

Open-mouth versus closed-mouth X-ray in the evaluation of adenoid hypertrophy

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Abstract

Aims: This study aimed to compare the outcomes of open-mouth and closed-mouth X-rays concerning the detection of hypertrophic adenoids and decision-making about adenoidectomy as this has been insufficiently explored.

Materials and Methods: In the otolaryngology ward, 140 patients with chronic difficulty in breathing were divided into two groups (open-mouth and closed-mouth X-rays). Analyze the *t*-test for adenoid thickness, nasopharyngeal diameter, and soft palate (SP) thickness in both groups.

Statistical Analysis Used: Comparison between open-mouth and closed-mouth groups was statistically significant for the detection of nasopharyngeal diameter ($P = 0.015$) but not for adenoid thickness ($P = 0.062$) and SP thickness ($P = 0.176$).

Results: The total clinical score in diagnosing hypertrophied adenoid was not significant between the two groups ($P = 0.257$).

Conclusions: Diagnosis and decision-making about adenoidectomy cannot be determined solely through radiographic imaging techniques.

Keywords: Adenoidectomy, adenoids, hypertrophy, nasopharynx, X-rays

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INTRODUCTION

The adenoid is a nasopharyngeal lymphatic tissue that enlarges due to chronic infection, leading to physical and pathological obstruction in the upper respiratory tract.^[1] The prevalence rate of adenoid hypertrophy in nasal obstruction is 49.70%.^[2] Adenoid enlargement with failure to maintain upper airway patency can negatively impact blood gas homeostasis causing a decrease in arterial oxygen and an increase in carbon dioxide.^[3,4]

Radiography significantly decreases the size of the residual nasopharyngeal airway (NA) in symptomatic children.^[5] The previous study has demonstrated that a radiographic examination is an ineffective tool in measuring the adenoidal size and its use in the decision-making process associated with adenoidectomy. This technique is used by pediatricians when requiring assessments.^[6] The study, claims that skull lateral soft tissue X-ray, using the Cohen and Konak method, has high specificity (100%), high sensitivity (94.7%),

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and high accuracy (83.3%) in the detection of adenoid enlargement.^[7] McNamara and Fujioka are the most reliable method to replace nasoendoscopy, which is invasive and not available in some hospitals.^[7,8]

There are insufficient data regarding the value and reliability of closed-mouth and open-mouth x-ray in the evaluation of adenoid hypertrophy. This study, therefore, sets out to explore the efficacy of these radiographical techniques in the detection of hypertrophic adenoids causing nasopharyngeal obstruction and then compare the radiological findings with a clinical severity tool. This enables greater focus on a comparison between open-mouth and closed-mouth NA radiography techniques and total clinical evaluation for the diagnosis and surgery [Supplementary File 1].

MATERIALS AND METHODS

Study design, setting, and sample size

This was a cross-sectional study, after ethical clearance, the study was conducted at the otolaryngology ward in a tertiary referral hospital between August 2016 and January 2018. Patients having symptoms (moderate to severe) of chronic mouth breathing difficulties (such as snoring, sleep apnea, and nasal obstruction) were recruited.^[6] Power was calculated by G*power 3.1 software (Germany) and it was found 89%.

Data collection (inclusion and exclusion criteria)

Participant age criteria for the clinical suspicion of NA obstruction owing to adenoid enlargement were 3–14 years. Data collected in the questionnaire related to symptoms are as follows:

- Mouth breathing
- Obstructive breathing during sleep
- Sleep apnea.

Aljahdali *et al.*^[9] proposed a symptomatology score and patients with a total score of >0 were included in the study, whereas the patient having severe tonsillar hypertrophy, choanal atresia, septal deviation, allergic rhinitis, or distinct craniofacial dysmorphism were excluded. Patients with neuromuscular disorders or getting any medical treatment were also excluded from the study.

Ethical approval

The study was approved by the Research Ethics Committee at faculty of medicine, King AbdulAzizUniversity under reference number 450-18. Each participant's parent initially approached the symptomatology score and all were provided a detailed questionnaire and written consent before recruitment. The study was conducted under the Declaration of Helisinki.

Clinical evaluation

One technician with more than 5 years of experience was assigned to take open-mouth or closed-mouth lateral NA radiograph images using a convenient sampling technique. The stabilization was done by the active restraint method and no device was used. However, no harm was reported during the study and all the procedures were conducted under a fully trained and competent team. The radiations were given under the as low as reasonably achievable guiding principle of radiation. Based on the open-mouth and closed-mouth X-rays, participants were divided into the following two groups:

- Group I – Open-mouth X-ray
- Group II – Closed-mouth X-ray.

