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Research Article

Clinical and Cephalometric Assessments in Grade II and Grade IV Adenoid Hypertrophy: A Cross-Sectional Study

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Abstract

Background: Adenoid hypertrophy is one of the most common causes of nasal obstruction, and physicians use different methods to investigate it to reach a definite diagnosis.

Objectives: This study aims to determine whether there are clinical differences between grade II and IV adenoid hypertrophy and whether there is a positive correlation between adenoid-nasopharyngeal ratio and endoscopic examination findings.

Methods: This study was carried out on 120 patients; they were confirmed with five clinical tests (graded mirror, water-retention, lip-seal, deep-breath, and functional tests) and lateral cephalometric radiographs to measure the adenoid-nasopharyngeal ratio. Kruskal-Wallis test was used for the mirror test, while the Chi-squared test was used for the rest to detect the differences among groups. Spearman's correlation coefficient test was used to determine the correlation between the adenoid-nasopharyngeal ratio and endoscopic findings.

Results: The age range of the patients was 6-12 years [mean age = 9.13 ± 1.97 years], 60.8% male, 39.2% female. Kruskal-Wallis and Chi-squared tests showed a statistically significant difference with $P < 0.01$ between groups. A strong positive significant correlation at $P < 0.01$, Spearman's test 0.94 was found between adenoid-nasopharyngeal ratio and endoscopic findings.

Conclusion: Lateral cephalogram and nasal endoscopy can detect most pathologies associated with airway blockage. There are clinical differences between grade II and grade IV adenoid hypertrophy, and there is a good correlation between the adenoid-nasopharyngeal ratio measured by lateral cephalogram and endoscopic findings.

Keywords: Cephalometrics; Cross-sectional; Endoscopy; Grade II adenoid; Hypertrophy; Lip-seal; Water-retention.

Introduction

At the median of the posterior wall of the nasopharynx, there is a collection of lymphatic tissues named the adenoids (pharyngeal tonsils). They represent the superior part of Waldeyer's ring. Because of their location and structure, the adenoids capture any virus or bacteria that enters the human body through the nasal routes (1).Adenoid size increases between three and six years old and is related to the reduction of the growth of the nasopharynx. Then, after six, the adenoid stops growing under normal conditions, and the nasopharyngeal cavity widens; later on, some expansion of the adenoid could happen (due to the fibrous tissue involution) (2).Adenoid hypertrophy could block the choanae, causing symptoms such as mouth breathing, hyponasal speaking, and snoring. It could also produce otitis media with effusion (3) and conductive hearing loss (4). Craniofacial changes caused by chronic adenoid hypertrophy cause a facial feature named the adenoid face, characterized by a long face, retrognathic mandible, underdevelopment of the maxilla, constructed upper arch, and incompetent lips (5-7). Orthodontic correction of those changes would greatly depend on age of the patients (8) Various methods have been used to detect adenoid hypertrophy; some of them were invasive; others provided digital imaging; the first one includes manual finger pressure, posterior rhinoscopy by a special mirror, rigid or flexible nasopharyngoscopy; the second includes ultrasonography, lateral cephalogram, computed tomography (CT) or Magnetic resonance imaging (MRI) (9). The most effective and accurate method is the flexible fiberoptic endoscopy since it gives a direct visualization of the nasal and nasopharyngeal area, giving more precise measurements of the size of the adenoids (10). Since there were insufficient studies that compare grade II and grade IV adenoid hypertrophy using clinical tests, the current cross-sectional study was designed to do so in addition to the use of adenoid-nasopharyngeal ratio (ANR) for cephalometric assessments of adenoids.

