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Original Research Article

Endoscopy versus Lateral X-Ray for Assessing Adenoid Hypertrophy in Children and Adolescents: A Prospective Comparative Study

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Conflict of interest: Nil

Abstract

Background: Adenoid hypertrophy is a frequent cause of nasal obstruction, mouth breathing, snoring, and otologic symptoms in children. Lateral nasopharyngeal radiography is commonly used, while nasal endoscopy allows direct visualization.

Objective: To compare grading and diagnostic performance of lateral nasopharyngeal X-ray with rigid nasal endoscopy for adenoid hypertrophy in children and adolescents.

Methods: This prospective observational comparative study included symptomatic patients aged 4–16 years attending a tertiary ENT center. Each participant underwent lateral nasopharyngeal X-ray (Fujioka adenoid–nasopharyngeal [A/N] ratio grading) and rigid nasal endoscopy (Clemens grading) within 48 hours. Agreement between modalities was assessed using weighted Cohen's kappa. Diagnostic accuracy of X-ray was calculated using endoscopy as the reference standard for clinically significant adenoid hypertrophy (grade ≥2).

Results: A total of 97 participants were analyzed (mean age 8.4 ± 3.1 years; 59.8% male). Nasal obstruction was present in all patients (100%), followed by mouth breathing (93.8%) and snoring (87.6%). Exact grade concordance between X-ray and endoscopy was 74.2%, with excellent agreement (weighted kappa = 0.812; $p < 0.001$). For clinically significant hypertrophy (grade ≥2), X-ray showed sensitivity 91.9%, specificity 82.6%, PPV 96.3%, NPV 67.9%, and overall accuracy 90.7%.

Conclusion: Lateral nasopharyngeal X-ray demonstrates high sensitivity and accuracy with excellent agreement compared with nasal endoscopy for clinically significant adenoid hypertrophy. Endoscopy remains preferable when detailed anatomical assessment is required, while X-ray is a useful alternative when endoscopy is unavailable or not feasible.

Keywords: adenoid hypertrophy; nasal endoscopy; lateral nasopharyngeal radiograph; diagnostic accuracy; paediatrics.

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Introduction

Adenoids are submucosal lymphoid tissue located at the junction of the nasopharyngeal roof and posterior wall and form part of Waldeyer's ring, contributing to immune defense in early childhood. [1] Adenoids enlarge in early childhood, peak around six years of age, and usually regress toward puberty, although persistence may occur. [1] Enlarged adenoids can obstruct the nasopharyngeal airway, leading to nasal obstruction, mouth breathing, snoring, rhinorrhea, and hyponasal speech. [2] Obstruction near the Eustachian tube orifice may impair middle-ear ventilation, causing ear symptoms, conductive hearing loss, and recurrent otitis media with or without effusion. [3] Long-standing obstruction may be associated with adenoid facies and dentofacial changes. [4] Diagnostic assessment includes clinical evaluation, lateral nasopharyngeal radiography, and nasal endoscopy. [5] Radiographs estimate adenoid size using the adenoid-to-nasopharyngeal (A/N) ratio but provide a two-dimensional assessment, whereas endoscopy provides direct visualization and allows dynamic grading of choanal obstruction. [5] Our study compares grading distribution, agreement, and diagnostic performance of lateral radiography against endoscopy in symptomatic children and

adolescents. Although nasal endoscopy is considered a direct method to assess choanal obstruction, it may be poorly tolerated in some children and is not universally available in all settings. Our study therefore evaluates whether lateral nasopharyngeal radiography can reliably grade clinically significant adenoid hypertrophy when compared with endoscopy.

Aim: To compare grading and diagnostic performance of lateral nasopharyngeal X-ray versus rigid nasal endoscopy for adenoid hypertrophy in symptomatic children and adolescents.

