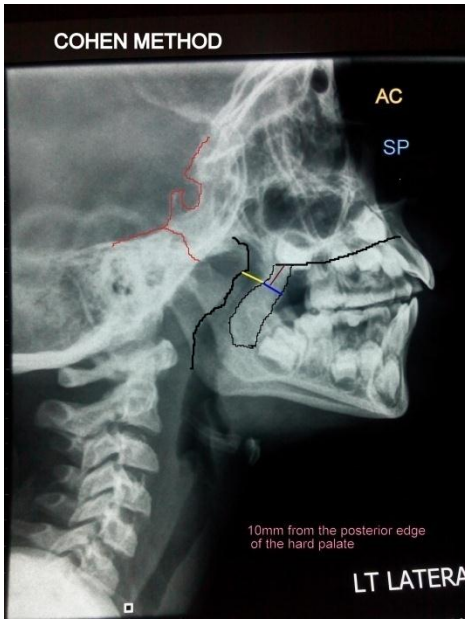
Fujioka et al. Figure 5

Adenoid Nasopharyngeal Ratio AN: Ratio between adenoid and nasopharyngeal space.

Adenoid(A): greatest distance between a line drawn along the straight part of the inferior margin of the basiocciput and the point of maximal convexity of the anterior outline of the adenoid.

Nasopharyngeal space (N): distance between the posterior and superior edge of the hard palate and posteroinferior margin of the sphenobasioccipital synchrondosis

Figure 5. RADIOGRAGH OF THE POSTNASAL SPACE ANNOTED FOR THE FUJIOKA et al ASSESMENT METHOD (13)



Cohen et al Figure 6

Air column (AC in mm): distance between the superior outline of the soft palate at 10mm from the posterior edge of the hard palate and anterior outline of the adenoid.

Soft palate thickness (SP): thickness of the soft palate 10mm from the posterior edge of the hard palate.

Air column soft palate ratio (AC:SP)

Figure 6. RADIOGRAPH OF THE POSTNASAL SPACE ANNOTED FOR THE COHEN et al ASSESMENT METHOD (13)

RADIOLOGICAL ASSESMENT SCORE (1,10)

TABLE 6: COHEN METHOD VALUES FOR ADENOID GRADING

COHEN	
Normal	>1
Mild	>0.81<=1
Mod severe	>0.5<=0.8
Severe	<=0.5

TABLE 7: FUJIOKA METHOD VALUES FOR ADENOID GRADING (1)

FUJIOKA	
Mild to mod	25 to <50%
Mod Severe	50 to < 75%
Severe	>=75%

Finally, a comparison of each of these radiological assessment methods with the clinical assessment was performed.

DATA MANAGEMENT AND ANALYSIS

DATA COLLECTION

Patient symptoms and radiographic findings were documented on a data collection sheet and thereafter the information was fed into a database.

A biostatistician was involved in data analysis.

DATA ANALYSIS AND PRESENTATION

Data analysis was conducted using SPSS version 19. The overall mean (SD) age of patients with adenoid hypertrophy (AH) was calculated and an age frequency distribution was plotted based on one-year age groups. Sex distribution and clinical features of AH including symptoms reported by mother and findings on physical examination by the clinician were analysed using proportions and presented as frequency distributions. Two clinical scores were then calculated and two radiological scores for assessing AH (Fujioka and Cohen scores) were also computed based on standard formulas used in computing these radiologic scores. The first clinical score was based on caregiver report of severity or frequency of occurrence of three AH features (snoring, difficulty in breathing and sleep apnea) and the second on clinical examination of mouth breathing categorized into 4 grades (A, B, C and D). The percentage of patients in each category of the two clinical scores were calculated. Next, each clinical score was cross tabulated with child attributed (sex, age) and a chi square test used to examine statistical significance for sex and clinical score while an ANOVA was used to test associations between child age and clinical scores. During the final stage of analysis associations between the different clinical scores and the radiologic scores were examined using cross tabulations. In additions measures of

diagnostic performance of the clinical scores compared to the radiologic scores were calculated used sensitivity, specificity, positive and negative predictive values.

ETHICAL CONSIDERATIONS

Patients who had the PNS done were those already assessed clinically as requiring the radiographic examination and adenotonsillectomy due to severity of symptoms.

Patient confidentiality was maintained by using only the investigation number as the identification criteria. The patients name, hospital number, religious background and ethnicity were not required for this study.

The study adhered to the ALARA Principle of keeping the radiation exposure As Low as Reasonably Achievable.

A written informed consent from the guardian of the child was mandatory.

RESULTS

There were a total of 55 children enrolled into the study. All the 55 patients underwent clinical examination and radiological investigations and were therefore included in the analysis presented in this chapter.

The mean age of the children was 36.2months (SD ± 14.6) with a range from 12 months to 72 months. The mode was 24 months and 36 months with 7 (12.7%) children in each of these ages. Figure 7 presents age distribution according to 1-year age categories. The majority of children were aged either 24-35 months 18 (32.7%) or 36-47 months 16 (29.1%).

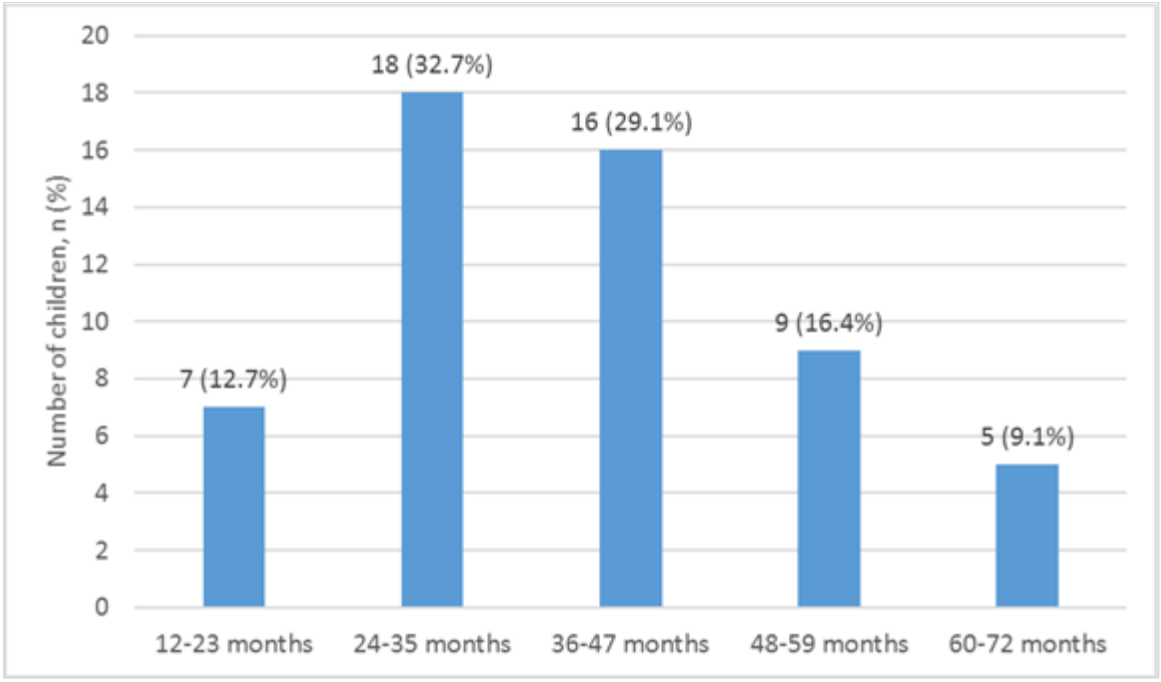


Figure 7: Age distribution of children undergoing clinical and radiological investigation of the postnasal space in KNH