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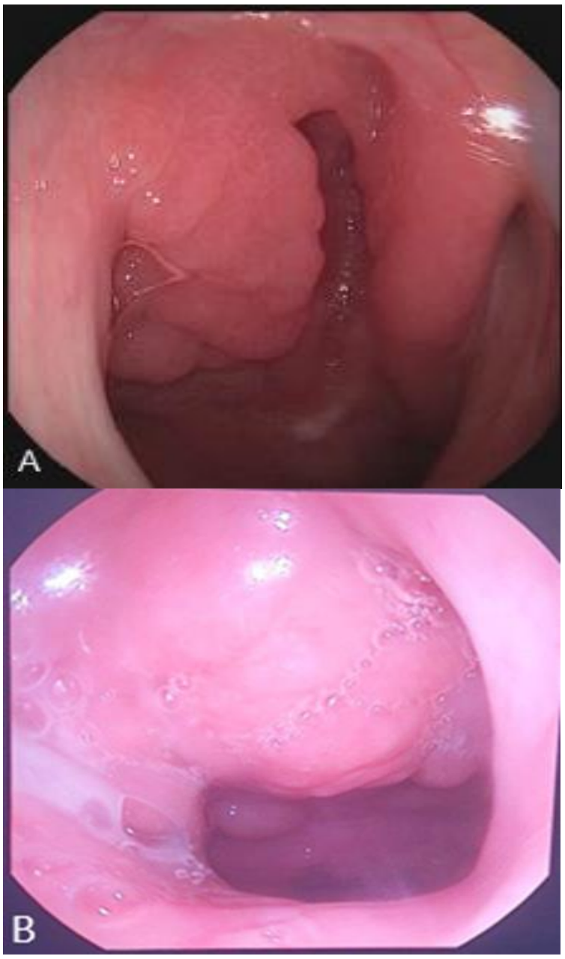
Subjects and Methods:

A cross-sectional study was carried out on 120 patients with 73 males and 47 females aged 6–12 years who were selected from the ear, nose, and throat (ENT) department at Imam Al-Hussein Medical City in Karbalaa and examined by a specialist otolaryngologist to detect the adenoids. The ENT specialist examined each patient to include or exclude patients using a flexible Storz Karl Storz Endoscope machine (model 495xx, 69495xx) under topical anesthesia with 2% xylocaine (Figure 1). The patients were allocated into three groups based on the endoscopic classification system of adenoids proposed by Cassano et al. (11) Grade I corresponds to the adenoid tissue covering less than 25% of the choanal openings; grade II corresponds to the adenoid tissue covering less than 50% of the choanal openings, with the Eustachian tube visible; grade III corresponds to a covering of about 75%, with the Eustachian tube slightly involved; and grade IV refers to a covering of over 75%, with the Eustachian tube completely covered (Complete choanal obstruction). The 120 patients were divided into control, grade II, and grade IV groups with 40 subjects in each group. The control group is free from any systemic disease and from adenoids diagnosed by the otolaryngologist using the endoscope. Subjects with systemic diseases, handicaps, previous maxillofacial trauma, past adenoidectomy, and grade I and III adenoids were excluded.



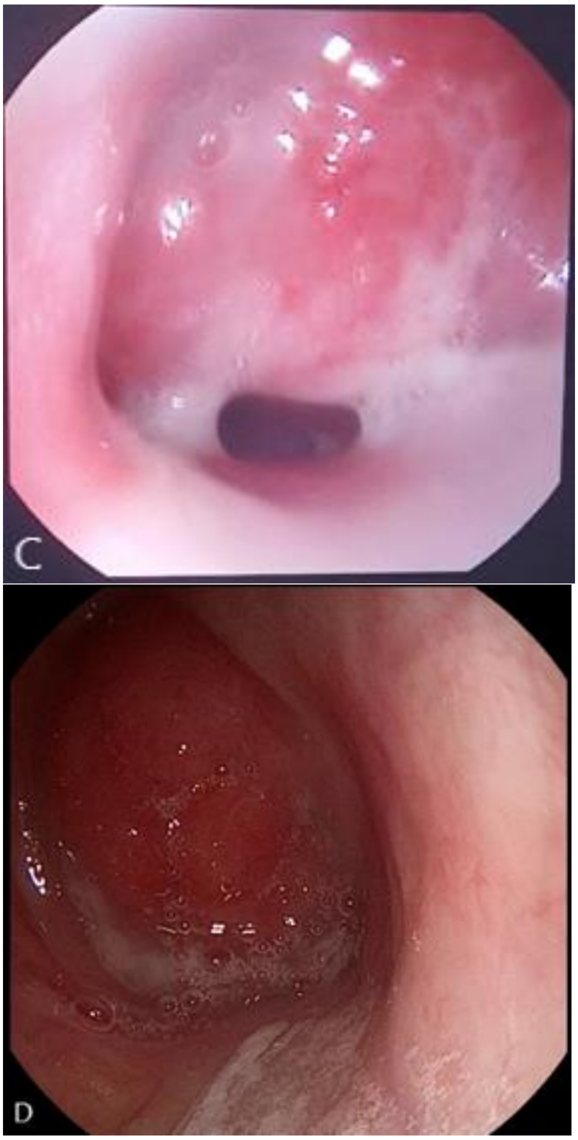


Figure 1: Endoscopic view shows adenoid hypertrophy A. Grade I, B. Grade II, C. Grade III, D. Grade IV.