Materials and Methods

This prospective observational comparative study was conducted in the Department of Otorhinolaryngology, Krishna Mohan Medical College & Hospital, and Mathura, India. Consecutive symptomatic patients aged 4–16 years presenting with nasal obstruction, mouth breathing, snoring, hyponasal speech, or recurrent otitis media were screened. Written informed consent was obtained from parents/guardians and assent was obtained where applicable. Patients were excluded if they had a history of adenoidectomy, congenital nasal anomalies or craniofacial syndromes, acute upper respiratory tract infection at the time of assessment, or inability/unfitness to undergo endoscopy. Of 100 eligible patients, 97 completed both assessments within 48 hours and were included in the analysis.

Lateral Nasopharyngeal Radiograph: Standard lateral nasopharyngeal soft-tissue radiographs were obtained with slight neck extension. Adenoid size was graded using the Fujioka A/N ratio as: Grade 0 (<0.25), Grade 1 (0.25–0.50), Grade 2 (0.50–0.75), Grade 3 (0.75–1.00), and Grade 4 (>1.00). Radiographs were interpreted by an ENT specialist using the A/N ratio method described by Fujioka.

Nasal Endoscopy: Rigid nasal endoscopy was performed using a 0° rigid endoscope (2.7 mm for younger children and 4.0 mm for older children) with standard light source and camera system, in the outpatient setting after topical decongestant and local anesthetic spray.Adenoid hypertrophy was graded using the Clemens criteria based on percentage choanal obstruction: Grade 0 (0–25%), Grade 1 (26–50%), Grade 2 (51–75%), Grade 3 (76–100%), and Grade 4 (near-total to total obstruction).

Outcome Measures: Primary outcomes were grade distribution by each modality, exact concordance, and agreement using weighted Cohen's kappa. Diagnostic performance of X-ray was calculated using endoscopy as the reference standard for clinically significant adenoid hypertrophy (grade ≥2).

Statistical Analysis: Categorical variables were expressed as n (%) and compared using chi-square test. Agreement was assessed using weighted Cohen's kappa. Clinically significant hypertrophy (grade ≥2) was compared using McNemar's test. One-way ANOVA was used to compare mean A/N ratio and mean endoscopic obstruction across endoscopic grades. A p-value <0.05 was considered statistically significant, and 95% confidence intervals were calculated for diagnostic parameters.

Ethics: Institutional ethics committee approval was obtained. The study was conducted in accordance with GCP guidelines.