Of the 55 children enrolled in the study 37 (67%) were male and the remaining 18 (33%) were female giving a ratio of 2 males: 1 female (Figure 8). The mean age of males was 36.9 months

(SD ± 14.9) compared to a mean age of 34.9 months (SD ± 14.4) among the females. The age difference between males and females was 2 months (95% CI -6.5 to 10.5) but this age difference was not statistically significant (p = 0.643).

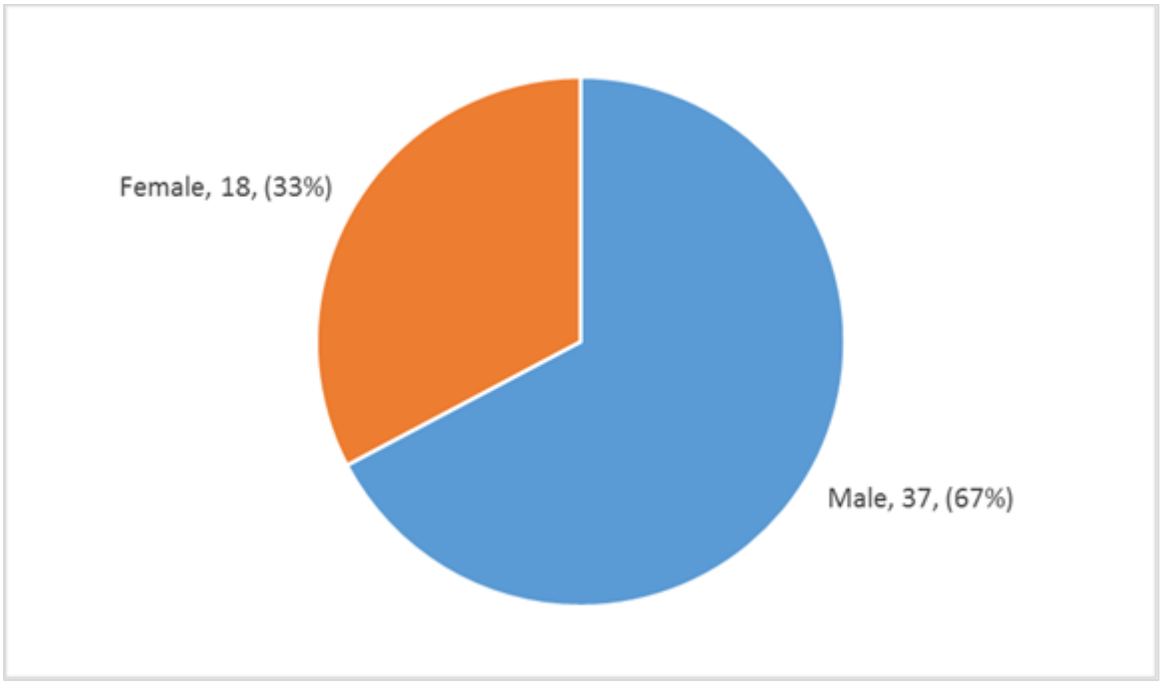


Figure 8: Sex distribution of children undergoing clinical and radiological investigation of the postnasal space in KNH

Clinical assessment of adenoid hypertrophy

The findings from history given by primary care givers regarding occurrence of clinical symptoms suggestive of adenoid hypertrophy are summarized in Table 8. Difficulty in breathing and snoring were reported in all the children while sleep apnea was present in 48 (87.3%) children and absent in 7 (12.7%). However, the severity of difficulty in breathing and snoring ranged from grade 1 (occasional) to grade 3 (always occurred). Most 26 (47.3%) children had

grade 2 difficulty in breathing and children were equally likely to have grade 2, 22 (40%) or grade 3, 22 (40%) snoring (Table 8).

Table 8: Patients symptoms grading

Grading symptom	Grade 0	Grade 1	Grade 2	Grade 3
Difficulty in breathing	-	12 (21.8%)	26 (47.3%)	17 (30.9%)
Snoring	-	11 (20%)	22 (40%)	22 (40%)
Apnea	7 (12.7%)	48 (87.3%)	na	na

Clinical signs and patient characteristics

Patients' age

Table 9 compares the mean ages of patients according to caregiver reported history of symptoms of adenoid hypertrophy. There was no statistically significant association between age and severity of difficulty in breathing ($p = 0.253$) or age and snoring severity ($p = 0.391$). Similarly the age difference between patients with sleep apnea and those with no sleep apnea was not statistically significant ($p = 0.337$).

Table 9: Mean age (±SD) of patients with varying severity of clinical symptoms of adenoid hypertrophy

Grading symptom	Grade 0	Grade 1	Grade 2	Grade 3	ANOVA P value
Difficulty in breathing	-	31 ± 16	39.3 ± 15.7	35.3 ±11.3	0.253
Snoring	-	41.7 ± 20.5	35.1 ±13.4	34.7 ± 12.3	0.391
Apnea	41.3 ± 20.5	35.5 ± 13.7	na	na	0.337

Patients' sex

The association between patients' sex and clinical symptoms of adenoid hypertrophy are shown in Table 10. None of the three clinical symptoms showed a statistically significant association with sex of the participating children: difficulty in breathing ($p = 0.593$), snoring ($p = 0.865$) and apnea ($p = 0.541$). Most 10 (55.6%) females had grade 2 difficulty breathing while for males 16 (43.2%) had grade 2 and 13 (35.1%) had grade 3 difficulty breathing. Regarding snoring severity 14 (37.8%) males and 8 (44.4%) females had grade 3 snores. Apnea was present in 33 (89.2%) males compared to 15 (83.3%) females.

