Comparing Flexible Nasal Endoscopy and Lateral Neck Radiography When Diagnosing Children with Adenoid Hypertrophy: A Case-Control Study

Original Investigation

Jad Hosri[1], Omar Aboul Hosn[1], Anthony Ghanem[1], Anne Marie Daou[1], Justin Ghadieh[1], Nader Zalaquett[2], Randa Barazi[1]

[1]American University of Beirut Medical Center, Department of Otolaryngology-Head and Neck Surgery, Beirut, Lebanon
[2]American University of Beirut Faculty of Medicine, Beirut, Lebanon

Abstract

Objective: To compare the reliability of flexible nasal endoscopy and lateral neck radiography in grading adenoid hypertrophy preoperatively in children.

Methods: A retrospective study was performed at a single tertiary care center. Medical records of children who underwent adenoidectomy between January 2019 and December 2023 were reviewed. Preoperative adenoid size was assessed by radiography or endoscopy and compared to intraoperative grading, the reference. Adenoid hypertrophy was graded as mild (25-50%), moderate (51-75%), or severe (76-100%).

Results: A total of 360 patients, 199 males and 161 females, were included. The mean age was 4.29±2.39 years. Preoperative and intraoperative grading matched in 58% of cases using endoscopy and 44.5% using radiography (p=0.028). Accurate grading was 1.7 times more likely with nasal endoscopy than radiography [odds ratio=1.72; 95% confidence interval (1.06-2.79)].

Conclusion: Flexible nasal endoscopy is more reliable than radiography in preoperative grading of adenoid hypertrophy in children.

Keywords: Adenoid hypertrophy, nasal endoscopy, radiography, pediatric otorhinolaryngology, diagnostic accuracy, preoperative assessment

ORCID IDs of the authors:
J.H. 0000-0002-7781-3486
O.A.H. 0009-0000-0891-2395
A.G. 0000-0002-8965-3619
A.M.D. 0009-0004-2794-7795
J.G. 0009-0008-8513-0192
N.Z. 0009-0008-7206-152X
R.B. 0000-0002-5227-6215

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Corresponding Author:
Jad Hosri, MD;
hosri94@gmail.com

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Introduction

Adenoid hypertrophy is the most common cause of upper airway obstruction in children and adolescents with a global prevalence ranging from 34% to 49% (1). The development of adenoid hypertrophy primarily stems from infectious origins, mainly respiratory and non-respiratory viruses, as well as aerobic and anaerobic bacteria. However, various non-infectious mechanisms may also contribute as the pathogenesis is believed to entail a complex interplay among immune, hormonal, and genetic factors, and may manifest with or without concurrent acute or chronic infections (2).

Common signs and symptoms of adenoid hypertrophy include nasal obstruction, chronic mouth breathing, mucopurulent rhinorrhea, and recurrent infections such

as upper respiratory tract infections and otitis media (3). Additionally, obstructive sleep apnea and irregularities in language and speech development may be observed. Chronic mouth breathing stemming from nasal obstruction can affect facial and dental development, potentially resulting in what is commonly referred to as adenoid facies or long face syndrome (4).

Besides clinical assessment, several diagnostic modalities can be relied upon to confirm the diagnosis of adenoid hypertrophy, including lateral neck radiography and flexible nasal endoscopy. The latter represents a safe office-based procedure with minimal associated complications. By enabling direct visualization of the nasopharynx and its structures, it stands as an exceptionally precise diagnostic tool for identifying adenoid hypertrophy. Nonetheless, successful execution hinges on the child's cooperation, as some may find the procedure uncomfortable (5). In such instances, clinicians have turned to lateral neck radiography as a readily available and less invasive tool for diagnosing and grading adenoid hypertrophy. These radiographs can identify the adenoids as the underlying cause of nasal obstruction and offer valuable insights into their size, shape, and position before surgical intervention (6). While various measurements exist for grading the adenoid size, the adenoid/nasopharynx ratio (A/N ratio), is the most widely used and represents the ratio of adenoid thickness to nasopharynx thickness (7).

In the current literature, there is limited comparative research evaluating the reliability and effectiveness of these two methods in the preoperative diagnosis of adenoid hypertrophy in children, which can provide valuable insights into their respective diagnostic accuracy, potential advantages, and limitations. Therefore, the objective of this study is to compare the reliability of flexible nasal endoscopy and lateral neck radiography in the preoperative diagnosis of children with adenoid hypertrophy, thereby aiding clinicians in making informed decisions about the optimal diagnostic approach for children with such a condition.