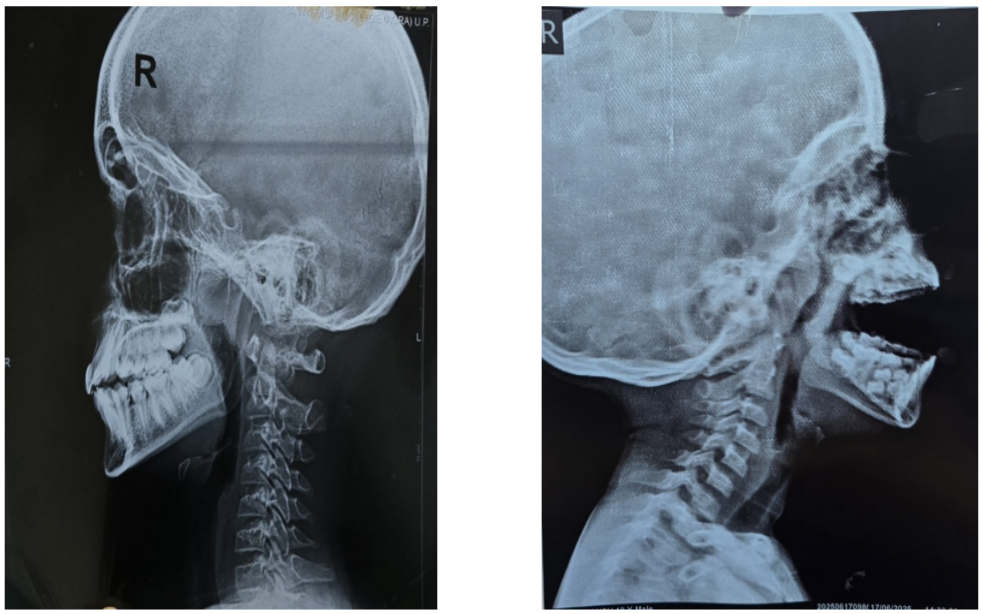

Figure 1: Lateral nasopharyngeal soft-tissue radiograph demonstrating adenoid hypertrophy

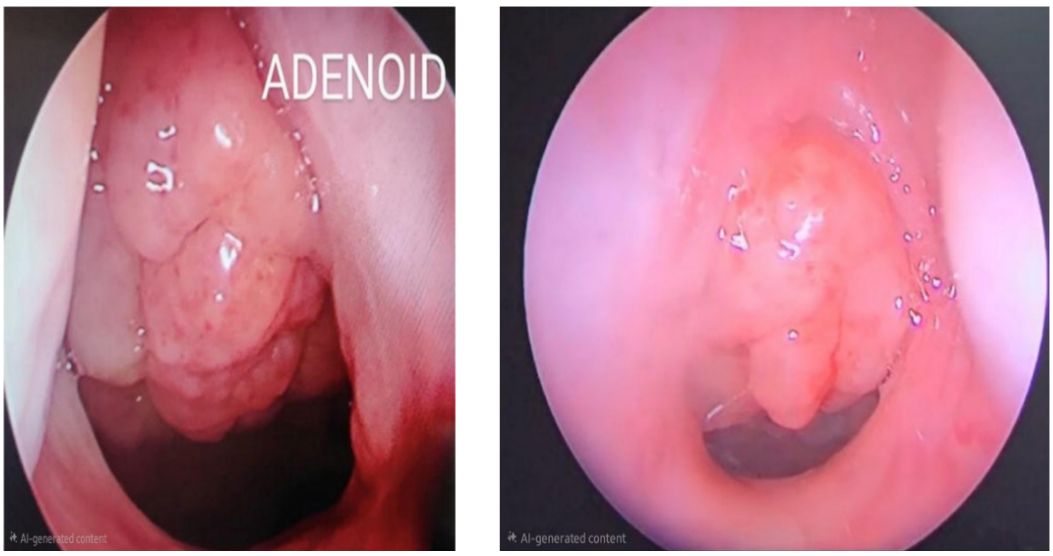

Figure 2: Rigid nasal endoscopy image demonstrating choanal obstruction due to adenoid hypertrophy

Results

Table 1: Baseline demographic and clinical characteristics (n=97)

Variable	Value
Age (years), Mean ± SD	8.4 ± 3.1
Age range (years)	4–16
Sex, n (%)	Male 58 (59.8%); Female 39 (40.2%)
Nasal obstruction, n (%)	97 (100.0%)
Mouth breathing, n (%)	91 (93.8%)
Snoring, n (%)	85 (87.6%)
Recurrent ear infections, n (%)	32 (33.0%)
Hyponasal speech, n (%)	45 (46.4%)

Representative images are shown in Figures 1 and 2. In total, 97 participants were included (mean age 8.4 ± 3.1 years; range 4–16 years), with male predominance (59.8%). Nasal obstruction was present in all participants (100%), followed by mouth breathing (93.8%) and snoring (87.6%). Recurrent ear infections and hyponasal speech were reported in 33.0% and 46.4%, respectively.