Table 10: Sex distribution of patients with varying severity of clinical symptoms of adenoid hypertrophy

Grading symptom	Male	Female	Chi	P value
Difficulty in breathing				
Grade 1	8 (21.6%)	4 (22.2%)	1.04	0.593
Grade 2	16 (43.2%)	10 (55.6%)		
Grade 3	13 (35.1%)	4 (22.2%)		
Snoring				
Grade 1	8 (21.6%)	3 (16.7%)	0.29	0.865
Grade 2	15 (40.5%)	7 (38.9%)		
Grade 3	14 (37.8%)	8 (44.4%)		
Apnea				
Present	33 (89.2%)	15 (83.3%)	0.37	0.541
Absent	4 (10.8%)	3 (16.7%)		

A clinical score was calculated using information on the severity of clinical symptoms obtained from caregiver history. The score ranged from -1.7 to 3.97 among participants. The mean clinical score was 1.93 (SD ± 1.64). The distribution of the score is shown in figure 9 based on categorization into 4 levels representing symptom severity: mild (< -1), moderate (-1 to 3.5) and severe (> 3.5).

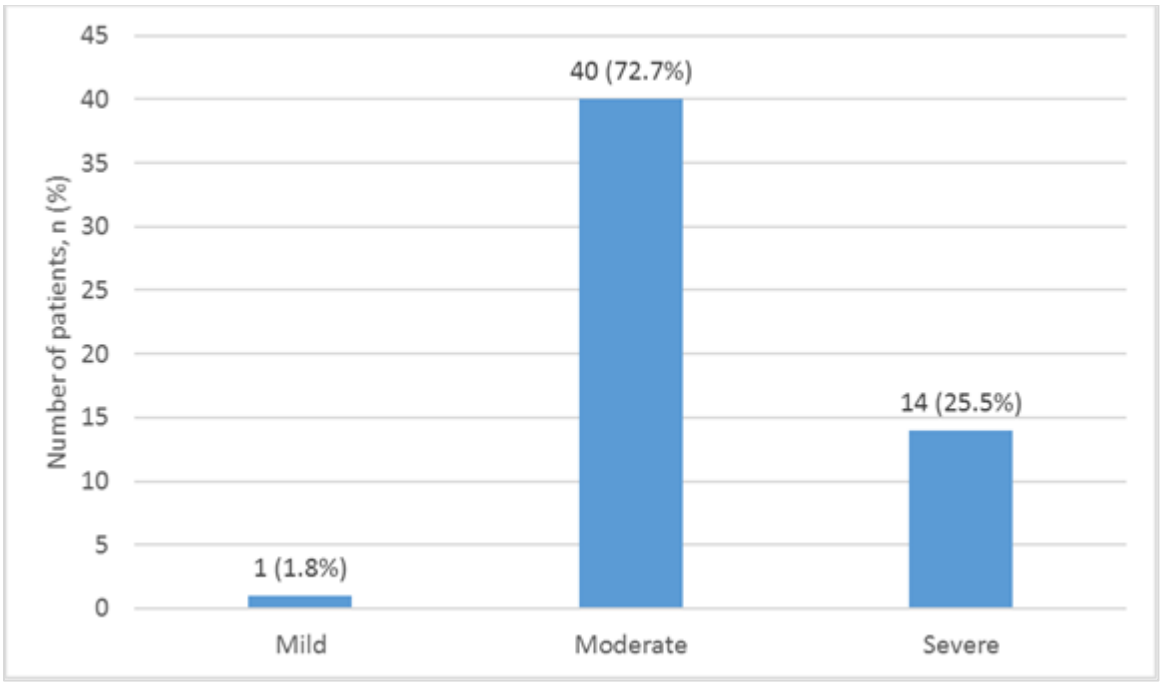


Figure 9: Severity of clinical symptoms obtained from caregiver history

Clinical assessment based on clinician observation of mouth breathing

The findings of patient assessment based on the degree of mouth breathing as observed by the clinician is presented in table 11.

Table 11: Characteristics of patients according to clinician physical assessment of patient

	Clinical score 2: Mouth breathing score				
Grading symptom	**A (n = 2)**	**B (n = 12)**	**C (n = 26)**	**D (n = 15)**	**P value**
Mean age (±SD)	-	39.3 ±16.6	34.3± 13.1	38.5±16.3	0.549
Sex, n (%)					
Male	1(2.7%)	6(16.2%)	19(51.4%)	11(29.7%)	0.467
Female	1(5.6%)	6(33.3%)	7(38.9%)	4(22.2%)	

Majority of the children had moderate mouth breathing. Of these, 51.4 % were male and 38.9% were female. Mouth breathing did not have a statistically significant association with patient gender (p= 0.467) and patient age (p=0.549).

Post Nasal Space Radiography

Using the post nasal space radiograph for each participant the ratio of airway to nasopharynx was calculated to yield the Fujioka score. The A: N ratio ranged from 24% to 91% with a mean score of 64% (SD ± 14.5).