Informed consent had been taken from each patient participated in the study. Five clinical tests were used in this study. In the *graded mirror test*, the water vapor marked on the mirror from the exhaled air with a marker to measure the area of interest (Low nasal flow: up to 30 mm; Average nasal flow: 30–60 mm; High nasal flow: above 60 mm) (Figure 2). While in the *water-retention test*, the patient was asked to hold the water (about 15ml) still in his mouth for 3 minutes without swallowing. In the *lip-seal test*, the patient was asked to seal his lips completely for 3 minutes. In the *deep-breath test*, the patients were instructed to breathe deeply through their noses while keeping their lips closed. Those who breathe through their noses have better than average voluntary function of the alar muscles, which change the size and shape of the external nares during inhalation. Mouth breathers, on the other hand, don't change the shape and size of their nostrils when they breathe via the nose, and they even occasionally compress their external nares while inhaling. Lastly, in the *functional test*, the patients were instructed to bend their knees quickly ten times. They were considered pure nose breathers if they were able to maintain quiet nasal breathing for the 30 seconds following the exercise (12, 13).

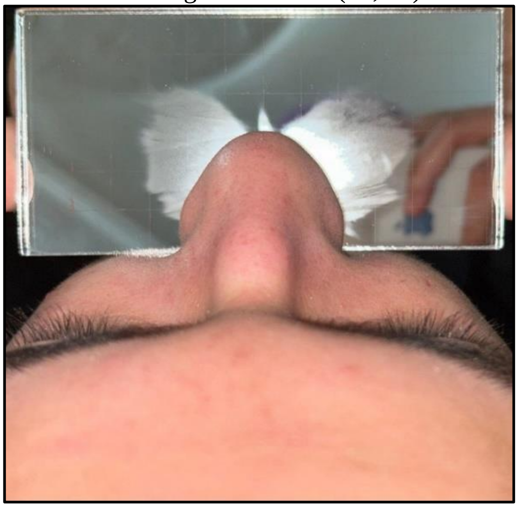


Figure 2: The steam halo generated on the graded mirror.

Lateral cephalometric radiograph has been taken for the included patients in the department of radiology at Imam Al-Hussein Medical City in Karbalaa, with the use of the Hyperion X9 Pro professional 3-in-1 full-touch imaging system by the same x-ray specialist at centric occlusion in natural head position (14) with the head fixed by ear rods laterally and a plastic stopper (nasion support) on the bridge of the nose anteriorly, fixing the Frankfort plane horizontally (15). The x-ray beam's central ray entered through the subject's right external auditory meatus and left from the left side meatus. ANR was measured using the guidelines from Fujioka et al. (16) to measure the Adenoid hypertrophy. The width of the adenoid depth (AD) will be measured by drawing a line at a right angle from the straight part of the anterior margin of the basi-occiput to the part of the adenoid that is the most rounded. The nasopharyngeal depth (ND) will be measured by drawing another line from the sphenoid-occipital synchondrosis to the posterosuperior edge of the hard palate. ANR will then be calculated by dividing AD by ND (16, 17) (Figure 3).Tracing processes have been made by the researcher using Autodesk AutoCAD 2020 (18).

Statistical analysis

Kruskal-Wallis test was used for the mirror test, while the Chi-squared test was used for the rest to detect the differences between the control group, grade II, and grade IV adenoid. Spearman's correlation coefficient test was used to determine the correlation between the ANR and endoscopic findings. Analysis was performed using a statistical package for social science (SPSS version- 26). A *P*-value < 0.05 was considered a statistically significant difference.