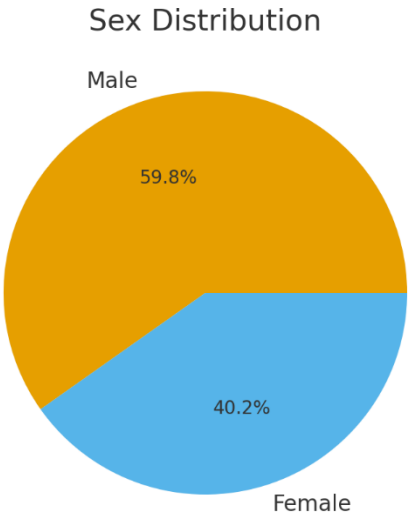

Figure 3: Sex distribution

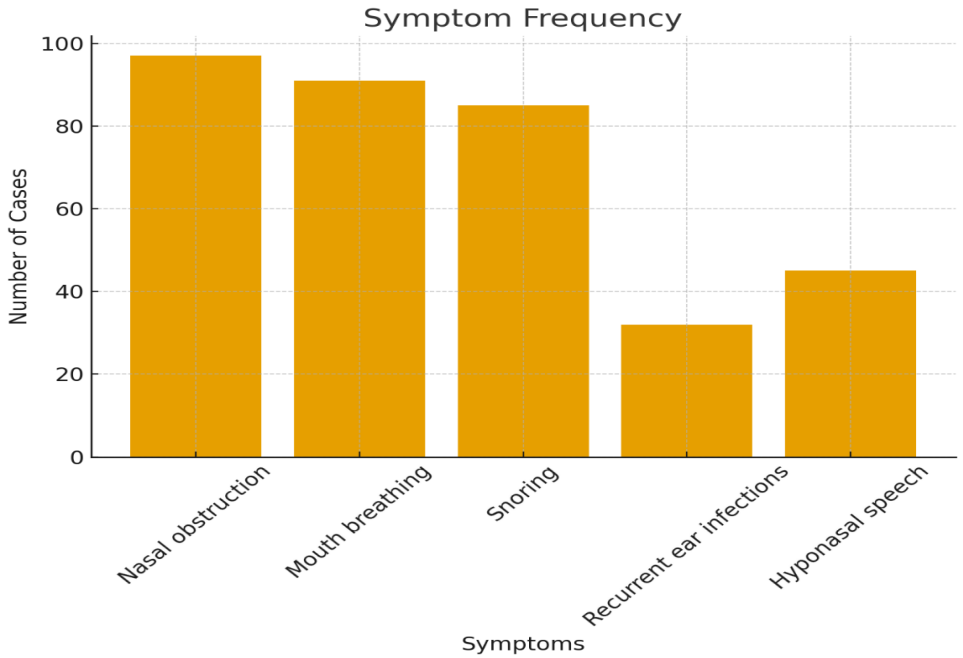

Figure 4: Symptom Frequency

Table 2: Distribution of adenoid hypertrophy grades by modality

Grade	Endoscopy n (%)	X-ray n (%)
0	5 (5.2)	6 (6.2)
1	18 (18.6)	21 (21.6)
2	35 (36.1)	38 (39.2)
3	31 (32.0)	27 (27.8)
4	8 (8.2)	5 (5.2)

Overall comparison of grade distribution between modalities (chi-square test): p = 0.842. Grade 2 was the most frequent grade on both endoscopy (36.1%) and X-ray (39.2%), followed by Grade 3. Overall grade distribution between the two modalities did not differ significantly (chi-square p = 0.842).