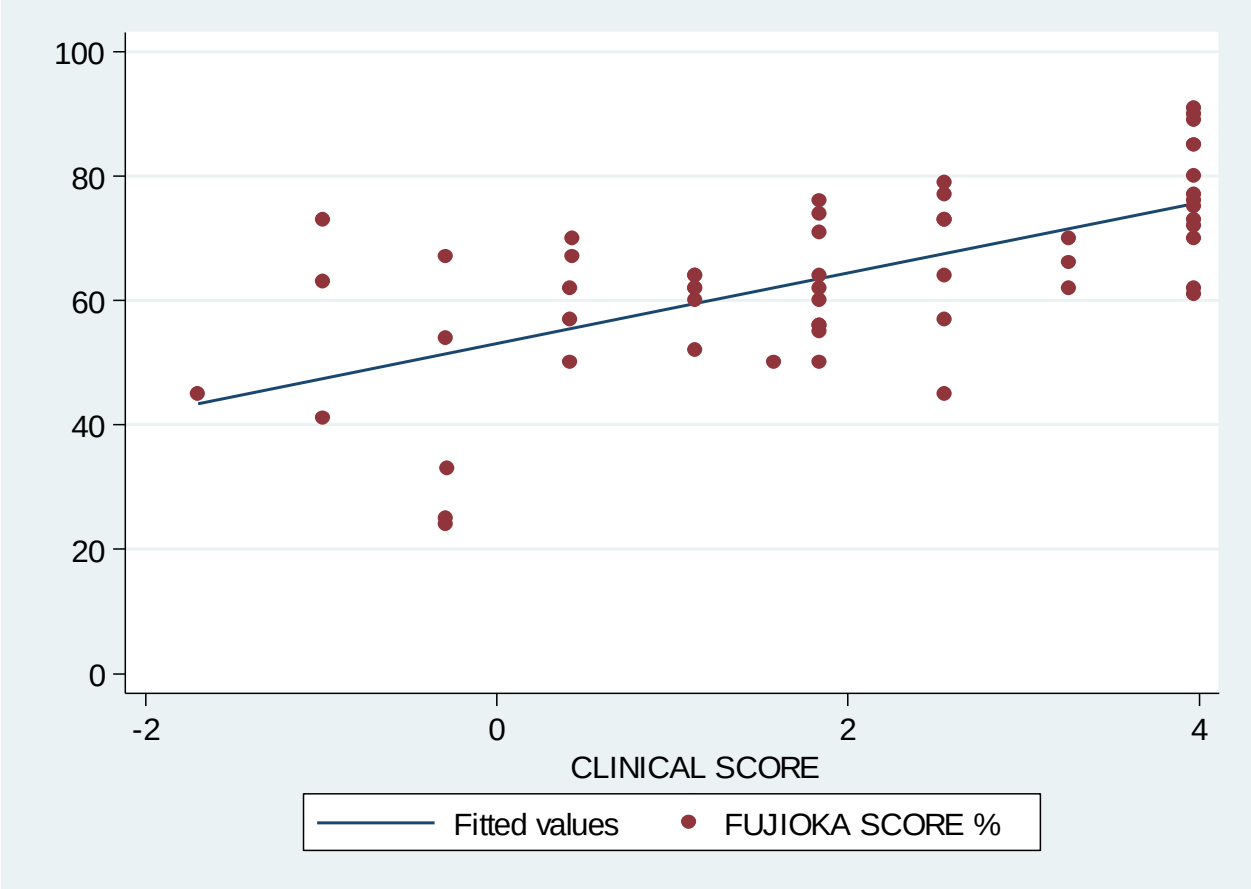


Figure 10: Association between Fujioka score and clinical severity score 1

There was a strong positive correlation between Fujioka score and the clinical score 1. The nonparametric correlation was significant between clinical score and Fujioka score [Spearman's rho (ρ) = 0.629, $p < 0.001$].

Table 12 shows that there was a significant association between Fujioka score and clinical score 1 after adjusting for the effect of patients age and sex. The Fujioka score increased by 5.6% for each unit increase in clinical score ($p < 0.001$). Age ($p = 0.5$) and sex ($p = 0.789$) did not have a significant effect on the patients Fujioka score.

Table 12: Linear regression of clinical score 1 against Fujioka score

	Coefficient	Standard error	t statistic	P	95% confidence interval	
Clinical score	5.67	0.946	5.99	<0.001	3.77	7.57
Age in months	-0.07	0.106	-0.68	0.5	-0.28	0.14
Sex (Female)	0.88	3.279	0.27	0.789	-5.70	7.47
Constant	54.53	6.563	8.31	<0.001	41.36	67.71

There was a statistically significant association between clinical score 1 and Fujioka score (Fisher's exact $p < 0.001$) based on categorization of the respective scores into levels of severity (mild, moderate and severe). As shown in Table 13, most (32 out of 40) patients with moderate clinical scores also had moderate Fujioka score and most (9 out 14) severe care giver clinical scores also had severe Fujioka scores.

Table13: Association between patient classification on the clinical score 1 and Fujioka score

	Fujioka score			
	Mild to moderate	Moderately severe	Severe	Total
Clinical score 1				
Mild	1	0	0	1
Moderate	5	32	3	40
Severe	0	5	9	14
Total	6	37	12	55

Table 14: Association between patient classification on the clinical method 2 and Fujioka score

	Fujioka score			
	Mild to moderate	Moderately severe	Severe	Total
Clinical score 2				
A	1	0	1	2
B	5	7	0	12
C	0	24	2	26
D	0	6	9	15

Comparing the Fujioka method with mouth breathing scoring system, 24 out of 26 of the patients classified with moderate mouth breathing were also graded as having moderate AH in the Fujioka method. Of those who were categorized as having severe mouth breathing, 9 out of 15 also had severe grading according to the Fujioka method.

Cohen method

The AC: SP ratio was used to calculate the Cohen score for each radiograph. The Cohen score ranged from 0.125 to 1.2 with a mean score of 0.55 (SD ± 0.28). The correlation between Cohen score and clinical scores 1 of adenoid hypertrophy is shown in Figure 11.

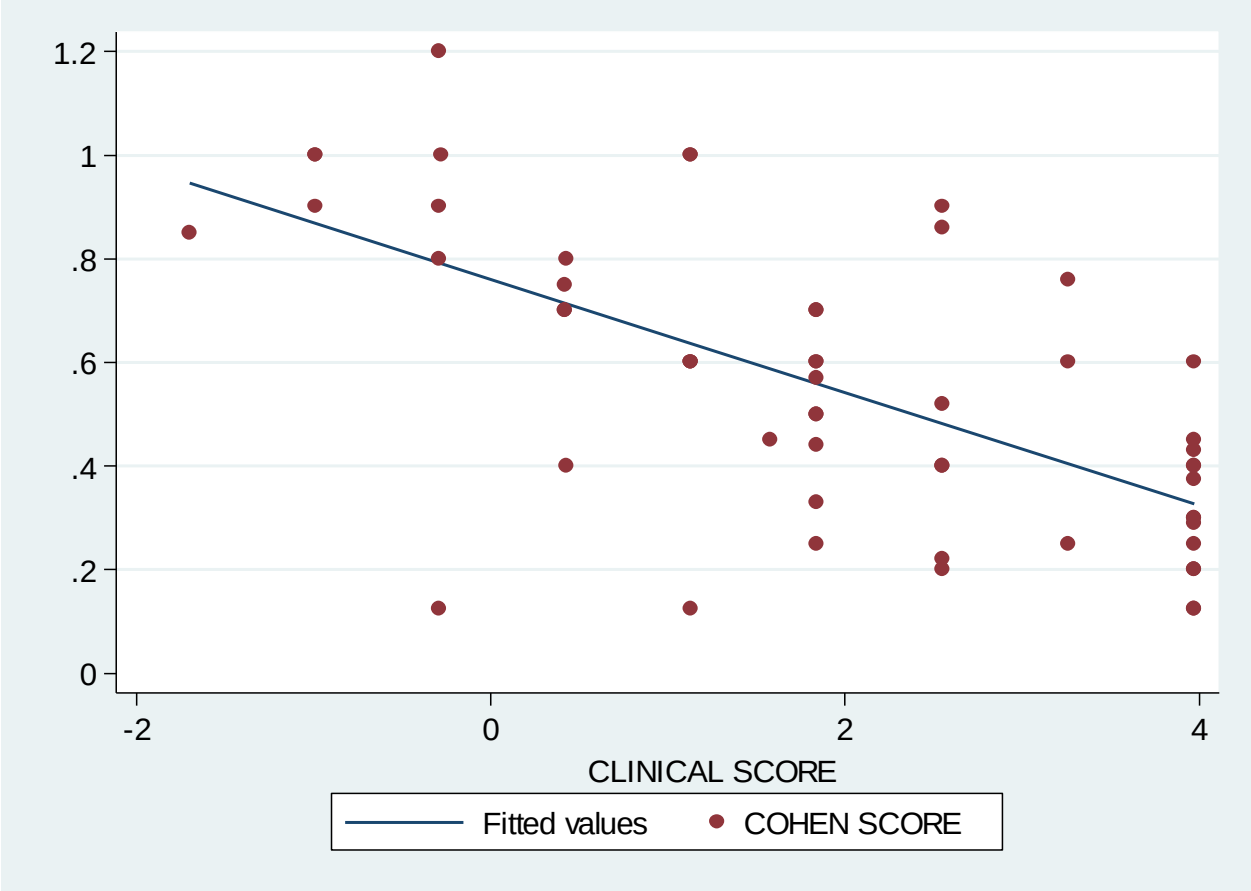


Figure 11: Association between Cohen score and clinical severity score 1

There was a strong negative correlation between Cohen score and the clinical score. The nonparametric correlation was significant between clinical score and Cohen score [Spearman's rho (ρ) = - 0.625, $p < 0.001$].