The radiographs were taken from the side (laterally) during the inspiration phase of breathing in a standing position. X-ray images of either open mouth or closed mouth were developed for each participant by two independent radiologists and each radiologist had more than 5 years of work experience. However, in case of any disagreements or a major error of measurement, a third-party expert would have been contacted to review. Measurements of the following criteria were obtained:

- Adenoid thickness.
- Nasopharyngeal diameter
- Soft palate (SP) thickness.

The method of Cohen and Konak^[8] was used to measure the (air column [AC]/SP) NA/SP ratio. Similar to Cohen and Konak, the present study incorporated a simple method for examining the radiographic images, in which it compared the thickness of the SP with the AC at a position adjacent to the superior anterior part of the palate. SP thickness was taken approximately 1 cm below the upper end of the SP and reduced to half a centimeter in children >3 years. This point is specified as the position slightly higher than the maximal convexity of the adenoids. The adenoid is classified as small in size if the SP is narrower than the airway ($AC/SP \leq 0.5$) [Figure 1]; it is classified as medium in size when the airway is narrower than the SP but wider than half its thickness ($0.5 \leq AC/SP < 1.0$); and is considered large when the airway is narrower than half of the palate's thickness ($AC/SP < 0.5$). The symptomatology scores used by Aljahdali *et al.*^[9] were adopted. This clinical score evaluated the clinical obstructive symptoms: mouth breathing, snoring, and sleep-obstructive breathing. Each symptom was scored as absent (0), mild (1), moderate (2), and severe (3). Based on the total clinical score, the patients were categorized into:

- <1 – Mild
- 2–4 – Moderate
- >4 – Severe.

Data analysis

The statistical analysis using the Pearson Chi-square test was used for the demographics. The mean values were presented with a 95% confidence interval and a 5% margin of error. Using the NA/SP ratios, the intraclass correlation coefficient was calculated to detect reliability. *T*-test analysis of both groups was made based on the mean values of the radiographical images and clinical scores. A significance level of <0.05 was considered statistically significant.

RESULTS

The sample size of 140 patients was clinically examined and radiological investigations were recruited. The majority were males (65%) and the minority were females (35%). Table 1 shows that most patients were aged between 3 and 7 years (73.6%), whereas 26.4% were aged between 8 and 14 years. Hypertrophy patients with open-mouth X-rays (Group I, 36.4%) and patients with closed-mouth X-rays (Group II, 63.5%) [Table 1]. It shows that their population characteristics are similar. There was no significant difference based on gender ($P = 0.494$, $\chi^2 = 0.464$, $df = 1$) and age ($P = 0.074$, $\chi^2 = 3.182$, $df = 1$) for the open-mouth and closed-mouth radiographs.

Figure 2 presents the majority of participants who presented moderate (62.7% and 51.7%) or severe clinical symptoms (31.4% and 42.7%) of adenoid hypertrophy in Groups I and II. Table 2 compares the clinical assessment for participants, who had snoring, mouth breathing, and obstructive breathing while sleeping in both groups. Mouth breathing is the highest moderate symptom in Group I (41.2%) and Group II (29.4%) [Table 2].

Low-quality radiographs were omitted, which resulted in six missing cases. Table 3 presents a comparison of the total clinical score and adenoid thickness of Groups I and II and Figure 3 shows radiographs of open-mouth and closed-mouth positions. The adenoid thickness was better detected among Group 1 patients than Group II patients. No significant values were obtained concerning adenoid thickness ($P = 0.062$, $\bar{X} = 0.28$), and no significance was detected when correlating the thickened adenoids to total clinical scores ($P = 0.257$, $\bar{X} = 0.03$). These results suggest