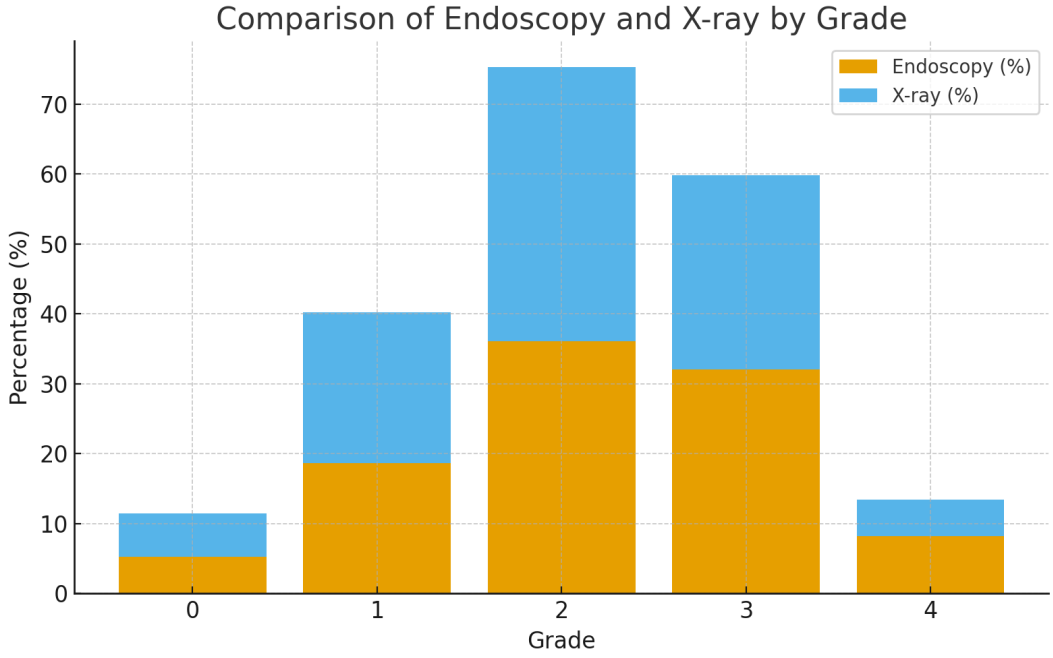

Figure 5: Agreement between X-ray and endoscopy grades

Table 3A: Concordance matrix

X-ray \ Endoscopy	G0	G1	G2	G3	G4
G0	4	2	0	0	0
G1	1	15	4	1	0
G2	0	1	28	8	1
G3	0	0	3	21	3
G4	0	0	0	1	4

Table 3B: Agreement summary

Agreement metric	Value
Exact concordance, n/N (%)	72/97 (74.2%)
Weighted Cohen's kappa	0.812 ($p < 0.001$)

Exact grade concordance between X-ray and endoscopy was 74.2% (72/97). Agreement between modalities was excellent (weighted Cohen's kappa = 0.812; $p < 0.001$).