Table 15 shows that there was a significant association between Cohen score and clinical score after adjusting for the effect of patients age and sex. The Cohen score decreased by 0.11 for each unit increase in clinical score ($p < 0.001$). Age ($p = 0.211$) and sex ($p = 0.963$) did not have a significant effect on Cohen score.

Table 15: Linear regression of clinical score 1 against Cohen score

	Coefficient	**Standard error**	**t statistic**	**P**	**95% confidence interval**	
Clinical score 1	-0.11	0.018	-5.98	<0.001	-0.14	-0.07
Age in months	0.00	0.002	1.27	0.211	0.00	0.01
Sex (Female)	0.00	0.063	-0.05	0.963	-0.13	0.12
Constant	0.67	0.125	5.33	<0.001	0.42	0.92

There was a statistically significant association between clinical score and Cohen score (Fisher's exact $p < 0.001$) based on categorization of the respective scores into levels of severity (mild, moderate and severe). As shown in Table 16, most (30 out of 40) patients with moderate clinical scores also had normal (12) or mild (18) Cohen scores and most (13 out 14) severe clinical scores also had normal Cohen scores.

Table 16: Association between patient classification on the clinical score 1 and Cohen score

	Cohen score				
	Normal	Mild	Moderately severe	Severe	Total
Clinical score 1					
Mild	0	1	0	0	1
Moderate	6	4	18	12	40
Severe	0	0	1	13	14
Total	6	5	19	25	55

Table 17: Association between patient classification on the clinical score 2 (mouth breathing) and Cohen score

	Cohen score				
	Normal	Mild	Moderately Severe	Severe	Total
Clinical score 2					
A	1	1	0	0	2
B	4	4	3	1	12
C	1	0	15	10	26
D	0	0	1	14	15
Total	6	5	19	25	55

Table 18: Association between patient classification on the clinical score 1 and clinical score 2

	Clinical score 2: mouth breathing				
	A	B	C	D	Total
Clinical score 1					
Mild	0	1	0	0	1
Moderate	2	11	23	4	40
Severe	0	0	3	11	14
Total	2	12	26	15	55

Accuracy of clinical scoring systems compared to radiological methods

Table 19: Mild adenoid hypertrophy

	Cohen method		**Fujioka method**	
	Mild adenoid hypertrophy		**Mild adenoid hypertrophy**	
	Present	Absent	Present	Absent
Clinical scoring criteria 1 mild AH				
Present	4	8	5	7
Absent	1	42	1	42
Sensitivity, % (95% CI)	80 (69.4 - 90.6)		83.3 (73.5 - 93.2)	
Specificity, % (95% CI)	84 (74.3 - 93.7)		85.7 (76.5 - 95)	
PPV, % (95% CI)	33.3 (20.9 - 45.8)		41.7 (28.6 - 54.7)	
NPV, % (95% CI)	97.7 (93.7 - 100)		97.7 (93.7 - 100)	

Only 1 patient in clinical scoring method 2 with mild AH. With a single patient, it is not feasible to calculate the sensitivity, specificity, ppv and npv of a test. These measure will always be 0% or 100% and this is not useful information.

Table 20: Moderate adenoid hypertrophy

	Cohen method		**Fujioka method**	
	Moderate adenoid hypertrophy		**Moderate adenoid hypertrophy**	
	Present	Absent	Present	Absent
Clinical scoring criteria 1 for moderate AH				
Present	18	22	32	8
Absent	1	14	5	10
Sensitivity, % (95% CI)	94.7 (88.8 – 100)		86.5(77.5-95.5)	
Specificity, % (95% CI)	38.9 (26-51.8)		55.6(42.4-68.7)	
PPV, % (95% CI)	45 (31.9-58.2)		80(69.4-90.6)	
NPV, % (95% CI)	93.3 (86.7-99.9)		66.7(54.2-79.1)	
Clinical scoring criteria 2 for moderate AH				
Present	15	11	24	2
Absent	4	25	13	16
Sensitivity, % (95% CI)	79(68.2-89.7)		64.9(52.3-77.5)	

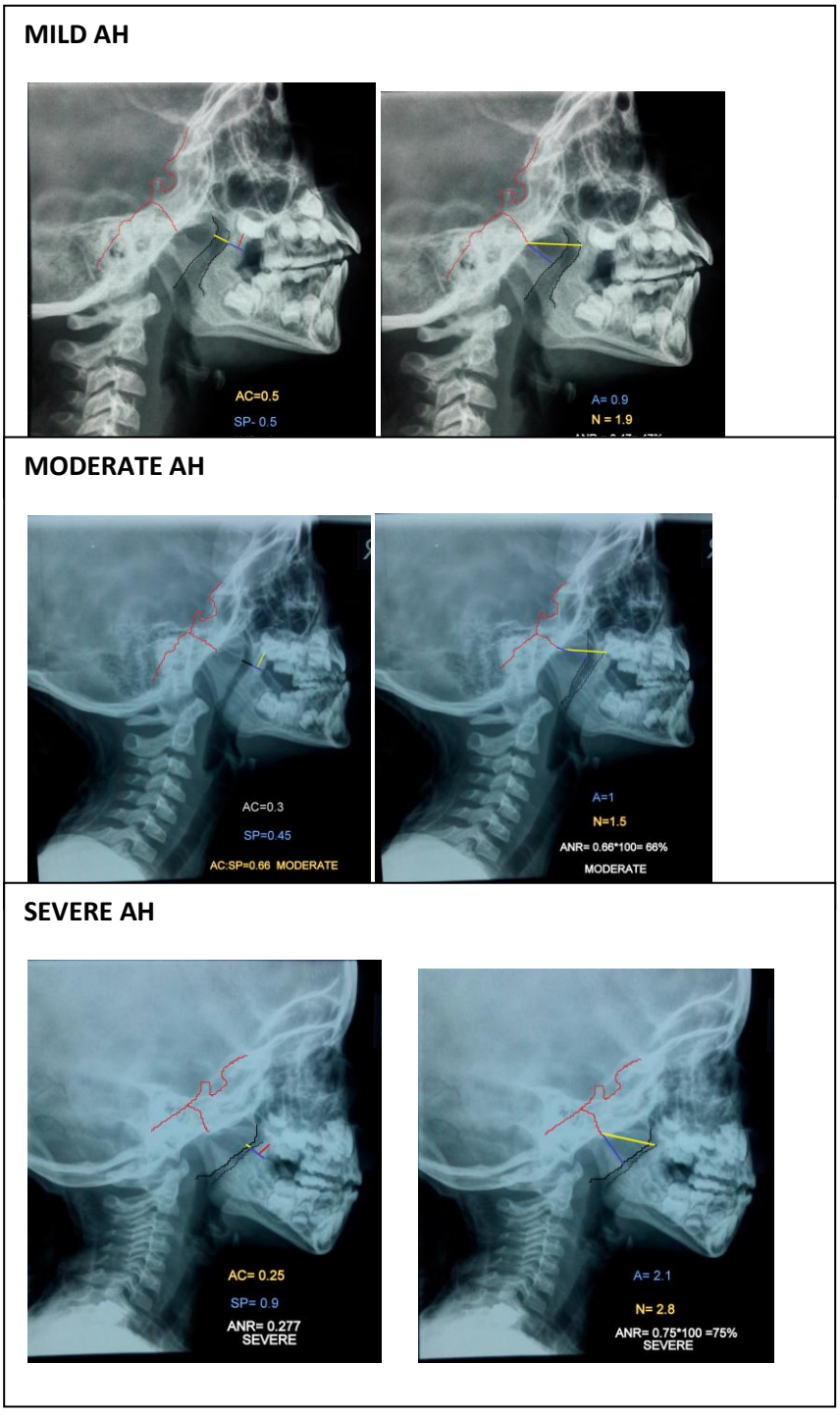
Specificity, % (95% CI)	69.4(57.3-81.6)	88.9(80-97.2)
PPV, % (95% CI)	57.7(44.6-70.8)	92.3(85.3-99.4)
NPV, % (95% CI)	86.2(77.1-95.3)	55.2(42-68.3)