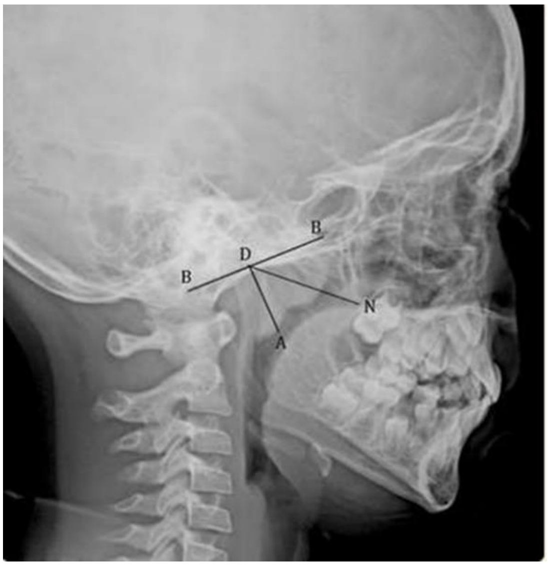


Figure 3: Cephalometric radiograph, where BB is the line drawn along the straight part of the anterior margin of the basiocciput; AD is the adenoid depth; ND is the nasopharyngeal depth (17).

Results

This study was conducted on 120 participants (mean age = 9.13 ± 1.97 years, range 6-12 years, 60.8% male, 39.2% female). Different results were found across the study; for the graded mirror test, 38 subjects from the control group had a high nasal flow, two subjects had average nasal flow, and nobody was found to have low nasal flow. While in grade II, ten subjects had a high nasal flow, 29 subjects had an average nasal flow, and only one subject had a low nasal flow. In grade IV, three subjects had a high nasal flow, 28 subjects had an average nasal flow, and only nine subjects had a low nasal flow (Table 1).

Table 1: Descriptive statistics for the graded mirror test

Group	Graded mirror test	Frequency	%
Control	0	0	0
	1	2	5.0
	2	38	95.0
Grade II	0	1	2.5
	1	29	72.5
	2	10	25.0
Grade IV	0	9	22.5
	1	28	70.0
	2	3	7.5

* 0 for Low nasal flow, 1 for Average nasal flow, and 2 for High nasal flow.

Kruskal-Wallis Test showed a statistically significant difference between groups (Table 2).

Table 2: Kruskal-Wallis test for comparison among groups for the mirror test

Kruskal-Wallis test		
Pairwise Comparisons of Groups		
Between groups	Statistics	*P*-value
Grade IV- Grade II	16.53	0.018
Grade IV- Control	55.89	0.000
Grade II- Control	39.36	0.000

*Highly significant when *P*-value < 0.01.

For the water-retention and lip-seal tests, all subjects from the control group passed the two tests successfully, while 37 subjects from grade II passed the test, and half of the subjects from grade IV passed. For the deep-breath test, all the subjects in the control group could take a deep breath successfully; 37 subjects from grade II passed the test, while only 16 subjects from grade IV passed. Meanwhile, for the functional test, the control group could do it; 36 subjects from grade II passed the test, while only 12 subjects from grade IV passed (Table 3). Chi-Squared test showed a highly significant difference at *P*-value < 0.01 across groups (Table 4). A very strong correlation was found between ANR and endoscopic findings at *P*-value < 0.01 and Spearman's correlation coefficient equal to 0.94.

Table 3: Descriptive statistics of the distribution of clinical examination variables among groups

Variable	Group	Result	Frequency	%
Water-retention test	Control	1	40	100.0
	Grade II	0	3	7.5
		1	37	92.5
	Grade IV	0	20	50.0
		1	20	50.0
Lip-seal test	Control	1	40	100.0
	Grade II	0	3	7.5
		1	37	92.5
	Grade IV	0	20	50.0
		1	20	50.0
Deep-breath test	Control	1	40	100.0
	Grade II	0	3	7.5
		1	37	92.5
	Grade IV	0	24	60.0
		1	16	40.0
Functional test	Control	1	40	100.0
	Grade II	0	4	10.0
		1	36	90.0
	Grade IV	0	28	70.0
		1	12	30.0

*0 describes subjects who could not pass the test. *1 describes subjects who could.