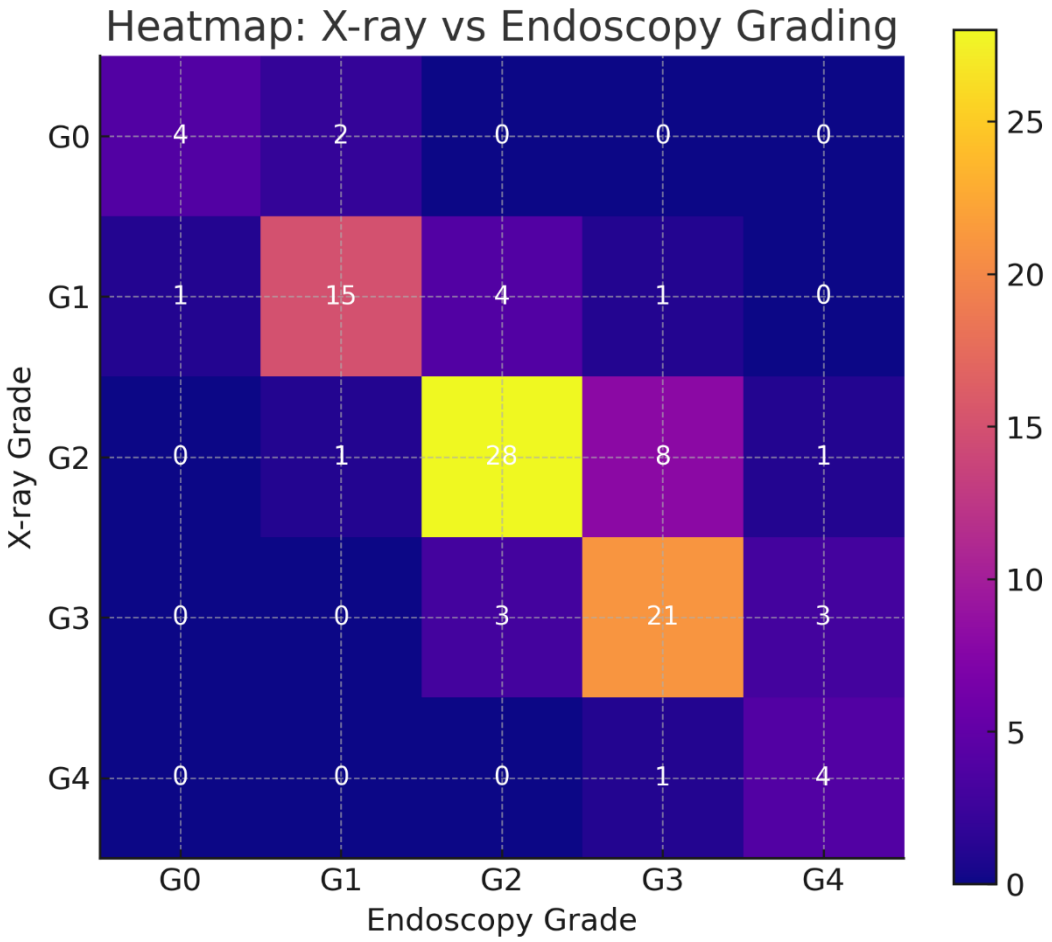

Figure 6: X ray vs Endoscopy Grading

Table 4: Diagnostic performance of lateral X-ray (reference: endoscopy; clinically significant = Grade ≥2)

Metric	Estimate	95% CI
Sensitivity	91.9%	84.7–96.1%
Specificity	82.6%	62.9–93.0%
Positive Predictive Value (PPV)	96.3%	90.5–98.5%
Negative Predictive Value (NPV)	67.9%	50.7–81.2%
Overall accuracy	90.7%	83.2–95.2%
McNemar's test p-value	0.727	—

Using endoscopy as the reference standard for clinically significant hypertrophy (grade ≥2), lateral X-ray demonstrated sensitivity of 91.9% and specificity of 82.6%. PPV was 96.3% and NPV was 67.9%, with an overall accuracy of 90.7%. McNemar's test showed no significant difference in paired classification (p = 0.727).