Table 21: Severe adenoid hypertrophy

	Cohen method		**Fujioka method**	
	Severe adenoid hypertrophy		**Severe adenoid hypertrophy**	
	Present	Absent	Present	Absent
Clinical scoring criteria 1 for severe AH				
Present	13	1	9	5
Absent	12	29	3	38
Sensitivity, % (95% CI)	52 (38.8-65.2)		75 (63.6-86.4)	
Specificity, % (95% CI)	96.7 (91.9-100)		88.4 (79.9-96.8)	
PPV, % (95% CI)	92.9 (86.1-100)		64.3 (51.6-77)	
NPV, % (95% CI)	70.7(58.7-82.8)		92.7 (85.8-99.6)	

Clinical scoring criteria 2 for severe AH				
Present	14	1	9	6
Absent	11	29	3	37
Sensitivity, % (95% CI)	56(42.9-69.1)		75 (63.6-86.4)	
Specificity, % (95% CI)	96.7(91.9-100)		86.1(76.9-95.2)	
PPV, % (95% CI)	93.3(86.7-99.9)		60(47.1-73)	
NPV, % (95% CI)	72.5(60.7-84.3)		92.5(85.5-99.5)	

FIGURE 12: ANNOTED SAMPLE RADIOGRAGHS OBTAINED FROM THIS STUDY



DISCUSSION

The primary objective of this study was to determine the correlation of clinical assessment and grading of AH with the PNS radiographic findings, in children diagnosed to have AH at the Kenyatta National Hospital.

We found that in assessing for mild AH, the Fujioka method compared favourably with clinical assessment of mouth breathing. It had a sensitivity of 83.3%, specificity of 85.7%, a positive predictive value of 41.7% and a negative predictive value of 97.7%. Meaning, it is good in the diagnosis and ruling out of mild AH. These statistics were better than those in Naushaba's study(1) whereby, in assessment of mild adenoid hypertrophy, sensitivity was 36% and specificity was 53%. The differences could stem from the fact that his study included a wider age bracket, 3-12 years, while our study had an age bracket of 1-6 years (2) (8) (1) . This difference in PPV could be as a result of the subjective nature of caregiver history. They may prefer to exaggerate the symptoms in the belief that speedy intervention may be carried out.

In the assessment of moderate AH, when compared to caregiver history as the clinical parameter, the sensitivity of Fujioka method is 86.5%, specificity is 55.6%, PPV is 85% and NPV is 66.7%. When compared to the clinical assessment based on clinician observed mouth breathing the findings were: sensitivity of 64.9%, specificity of 88.9%, PPV of 92.3% and NPV of 55.2%. This difference could be a result of variations in adenoid growth. Theories also exist that the adenoid enlargement can be in lateral directions which will be missed on a 2D lateral radiograph of the postnasal space. Wright and his colleagues stressed this fact in their study on the importance of endoscopy in the assessment of adenoid enlargement in lateral direction rather than anterior direction (5,30). Naushaba et al, in the study on radiological estimation of adenoid

weight, comparing the AN ratio to VNP, found that sensitivity and specificity of the AN ratio in moderate adenoid hypertrophy was 91.6% and 89.4% respectively. He concluded that AN ratio had better specificity and sensitivity for moderate to severe AH. (1)

For severe AH, comparing the Fujioka method to the care giver history, the sensitivity, specificity, PPV and NPV are 75%, 88.4%, 64.3% and 92.7% respectively. Comparison to the mouth breathing score yielded a sensitivity of 75%, a specificity of 86.1%, a PPV of 60% and NPV of 92.5%. These findings are similar to Naushaba's study where the sensitivity and specificity for severe AH using the AN ratio was 94.8% and 90% respectively. This means that if a child is classified as not having severe AH using the Fujioka method, they are highly likely not to have it. This method was found to be accurate in identifying the true positives and even more accurate in identifying the true negatives.

The Cohen method has yielded dismal results in various studies. In the study by Murilo and Shizue on radiographic adenoid assessment, they state that the Cohen method yielded weak correlation analysis compared to clinical assessment methods while the Fujioka method showed satisfactory levels of reproducibility (13,24,31).

Worm and Prescott compared the methods most used when using the cavum radiograph, which are the Johanneson, Fujioka and Crepeau, and Cohen and Konak, and they found that the method of Cohen and Konak had the best results and the best efficiency(23). From this study, tables 15, 16 and 17 demonstrate the findings from the Cohen method. The Cohen method was found to be appropriate for the diagnosis and ruling out of mild adenotonsillar hypertrophy. It had a

sensitivity of 80%, a specificity of 84% and a NPV of 97.7%. However, bias in guardian history is the likely cause of the low PPV of 33.3%.

In moderate AH, the Cohen method was fairly accurate in diagnosing the AH (79-94.7% sensitivity and 45-57.7% PPV) and very accurate in ruling out AH in those who truly do not have the disease (NPV 86.2- 93.3% and specificity 38.9-69.4%). The wide variation in the specificity is likely due to the subjective caregiver history.