Table 4: Chi-squared test of the distribution of clinical examination among groups

Variable	Group	Result	Observed count	Expected count	Chi-squared test	*P*-value
Water-retention test	Control	0	0	7.7	37.54	0.000 (HS)
		1	40	32.3		
	Grade II	0	3	7.7		
		1	37	32.3		
	Grade IV	0	20	7.7		
		1	20	32.3		
Lip-seal test	Control	0	0	7.7	37.54	0.000 (HS)
		1	40	32.3		
	Grade II	0	3	7.5		
		1	37	32.3		
	Grade IV	0	20	7.7		
		1	20	32.3		
Deep-breath test	Control	0	0	9	49.03	0.000 (HS)
		1	40	31		
	Grade II	0	3	9		
		1	37	31		
	Grade IV	0	24	9		
		1	16	31		
Functional test	Control	0	0	10.7	58.64	0.000 (HS)
		1	40	29.3		
	Grade II	0	4	10.7		
		1	36	29.3		
	Grade IV	0	28	10.7		
		1	12	29.3		

HS: highly significant at *P* < 0.01

Discussion:

Hypertrophy of the lymphoid tissues plays an essential role in the constriction of the nasal airways (17, 19), and to aid the breathing process, the child substitutes nasal breathing with oral breathing and becomes a mouth breather (20). Clinical recognition of mouth breathers could be done by different approaches (13, 21). The most common breathing tests used in the dental office by the orthodontists are the lip-seal, mirror, and lastly, water-retention tests (13). Significant differences at *P*-value < 0.01 were found among groups for the five clinical tests. Although the graded mirror test was used to access nasal patency and is very useful in unilateral nasal obstruction, done by a special mirror with equal divisions of squares, it was not standardized (13). Water retention and lip-seal tests are easy and do not need any equipment to diagnose oral breathing. Still, there needed to be more agreement on the manner of application, so to standardize the breathing tests, three minutes was the optimum time chosen in this study (22). The choice of this longer period was essential because mouth breathers might breathe through their noses even when there was an obstruction, but only for a short period, depending on the level of nasal obstruction (13). Morais-Almeida et al. (23)

suggested an absence of lip-seal caused by hypotonicity of the orbicularis oris muscle. Kalaskar et al. (24) added that facial divergence, long face, short lips, and oral breathing cause incompetent lips. Maintaining the lip closure for up to three minutes was considered a training process used by the patient to restore nasal breathing throughout the test day after day at home after removing the causative factor of nasal obstruction (13). So, the lip-seal test in the study could be efficient for the patients after that. The two tests, the deep-breath test and the functional test, could be misleading, especially in children, because most children do not do it well, and it could be not easy. Applying only one test to check the airway's patency could be unreliable; it is better to choose at least two tests as an initial step for the diagnosis of a mouth breather, just like the mirror test with the water-retention or lip-seal test could be a good suggestion (13). Attaining nasal breathing is especially important for children since they are growing, and oral breathing could have deleterious effects on craniofacial features (25). In the case of adenoid hypertrophy, there are various methods to detect adenoid size (26); the palpation method and the posterior rhinoscopy are old methods. They are hard to do and traumatic to the patient, and greatly depend on the patient's cooperation, the results do not correlate well with the endoscopic findings, and they give wrong results of the adenoid size (26). Most otologists suggested the endoscopic examination to check airway patency; using the nasopharyngoscope could be very efficient to measure adenoid size (10), especially before adenoidectomy (9, 27); this procedure was mandatory in this study. Although the endoscopic examination is quick and informative and produces a 3D image, it is limited to the clinical specialist and cannot be done by the primary care physician. Also, the incomplete relaxation of the soft palate causes inaccuracy in the diagnostic results (9). In addition, endoscopic examination gives a negative result for nasal patency (28). Multiple radiologic imaging techniques could be used to estimate adenoid tissue size. The lateral cephalometric radiograph is simple, cost-effective, and with low radiation, mostly used to measure the adenoid size (29-31). However, MRI could detect adenoid size in different age groups (32). Moreover, CBCT could be used to examine the craniofacial area to reach a correct diagnosis and treatment (33-35). Fujioka et al. (16) suggested the use of the A/N ratio to measure the adenoid size; it depends on the measurement of the maximum convexity of the adenoids arising from the straight part of the basiocciput in an anteroinferior direction divided by the anteroposterior diameter of the nasopharyngeal area. In this study, the A/N ratio was strongly correlated with endoscopic findings, agreed with Moideen et al. (17). However, lateral cephalograms might overestimate the adenoid size (36); according to the systematic review by Major et al. (37), who suggested measurement of the size of the airways instead of the adenoid. Some limitations could be present with the lateral x-ray, and those greatly affect the results, such as head position, patient respiration, and phonation. The soft palate elevates and reduces the nasopharyngeal cavity during crying, mouth breathing, and swallowing. So, it is better to perform the exposure at an extended head position and the end of inspiration without crying or swallowing, and this is not easy for children (38). In addition, it is a 2D image and might have superimposition, artifacts, and errors (34).