Methods

Subjects and Study Design

After having obtained approval from the Institutional Review Board of the American University of Beirut (IRB ID: BIO-2020-0303, date: 25.11.2020), the medical records of pediatric patients (younger than 18 years of age) who presented to a tertiary care center for adenoidectomy between January 2019 and December 2023 were reviewed. Due to the retrospective nature of the study, informed consent was not obtained from the participants' parents. The study adhered to the principles outlined in the Declaration of Helsinki and was conducted according to the STROBE guidelines for observational studies.

Children exhibiting chronic obstructive symptoms such as mouth breathing, snoring, witnessed apneas, and frequent nighttime awakenings for at least three months were included in the study. Those with severe nasal septal deviation, choanal atresia, craniofacial anomaly, and neuromuscular disorder were excluded from the study. Patients with imaging performed more than one month before surgery were also excluded. Demographic and clinical data included age, gender, snoring, witnessed apneas/frequent nighttime awakenings, and recurrent ear or upper respiratory tract infections. Among the enrolled children who underwent adenoidectomy, preoperative assessment of adenoid size was conducted either by lateral neck radiography or by flexible nasal endoscopy. The preoperative adenoid grade was then compared to the intraoperative grade, which was considered the reference. In routine clinical practice, flexible nasal endoscopy is more commonly performed in older children, whereas lateral neck radiography is often preferred in younger patients due to limited cooperation. Consequently, the retrospective nature of our study resulted in an expected age imbalance between the two diagnostic groups. This potential selection bias was acknowledged, and the findings were interpreted with this consideration in mind.

Preoperative Grading of Adenoid Hypertrophy

Lateral neck radiographs were retrieved from electronic medical records and reviewed independently by a pediatric radiologist and pediatric otolaryngologist. The percentage of airway obstruction by adenoid hypertrophy was calculated as the ratio between adenoid size and nasopharyngeal size (A/N ratio). "A" refers to the distance measured perpendicular from the straight portion of the anterior border of the basioccipital bone to the point of greatest convexity in the pharyngeal tonsil. "N" refers to the distance between the posterosuperior part of the hard palate and the anterior border of the basioccipital bone (Figure 1). The authors then categorized adenoid hypertrophy as "mild," "moderate," or "severe" if the ratio was between 26-50%, 51-75%, and 76-100%, respectively.

In children undergoing nasal endoscopy, a zero-degree flexible endoscope (KARL STORZ Endovision, Inc. Charlton: USA) was inserted into the nose after nasal decongestion with lidocaine and xylometazoline nasal drops. All flexible endoscopes had the same diameter of 2.8 mm. The endoscope was navigated along the nasal floor until only the posterior end of the inferior turbinate was visible. Video recordings of this procedure were captured using a distal-chip camera and stored digitally. These videos were subsequently reviewed by two otolaryngologists with over five years of experience for assessment. The adenoids were then graded based on the percentage of nasopharyngeal (choanal) obstruction as mild (26-50% obstruction), moderate (51-75% obstruction), and severe (76-100% obstruction). None of the patients had both radiographic and endoscopic evaluations.

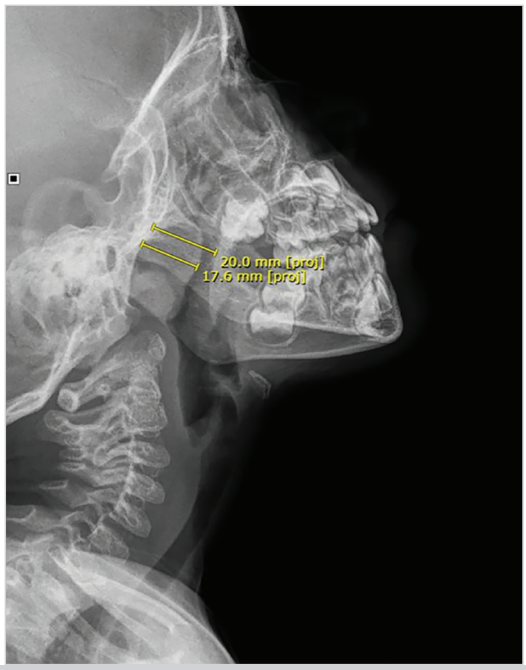

Figure 1. Lateral neck radiograph illustrating the measurement of adenoid and nasopharyngeal dimensions used to calculate the adenoid-to-nasopharynx ratio. The upper yellow line represents the depth of the nasopharyngeal airway (20.0 mm), while the lower line denotes the maximal thickness of the adenoid tissue (17.6 mm)

Intraoperative Grading of Adenoid Hypertrophy

Standard adenoidectomy was performed on each patient. Under general anesthesia, the patient was put in the rose position, and the mouth was opened with McIvor mouth gag (Aesculap AG, Tuttlingen, Germany). Two nasogastric tube catheters were introduced through the nasal cavity to retract the soft palate.