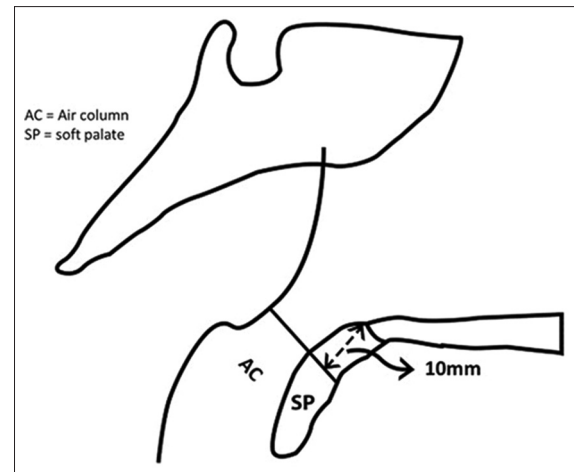


Figure 1: X-ray parameters of cavum

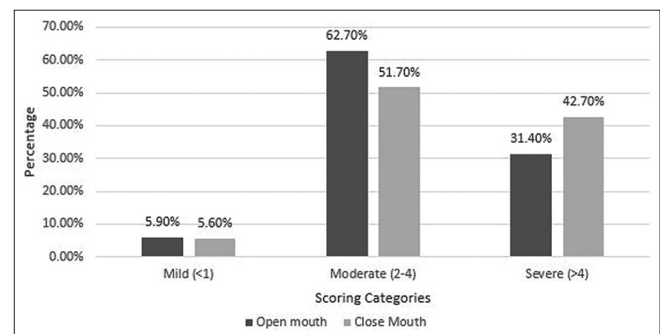


Figure 2: Total score of clinical presentation



Figure 3: Open-mouth and closed-mouth nasopharynx X-ray pictures of the participants. (a) Open mouth view postnasal X-ray radiograph for 3 years male patient showed thickened soft tissue of the adenoids and palatine tonsils. (b) Close mouth view postnasal X-ray radiograph for 4 years male patient showed thickened soft tissue of the adenoids and palatine tonsils

Table 1: Demographics of the participants

Measures	Items	Total participants (n=140; 100%), n (%)	Group I (open mouth) (n=51; 36.5%), n (%)	Group II (closed mouth) (n=89; 63.5%), n (%)	Chi-square - P (χ^2 , df)
Gender	Female	49 (35)	16 (31.4)	33 (37.1)	0.496 (0.464, 1)
	Male	91 (65)	35 (68.6)	56 (62.9)	
Age (years)	3-7	103 (73.6)	42 (82.4)	61 (68.5)	0.074 (3.182, 1)
	8-14	37 (26.4)	9 (17.6)	28 (31.5)	

Table 2: Clinical assessment of the participants

Scoring	Snoring, n (%)	Mouth breathing, n (%)	Obstructive breathing during sleep, n (%)
Total participants (n= 140)			
Absent	17 (12.1)	29 (20.7)	88 (62.9)
Mild	28 (20)	32 (22.9)	14 (10)
Moderate	52 (37.1)	47 (33.6)	27 (19.3)
Severe	43 (30.7)	32 (22.9)	11 (7.9)
Group I (open mouth) (n=51)			
Absent	9 (17.6)	8 (15.7)	34 (66.7)
Mild	15 (29.4)	12 (23.5)	8 (15.7)
Moderate	20 (39.2)	21 (41.2)	7 (13.7)
Severe	7 (13.7)	10 (19.6)	2 (3.9)
Group II (closed mouth) (n=89)			
Absent	8 (9)	13 (14.6)	54 (60.7)
Mild	13 (14.6)	20 (22.5)	6 (6.7)
Moderate	32 (36)	26 (29.2)	20 (22.5)
Severe	36 (40.4)	22 (24.7)	9 (10.1)

Table 3: Comparison between adenoid thickness, nasopharyngeal diameter, and soft palate thickness in Groups I and II

Variables	Groups	n	Mean	SD	P
Adenoid thickness	Group I (open mouth)	47	2.17	0.76	0.062
	Group II (closed mouth)	92	2.45	0.74	
Nasopharyngeal diameter	Group I (open mouth)	47	2.04	0.80	0.015
	Group II (closed mouth)	87	2.36	0.68	
SP thickness	Group I (open mouth)	47	2.14	0.41	0.176
	Group II (closed mouth)	87	2.28	0.62	
Total clinical score	Group I (open mouth)	51	2.25	0.56	0.257
	Group II (closed mouth)	89	2.37	0.59	

SD – Standard deviation, SP – Soft palate

X-ray technique when measuring the adenoid thickness in detecting adenoid hypertrophy is not significant as a constituent of the total clinical score.