For the diagnosis of severe AH, the Cohen method showed a fairly accurate ability to diagnose severe AH and excellence in ruling out severe AH (Table 21). This analysis showed that the Cohen method is excellent in diagnosis for extremes of the AH spectrum, that is, mild and severe AH. It gave a respectable analysis for moderate AH. This is due to patency of the airway being obviously unaffected or affected in both extremes. In the case of moderate AH, the concept of lateral adenoid hypertrophy, not visible on 2 D lateral radiographs, may play a role (5).

Additional data obtained from our study showed that the ratio of male to female children in the study was 2:1. There appeared to be a slight predominance of adenoid hypertrophy in male children aged 1- 6 years. This finding is similar to ratios demonstrated in other studies (32,33).

Symptoms exhibited in children with adenoid hypertrophy were assessed from clinical history obtained from the caregivers. In this study, all the children had difficulty in breathing and snoring, albeit to varying grades. The clinical symptom of sleep apnea was reported in 48 (87.3%) children and absent in 7(12.7%). This lead to the conclusion that children with adenoid

hypertrophy must all have the symptom of snoring, but not all will experience sleep apnea. Shu-Chi Mu et al in his study on indications of adenotonsillectomy in children with obstructive sleep apnea, stated that the American Academy of Pediatrics recommends systematic screening of children for a history of snoring. A positive history of snoring should then lead to further evaluation to rule out or confirm the impression of OSAS (34). Snoring was also demonstrated by Babak Saedi to have a significant relationship with the lateral radiograph (32). This study reflected similar findings to Shu- Chi Mu et al (34) when they demonstrated that snoring cut across the age brackets and that age had no statistically significant association with symptoms. Similarly, none of the three clinical symptoms assessed in this study showed a statistically significant association with sex of the participating children (5).

Classically, the physical signs considered indicative of adenoidal nasal obstruction in children have been mouth breathing and hyponasal speech (15). The clinician assessment facial chart was used to obtain the statistics regarding mouth breathing.

CONCLUSION

Several methods of adenoidal measurement have been reported. However, none has been widely accepted or implemented because the measurements have not expressed the maximal thickness of nasopharyngeal soft tissue, have not consistently shown landmarks and have been impractical and too time consuming to be adapted for routine use (27,1).

Our study demonstrated two simple radiological assessment methods that are reproducible in every clinical settting. The Fujioka method showed better accuracy than the Cohen method in the classification of moderate and severe AH. In keeping with Naushaba's conclusion (1). The

Cohen method on the other hand showed better specificity and NPV than the Fujioka method in the moderate and severe AH. This shows that both methods are complimentary to each other. In mild AH the sensitivity and specificity for both methods were comparable and fairly good.

RECOMMENDATIONS

i. The adaptation of the Fujioka and Cohen methods in assessment of postnasal radiographs at the KNH.

   Proposed sample reporting template from this study is:

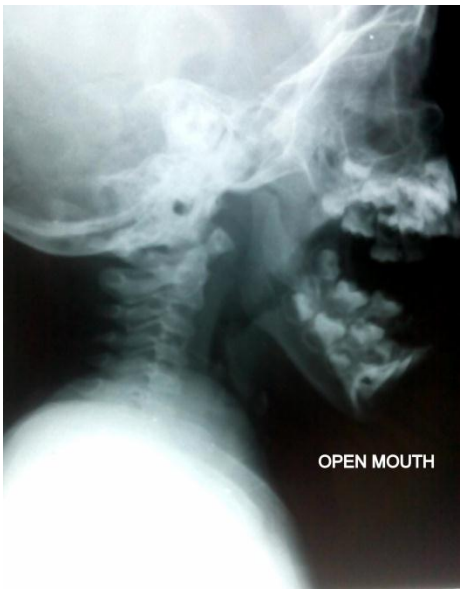
REPORT TEMPLATE

- There is (no) enlargement of post nasal space soft tissue with (no) narrowing of the nasopharyngeal airway.
- The ANR = …….
- The AC:SP = …….
- This is in keeping with (no/ mild/ moderate/ severe) adenoid hypertrophy.

ii. The postnasal radiograph should be utilized as a reliable screening tool for children with obstructive nasal symptoms, prior to surgery or rigid nasal endoscopy, in order to appropriately diagnose AH.

STUDY LIMITATIONS AND DELIMITATIONS

1. Small sample size that may not be a true representation of the population was due to PNS radiographs not being routinely performed prior to all adenotonsillectomies. Clinicians chose to operate based on clinical symptoms only.
2. Information bias, some guardians may alter information if they believe it may impact on their management.
3. Radiographs done in improper positioning due to the child being unable to close their mouth as a result of mouth breathing. This resulted in erroneous calculations and false narrowing of the airway.



4. Children being uncooperative due to fear.
5. Lack of flexible nasopharyngoscopy facility a KNH.
6. High cost and procedure complexities of rigid nasopharyngoscopy.

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APPENDICES

APPENDIX A: CONSENT FORM

A1. CONSENT FORM

Patient number: ……..…….

Title of study:

Correlation between clinical and radiological findings in pediatric adenoid hypertrophy at the Kenyatta national hospital.

Principal Investigator:

Dr. Cynthia Yiantet Sempele, MMed resident in Diagnostic Imaging and Radiation Medicine

Authorizing Body:

Kenyatta National Hospital/University of Nairobi Ethics and Research Committee.

Duration or authority: August 2015 to February 2016

Purpose of the study:

To determine the correlation of clinical assessment and grading of adenotonsillar hypertrophy (ATH) with the postnasal space (PNS) radiographic findings, in children diagnosed to have ATH at the Kenyatta National Hospital. The findings will help improve patient management by developing a more objective method in the assessment of the PNS radiograph.

Conduct of the study:

The child will be examined after initial contact is made with the ENT clinician and the criterion for enrollment is met. The availed postnasal radiographs will be interpreted by the principal investigator and a senior radiologist.

Risks and benefits

There are no risks foreseen since the study will only look at the clinical and radiological features of the illness and no treatment will be directly instituted. There will be no additional costs incurred when participating in the study.

Voluntary participation

Participation in the study is out of your free will. Medical care will not be denied for declining to participate. You may choose to withdraw from the study at any time with no consequences whatsoever.

Confidentiality

All information will be treated with confidentiality. Your identity will not be published whatsoever. The results obtained from the study will be always in my possession and no one else will be allowed to see the individual results.

KIBALI CHA RUHUSA

Nambari ya utafiti:……

Kichwa cha utafiti:

Uhusiano kati ya ugonjwa wa uvimbe wa nyuma ya pua kwa watoto na picha husika.

Mtafiti:

Dr. Cynthia Yiantet Sempele, MMed resident in Diagnostic Imaging and Radiation Medicine

Idhinisho kutoka:

Kenyatta National Hospital / Chuo Kikuu cha Nairobi Maadili na kamati ya utafiti.