A senior pediatric otolaryngologist assessed the adenoids using a laryngeal mirror and determined their size based on the degree of nasopharyngeal obstruction. Adenoid hypertrophy was graded as mild or grade 2 if the obstruction was between 26 and 50%, moderate or grade 3 if the obstruction ranged from 51% to 75%, and severe or grade 4 if the obstruction was 76% and beyond. The results recorded intraoperatively were considered as the reference adenoid size in this study.

Statistical Analysis

The SPSS (IBM SPSS Statistics for Windows, Version 29.0. Armonk, NY: IBM Corp.) was used for data analysis. Descriptive statistics were used to analyze continuous variables (means and standard deviations) and categorical variables (numbers and percentages). The chi-square test was used to determine the association between categorical variables. To measure the strength of association between categorical variables, the odds ratio (OR) and Spearman's correlation coefficient were calculated along with their 95% confidence interval (CI). The Mann-Whitney U test was used to determine the association between independent continuous variables. A one-way analysis of covariance (ANCOVA) was conducted to compare the effectiveness of the two methods whilst controlling for age. Statistical significance was set at a p-value less than 0.05.

Results

Demographic Data

A total of 360 patients, 199 males and 161 females, were included in this study. The mean age of the study group was 4.29±2.39 years. In patients who were diagnosed with lateral neck radiography (n=272), the male-to-female ratio was 1.28 compared to 1.09 in patients who were diagnosed with endoscopy (p=0.514). Patients in the endoscopy group (n=88) were significantly older than patients in the radiography group (6.62±3.08 vs. 3.53±1.49; p<0.001). Caregivers reported that more than two-thirds of patients were snorers and had at least one episode of witnessed apnea per night. Around 34% of the patients complained of associated recurrent infections such as pharyngitis and otitis media. None of the patients had severe structural deformities of the nasal septum and inferior turbinates (Table 1).

Reliability of the Two Methods

There was a statistically significant difference in the diagnostic accuracy of the two methods. The preoperative grading of adenoid hypertrophy was identical to the intraoperative grading in 58% of the cases using the flexible endoscopy compared to 44.5% of the cases using the lateral neck radiography (p=0.028). Moreover, the odds of having an accurate preoperative grading of adenoid hypertrophy were 1.7 times greater with nasal endoscopy than with lateral neck radiography [OR=1.72; 95% CI (1.06-2.79)].

Furthermore, lateral neck radiography was reported to overestimate the diagnosis in 47.1% compared to 35.2% in the endoscopy group (p=0.088). The percentage of the cases in which the preoperative adenoid hypertrophy grading was underestimated was lower in both groups (8.5% in the radiography group vs. 6.8% in the endoscopy group) (Table 2).

A one-way ANCOVA was conducted to investigate the effect of different diagnostic methods on the accuracy of preoperative adenoid grading, while accounting for age. Levene's test and normality checks were carried out, and the assumptions were met. There was a significant difference in the accuracy of preoperative grading [$F(1,357)=4.315$, $p=0.038$] between the endoscopy and radiography groups.

Discussion

This study demonstrated that flexible nasal endoscopy provides a more reliable preoperative assessment of adenoid hypertrophy compared to lateral neck radiography.

Table 1. Demographic data of the study population

Demographic data (n=360)	X-ray (n=272)	Endoscopy (n=88)	p-value
Gender (male:female ratio)	1.28	1.09	0.514
Age in years (mean±SD)	3.53±1.49	6.62±3.08	<0.001
Snoring, n (%)	188 (69.1)	60 (68.2)	0.715
Witnessed apnea, n (%)	172 (63.2)	58 (65.9)	0.464
Recurrent infections, n (%)	92 (33.8)	30 (34.1)	0.589

SD: Standard deviation

Table 2. Reliability of diagnostic methods in assessing adenoid size

Reliability, n (%)	X-ray (n=272)	Endoscopy (n=88)	p-value
Accurate	121 (44.5)	51 (58)	0.028*
Overestimate	128 (47.1)	31 (35.2)	0.088
Underestimate	23 (8.5)	6 (6.8)	

*: Statistically significant (p<0.05)

Endoscopic grading matched intraoperative findings in 58% of the cases, whereas radiography achieved 44.5% concordance (p=0.028). The odds of accurate preoperative grading were 1.7 times higher with endoscopy [OR=1.72; 95% CI (1.06-2.79)], and this difference remained significant after adjusting for age [F(1,357)=4.315, p=0.038]. These results highlight the superiority of flexible endoscopy as a diagnostic tool that allows direct visualization of the nasopharyngeal airway and more accurate assessment of adenoid size prior to surgery.