Table 3 indicates the total clinical score and nasopharyngeal diameter of Groups I and II. The nasopharyngeal diameter was better detected in Group I compared to Group II. Statistically significant values were obtained for nasopharyngeal diameter ($P = 0.015$, $\bar{X} = 0.32$) when comparing the 2 groups, but no significance was detected when comparing the diameter to the total clinical score ($P = 0.257$, $\bar{X} = 0.03$). SP thickness was slightly better detected in Group I compared to Group II, although there was no statistically significant difference between the two groups in measuring SP thickness ($P = 0.176$, $\bar{X} = 0.14$). The total clinical score in diagnosing hypertrophied adenoids was not statistically significant between the two groups ($P = 0.257$, $\bar{X} = 0.12$). That is, neither SP thickness nor total clinical score was statistically significant in detecting adenoid hypertrophy.

The comparison between adenoidectomy with total clinical score and X-ray techniques (Group I and II) showed no statistically significant difference between the two groups in

their decision for adenoidectomy ($P = 0.051$ and $P = 0.51$). However, a comparison between the groups on the correlation between total clinical score and adenoidectomy was statistically significant ($P = 0.046$).

DISCUSSION

The present study has compared the clinical scores of open-mouth and closed-mouth X-rays in the diagnosis of adenoid hypertrophy, measuring adenoid thickness, nasopharyngeal diameter, and SP thickness. Cohen and Konak^[8] compared the thickness of the SP and the airway lying posterior to the SP diameter. The results showed a positive correlation through radiographs having a significant difference between the total clinical scores in both open-mouth and closed-mouth X-rays.^[7]

The method suggested by Cohen and Konak^[8] fails to show fully the diagnostic advantages of either taking radiographic images in the open-mouth or closed-mouthed positions. Their study did not make a detailed comparison between radiographical imaging and clinical scores. This has led to misconceptions that may be resolved by the methodology of the present study since it compares differentiated clinical diagnostic values with the respective radiographical techniques in the evaluation. The results of the present study show that none were statistically significant comparisons between open-mouth and closed-mouth X-rays only in the nasopharyngeal diameter.

The sample of the present study was inhomogeneous. This may be because closed-mouth X-rays are generally more commonly used, since using this technique is easier for positioning a child. A comparable study to the present study conducted by Xi *et al.*^[10] emphasized the importance of focusing on the dynamic nature of the NA and explicated various physiological motions (swallowing, expiration, inspiration, and open- and closed-mouth positions) to help in detecting the size and shape of the airway and SP. Similarly, another study by Apaydin *et al.*^[6] stated that closed-mouth views demonstrated a stronger correlation with the symptomatology score compared to open-mouth views, with percentages of 73.6% versus 49%. A preference for taking closed-mouth X-rays may be based on the notion that opening the mouth during X-rays may cause retraction and thinning of the SP, increasing the NA/SP ratio. Moreover, the standardization challenges associated with varying degrees of mouth opening among patients pose a technical obstacle. Conversely, closing the mouth during imaging is simpler, and closed-mouth views may offer a more accurate representation of the patient's everyday

position. There was a statistically significant difference in grades between open-mouth and closed-mouth views showed statistical significance ($P = 0.01$).^[6] Similarly, the present study also found that the closed-mouth X-ray method is more reliable in measuring nasopharyngeal diameter than open-mouth X-rays.

Similarly, Kurien *et al.*^[11] have evaluated the reliability of X-rays in the performance of flexible nasopharyngoscopy for the diagnosis of adenoid hypertrophy. The results of the present study have suggested that radiological evaluation of the NA for adenoid hypertrophy diagnosis may be limited owing to the dynamic nature of the nasopharynx.

This suggests that it is better to utilize the X-ray technique that is best for patients depending on their circumstances, providing it maintains the perfect lateral view of the image. This facilitates a recommendation for using either technique depending on the circumstances, such as which is more comfortable for the patient, thus enabling more focused concentration on the position of the head and neck, rather than being distracted by the mouth position.

The exposure of the kid to radiation, the absence of consistency in procedure and film interpretation, and the production of a two-dimensional picture from a three-dimensional structure are all the downsides of lateral neck films.^[10] In various research, nasal endoscopy has been regarded as the gold standard for determining adenoid size.^[12,13] Future studies may improve accuracy through the inclusion of a greater number of participants and more equal representation for each technique.

CONCLUSIONS

The present study concluded that the total clinical score was not statistically significant for the two groups. This facilitates a recommendation for using either technique depending on the circumstances, such as which is more comfortable for the patient, thus enabling more focused concentration on the position of the head and neck, rather than being distracted by the mouth position. Diagnosis and decision-making about adenoidectomy cannot be determined solely through radiographic imaging techniques.

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Conflicts of interest

There are no conflicts of interest.

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