Conclusions
Clinical examination is the primary step in detecting long-term airway blockage. The primary diagnoses could detect most pathologies, however, sometimes they need confirmations, which include the lateral cephalogram and nasal endoscopy. There are clinical differences between grade II and grade IV adenoid hypertrophy, and there is a good correlation between ANR measured by lateral cephalogram and endoscopic findings.

Authors' declaration
Conflicts of Interest: None.
We hereby confirm that all the Figures and Tables in the manuscript are mine/ ours. Besides, the Figures and images, which are not mine /ours, have been given permission for re-publication and attached to the manuscript. Authors sign on ethical consideration's approval-Ethical Clearance: The project was approved by the local ethical committee in the College of Dentistry/University of Baghdad according to the code number (818 on 18/5/2023).

Conflicts of interest/ None.
Funding/ None

Authors' contributions
Afnan R. Hammood: Study conception & design, literature search, data acquisition, data analysis & interpretation, manuscript preparation.
Hayder F. Saloom: Conceptualization, methodology, validation, formal analysis, resources, data curation, visualization, supervision, project administration, manuscript editing & review.

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التقييمات السريرية وقياسات الرأس في الدرجة الثانية والدرجة الرابعة من تضخم اللحمية الانفية: دراسة مقطعية

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الخلاصة:
خلفية البحث: يعد تضخم اللحمية الانفية أحد الأسباب الأكثر شيوعًا لانسداد الأنف، ويستخدم الأطباء طرقًا مختلفة لفحصه للوصول إلى تشخيص محدد.
هدف الدراسة: تهدف هذه الدراسة إلى تحديد ما إذا كانت هناك اختلافات سريرية بين تضخم اللحمية الانفية من الدرجة الثانية والرابعة وما إذا كان هناك علاقة إيجابية بين نسبة اللحمية إلى البلعوم الأنفي ونتائج الفحص بالمنظار.
طريقة البحث: تم إجراء دراسة مقطعية على 120 مريضاً؛ تم تأكيدهم من خلال خمس اختبارات سريرية (اختبار المرآة المتدرجة، واختبار احتباس الماء، واختبار اغلاق الشفة، واختبار التنفس العميق، والاختبار الوظيفي) والصور الشعاعية الرأسية الجانبية لقياس نسبة اللحمية الأنفية الى البلعوم. تم استخدام اختبار كروسكال واليس لاختبار المرآة، بينما تم استخدام اختبار مربع كاي للباقي للكشف عن الاختلافات بين المجموعات. تم استخدام اختبار معامل ارتباط سبيرمان لتحديد العلاقة بين نسبة اللحميه الانفية الى البلعوم والنتائج بالمنظار.
النتائج: كان عمر المرضى 6-12 سنة [متوسط العمر = 9.13 ± 1.97 سنة]، 60.8% ذكور، 39.2% إناث وأظهرت اختبارات كروسكال واليس ومربع كاي وجود فرق ذو دلالة إحصائية مع (P < 0.01) بين المجموعات. تم العثور على علاقة إيجابية قوية وذات دلالة إحصائية عند قيمة (P < 0.01)، واختبار سبيرمان 0.94 بين نسبة اللحميه الانفية الى البلعوم والنتائج بالمنظار
الاستنتاج: يمكن لتصوير الرأس الجانبي والتنظير الأنفي اكتشاف معظم الأمراض المرتبطة بانسداد مجرى الهواء. هناك اختلافات سريرية بين الدرجة الثانية والدرجة الرابعة من تضخم اللحميه الانفية، وهناك علاقة جيدة بين نسبة اللحمية إلى البلعوم الأنفي المقاسة بواسطة مخطط الرأس الجانبي والنتائج بالمنظار.
الكلمات المفتاحية: قياسات الرأس، المقطع العرضي، التنظير، اللحمية من الدرجة الثانية، مرآة متدرجة، تضخم، ختم الشفة، احتباس الماء.