Our findings are consistent with several previous studies comparing these two modalities. Mlynarek et al. (8) and Pisutsiri et al. (9) reported stronger correlations between endoscopic and intraoperative measurements than between radiographic and intraoperative findings, emphasizing the advantage of dynamic visualization over static imaging. Similarly, Peedikakkal et al. (10) demonstrated that endoscopic grading not only aligns more closely with intraoperative assessment but also correlates better with clinical symptoms, underscoring its clinical relevance in the evaluation of adenoid hypertrophy.

Conversely, other studies, such as those by Caylakli et al. (11) and Lertsburapa et al. (12), have shown that lateral neck radiography remains useful in selected clinical settings, particularly when endoscopic evaluation is not feasible such as in very young or uncooperative children. The A/N ratio derived from radiographs can offer a reliable estimate of adenoid size in such cases, although radiography tends to overestimate smaller adenoids and underestimate larger ones.

Our findings support previous reports highlighting the limitations of lateral neck radiography in accurately assessing adenoid size. Several factors contribute to its tendency to overestimate adenoid hypertrophy. As a two-dimensional representation of a three-dimensional structure, radiographs can distort adenoid volume due to the irregular, lobulated ("cauliflower-like") shape of the tissue (13). Moreover, patient positioning and cooperation, particularly in younger children, may affect measurement accuracy and increase variability in the A/N ratio. Interpretation is also subjective, with interobserver differences among radiologists and potential artifacts from dental fillings or metallic objects that obscure the nasopharyngeal airway (10). Transient upper respiratory infections or delays between clinical assessment and imaging can further alter adenoid size and explain inconsistent results (14).

In contrast, our study showed that flexible nasopharyngoscopy provides a more direct and accurate assessment of adenoid size. This technique allows real-time visualization of the nasopharynx, dynamic evaluation of choanal obstruction, and detection of concurrent infections that may influence adenoid hypertrophy. It also permits assessment of adjacent nasal structures, such as the septum and turbinates, ensuring a more comprehensive airway evaluation. However, nasal endoscopy remains an invasive procedure that requires patient cooperation, which may be challenging in very young children (15).

Study Limitations

Several limitations were encountered when conducting this study. One is the retrospective design, where data collection was reliant on existing medical records. This study is also a single-center study, which may limit the generalizability of the findings. Moreover, both methods are operator-dependent techniques, which could affect the accuracy and reliability of the results. Variations in the nasopharyngeal space, in addition to soft palate elevation with catheters intraoperatively, may alter nasopharyngeal dimensions, potentially affecting measurement accuracy. Additionally, both endoscopic and X-ray evaluations are done with the patient upright compared to supine in the operating room. Flexible nasal endoscopy requires patient cooperation, which may be challenging in younger children. Finally, smaller nasal cavities with the presence of mucous may make endoscopic adenoid evaluation more difficult.

Conclusion

Flexible nasal endoscopy is more reliable than lateral neck radiography for the preoperative grading of adenoid hypertrophy in children. The accuracy of flexible nasal endoscopy, as evidenced by its higher concordance with intraoperative findings, suggests it should be preferred for assessing adenoid size preoperatively. Lateral neck radiography remains a valid alternative in patients who cannot tolerate the nasal endoscope.

Ethics

Ethics Committee Approval: This study was approved by the Institutional Review Board of the American University of Beirut (IRB ID: BIO-2020-0303, date: 25.11.2020) and adhered to the principles outlined in the Declaration of Helsinki.

Informed Consent: Due to the retrospective nature of the study, informed consent was not obtained from the participants' parents.

Footnotes

Authorship Contributions

Surgical and Medical Practices: R.B., Concept: A.G., R.B., Design: A.G., R.B., Data Collection and/or Processing: J.H., O.A.H., A.G., Analysis or Interpretation: J.H., Literature Search: J.H., O.A.H., A.M.D., J.G., N.Z., Writing: J.H., O.A.H., A.M.D., J.G., N.Z.

Conflict of Interest: The authors declare that they have no conflict of interest.

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Main Points

- Flexible nasal endoscopy is more reliable than lateral neck radiography in the preoperative grading of adenoid hypertrophy in children.
- Lateral neck radiography is more likely to overestimate adenoid size compared to flexible nasal endoscopy.
- The odds of having an accurate preoperative grading of adenoid hypertrophy were 1.7 times greater with nasal endoscopy than with lateral neck radiography.

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