Muda wa mamlaka: Agosti 2015 to Februari 2015

Sababu ya utafiti:

Utafiti huu una lengo la kuamua njia mwafaka ya kusoma picha ya nyuma ya pua ili kusaidia katika matibabu ya shida husika.

Maadili ya utafiti:

Mtoto atapimwa na daktari katika kliniki na picha ya nyuma ya pua itasomwa.

Hatari na manufaa :

Hakuna hatari imeazimiwa tangu utafiti itangalia makala ya kliniki ya ugonjwa na matibabu. Hakutakuwa na gharama za ziada zilizotumika wakati kushiriki katika utafiti.

Uhusika Kwa hiari :

Kuhusika kwa utafiti huu ni kwa hiari yako mwenyewe na hauwezi kushurutishwa. Utahudumiwa hata ingawa ukikataa kuhusika katika utafiti huu. Una uhuru kutamatisha kuhusika wakati wowote bila kuonewa kwa aina yoyote.

Usiri :

Taarifa zote zitashughulikiwa kwa siri. Utambulisho wako hautachapishwa popote. Matokeo kutoka utafiti yatakuwa daima katika milki yangu na hakuna mtu asiye na idhinisho yangu ambaye ataruhusiwa kuona matokeo hayo.

A2. CONSENT CERTIFICATE

I the investigator, have explained in detail the purpose of the study and hereby submit that privacy of all data collected will be maintained at all times.

Signature: …….

I the undersigned have been explained to and understand the above and voluntarily accept to participate in the study.

Signature / Thumb print (Parent /Guardian):

Telephone number (Parent/ Guardian) ….……

Mimi mtafitii naapa ya kwamba nimemweleza mhusika sababu na maadili ya uchunguzi. Naapa kuwa taarifa zote zitashughulikiwa kwa usiri.

Sahihi ……

Mimi mhusika nimeelewa maadili ya utafiti huu na nimekubali kushiriki kwa hiari yangu bila ya kushurutishwa.

Sahihi / Alama ya Kidole (Mzazi)…….

Simu 1 (Mzazi)……..

Contacts for clarification/ Nambari za simu

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Supervisor:

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University of Nairobi

Email address: kitonyi@uonbi.ac.ke

Kenyatta National Hospital/University of Nairobi Ethics and Research Committee

Telephone: (+254020) 2726300 Ext 44102

APPENDIX B: SAMPLE QUESTIONAIRE

STUDY TITLE: Correlation between clinical and radiological findings in pediatric adenoid hypertrophy at the Kenyatta national hospital.

DATE:

STUDY NUMBER: …….. AGE: ……

1. **PRIMARY CARE GIVER / MZAZI**

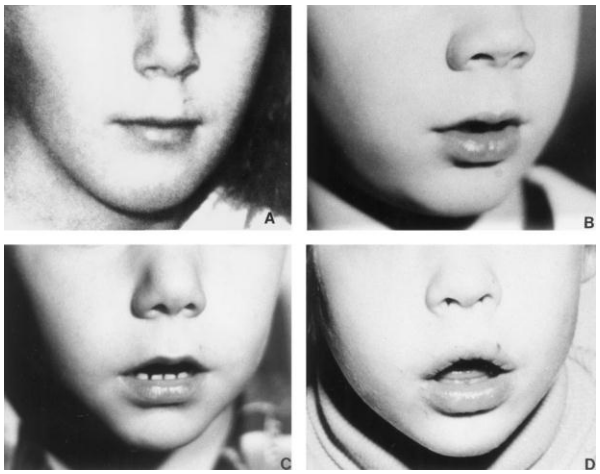
   PLEASE TICK APPROPRIATE BOX / WEKA ALAMA KWA NAFASI INAYOAMBATANA NA JIBU SAHIHI

SYMPTOMS **DALILI**	**NEVER** **LA** **(0)**	**OCCASIOLNALLY** **WAKATI** **MWINGINE** **(1)**	**FREQUENTLY** **MARA KWA** **MARA** **(2)**	**ALWAYS** **KILA WAKATI** **(3)**
DIFFICULTY IN BREATHING **(D)** SHIDA KUPUMUA				
SNORING **(S)** KUKOROMA				

SYMPTOM **DALILI**	**ABSENT (0)** **LA**	**PRESENT (1)** **NDIO**
SLEEP APNEA **(A)** KUKOSA KUPUMUA USINGIZINI		

2. CLINICIAN SECTION

PLEASE TICK THE IMAGE THAT BEST CORRESPONDS TO THE PATIENT



- A: None
- B : slight
- C : moderate
- D : marked

(pediatrics.aappublications.org at Kenya:AAP Sponsored on 2014)

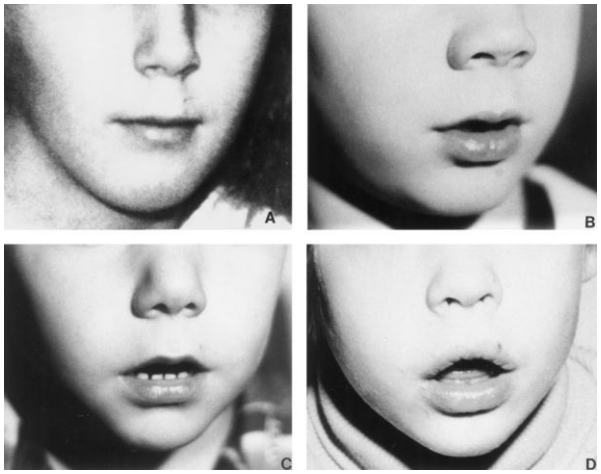
3. RADIOLOGICAL SECTION

FUJIOKA METHOD GRADING ……...

COHEN METHOD GRADING: …….

APPENDIX C: CLINICAL GRADING OF ATH

1. CLINICAL GRADING MOUTH BREATHING



- A: None
- B : slight
- C : moderate
- D : marked

2. CLINICAL GRADING SCORE: (14)

Categorization:

- Mild: score below -1
- Moderate: score -1 to 3.5
- Severe: score > 3.5

APPENDIX D: RADIOLOGICAL GRADING OF ATH

1. FUJIOKA METHOD

FUJIOKA	
Mild to moderate	25 to <50%
Moderately Severe	50 to < 75%
Severe	>=75%

2. COHEN METHOD

COHEN	
Normal	>1
Mild	>0.81<=1
Moderately severe	>0.5<=0.8
Severe	<=0.5

APPENDIX E: BUDGET

Estimated total cost of study is 149,000 Kenya Shillings divided as follows:

Statistician	- 45000
Questionnaire and research printing and binding	- 30000
Proposal printing and binding	- 6500
KNH/ ERC research fees	- 2000
Records KNH statistics research fees	- 500
Research assistants for patient recruitment and assistance in data compilation	- 20000
Stationery	- 10000
Mobile phone airtime to communicate with individuals involved with the study	- 5000
Internet payment	- 10000
Contingencies	- 20000