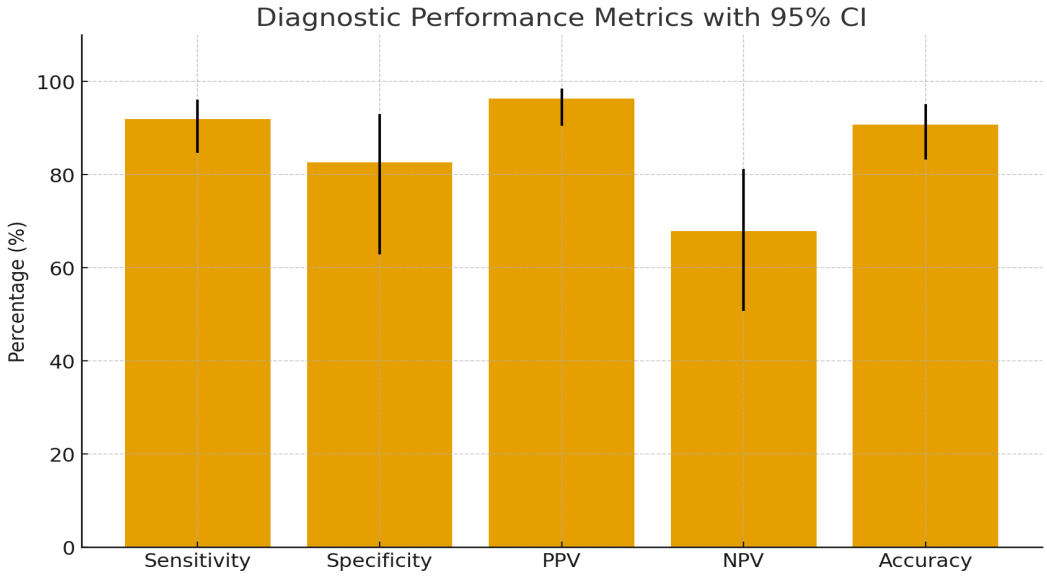

Figure 7: Diagnostic performance matrics

Table 5: Quantitative correlation across endoscopic grades

Endoscopic Grade	n	Mean A/N (X-ray) ± SD	Mean choanal obstruction (Endoscopy) ± SD
0	5	0.21 ± 0.04	18.4% ± 5.1%
1	18	0.41 ± 0.07	38.2% ± 6.9%
2	35	0.63 ± 0.05	64.8% ± 7.1%
3	31	0.82 ± 0.04	87.5% ± 5.8%
4	8	0.94 ± 0.03	98.1% ± 1.8%

One-way ANOVA showed significant differences across endoscopic grades for mean A/N ratio and mean choanal obstruction (p < 0.001 for both). Mean A/N ratio on X-ray and mean percentage choanal obstruction on endoscopy increased progressively with higher endoscopic grades, with statistically significant differences across grades (ANOVA p < 0.001 for both).

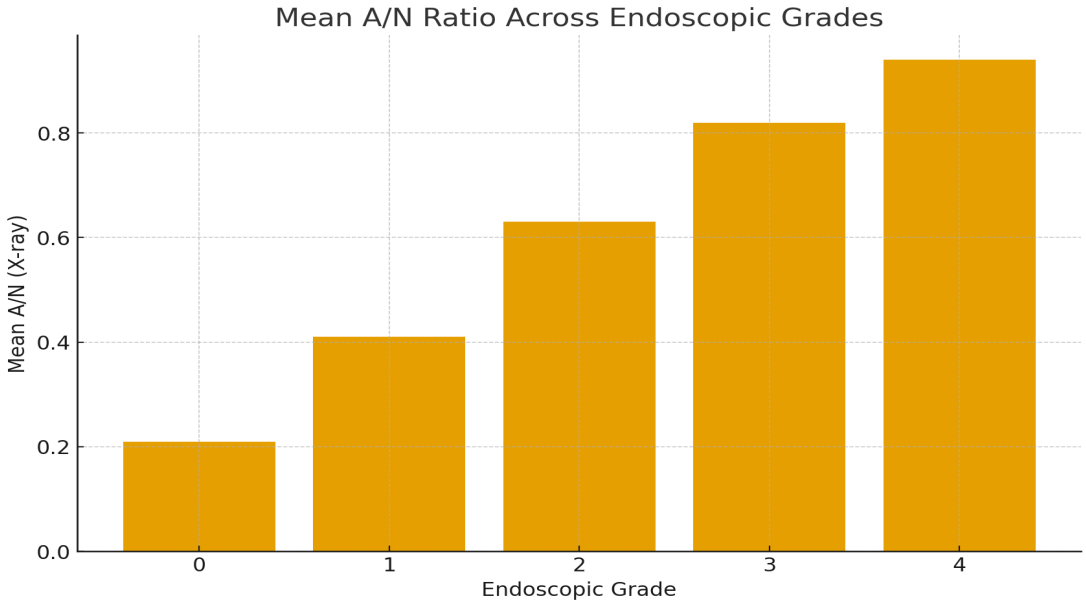

Figure 8: Mean A/N Ratio across Endoscopic Grades

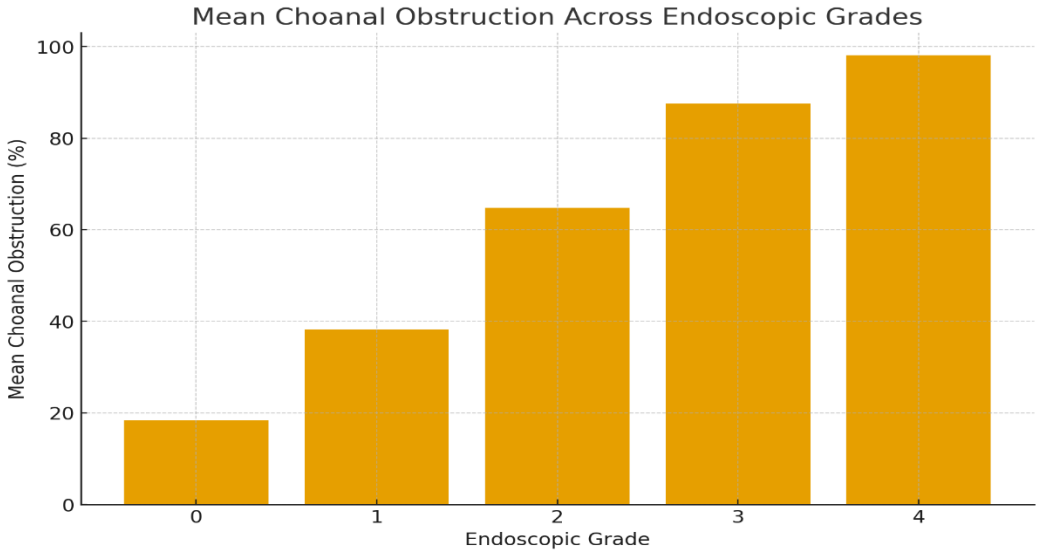

Figure 9: Mean Choanal Obstruction across Endoscopic Grades

Discussion

In this study, symptomatic children showed a high burden of nasal obstruction, mouth breathing, and snoring, consistent with the clinical profile typically associated with adenoid hypertrophy. [3,6] Grade distribution was comparable between X-ray and endoscopy, suggesting that radiographic grading broadly parallels endoscopic severity in routine clinical settings. [5-7]

Agreement between modalities was excellent (weighted kappa 0.812), supporting the reliability of lateral radiography as a screening tool when performed with standardized technique. [5,7,8]

Using endoscopy as the reference standard for clinically significant hypertrophy (grade ≥2), lateral X-ray demonstrated high sensitivity and overall accuracy. However, the lower NPV indicates that a "negative" or low-grade X-ray does not reliably exclude significant obstruction in all symptomatic patients; therefore, endoscopy remains important when clinical suspicion is strong or when surgical planning is required. [9-12]

A key strength of this study is the prospective design with both tests performed within 48 hours and use of established grading systems. Limitations include the single-center design and modest sample size. Endoscopy was used as the reference standard rather than intraoperative assessment for all cases, and inter-observer variability was not evaluated. Future multicenter studies with inter-observer reliability assessment and intraoperative correlation may further strengthen the evidence.

Clinically, these findings support the use of lateral X-ray as a practical screening tool for significant adenoid hypertrophy in settings where endoscopy is unavailable or poorly tolerated. However, endoscopy remains important in children with discordant symptoms, suspected additional nasal pathology, or when surgical planning is required.

Conclusion

Lateral nasopharyngeal X-ray demonstrates excellent agreement with rigid nasal endoscopy and shows high sensitivity and accuracy for clinically significant adenoid hypertrophy (grade ≥2) in symptomatic children and adolescents. While endoscopy remains the preferred method for detailed anatomical assessment and operative decision-making, lateral X-ray remains a practical and accessible first-line tool when endoscopy is not available or not feasible.

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