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Is Lateral Neck Radiography a reliable tool in the Diagnostic Evaluation of Adenoid Hypertrophy?

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ABSTRACT

Adenoid hypertrophy is one of the most prevalent pediatric conditions. This review aims to evaluate the diagnostic utility of lateral neck radiography in identifying and assessing adenoidal hypertrophy in children, and to compare its effectiveness with that of other diagnostic modalities. We searched systematic reviews and meta-analyses for the highest level of evidence synthesis to summarize diagnostic accuracy, reproducibility, and limitations of radiography in both general and specialized clinical settings. The review also describes how radiography is used to support early clinical decision-making and guide best practices in resource-limited settings. By collecting current evidence, this review presents a comprehensive overview of the role of lateral neck radiography in the diagnostic pathway for pediatric adenoidal hypertrophy.

Keywords: Lateral Neck Radiography, Adenoid Hypertrophy, Adenoid-nasopharynx (A/N) ratio, Obstructive Sleep Apnea Syndrome (OSAS)

1. INTRODUCTION

Adenoidal hypertrophy (AH) is a frequent problem in the pediatric population and has serious consequences for children's health. It may lower respiratory efficiency, negatively affect sleep, and disturb overall growth and development (Hunter et al., 2016). Hypertrophy of adenoidal tissue may cause chronic nasal obstruction, mouth breathing, and snoring. In more severe manifestations, chronic AH may contribute to the development of obstructive sleep apnea syndrome (OSAS), which is associated with behavioral problems (Ali et al., 1993), craniofacial deformities, and structural abnormalities of the tongue or palate (Lan et al., 2023), chronic rhinosinusitis and problems with correct word articulations (Niedzielski et al., 2023). AH is the most common cause of OSAS in preschool children, with adenoidectomy being the treatment of choice (Marcus et al., 2012). Early diagnosis and treatment are thus fundamental to minimizing developmental, functional, and psychological morbidity and improving overall quality of life in affected children (Baldassari et al., 2008).

In practice, pediatricians and primary care physicians are most often the first to evaluate children for AH. Clinicians typically base diagnostic decisions on their clinical judgement and selected investigations. Although many diagnostic

modalities are available, including flexible nasopharyngoscopy, radiography, and advanced imaging techniques such as MRI, many are challenging to implement in everyday pediatric settings. Flexible nasoendoscopy remains the gold standard for direct visualization. Still, its use is limited by factors such as the need for specialized equipment, training, higher costs, and restricted cooperation in younger children (Lertsburapa et al., 2010; Moideen et al., 2019; Pagella et al., 2011). Similarly, cross-sectional imaging is rarely feasible due to radiation exposure, expense, and reduced availability outside specialized centres.

Given these challenges, lateral neck radiography remains a cost-effective and widely available alternative, suited for pediatric patients. Compared with the endoscopic technique, it requires less operator expertise. These features provide distinct practical benefits that help to support early clinical decision making and guide subsequent referral practice. However, radiography also has considerable limitations, including reduced accuracy in moderate to severe hypertrophy and limited views of airway dynamics. It should be noted that lateral neck radiography does not replace endoscopic assessment, but it is considered a useful tool in primary care and resource-limited settings (Ishman et al., 2023).

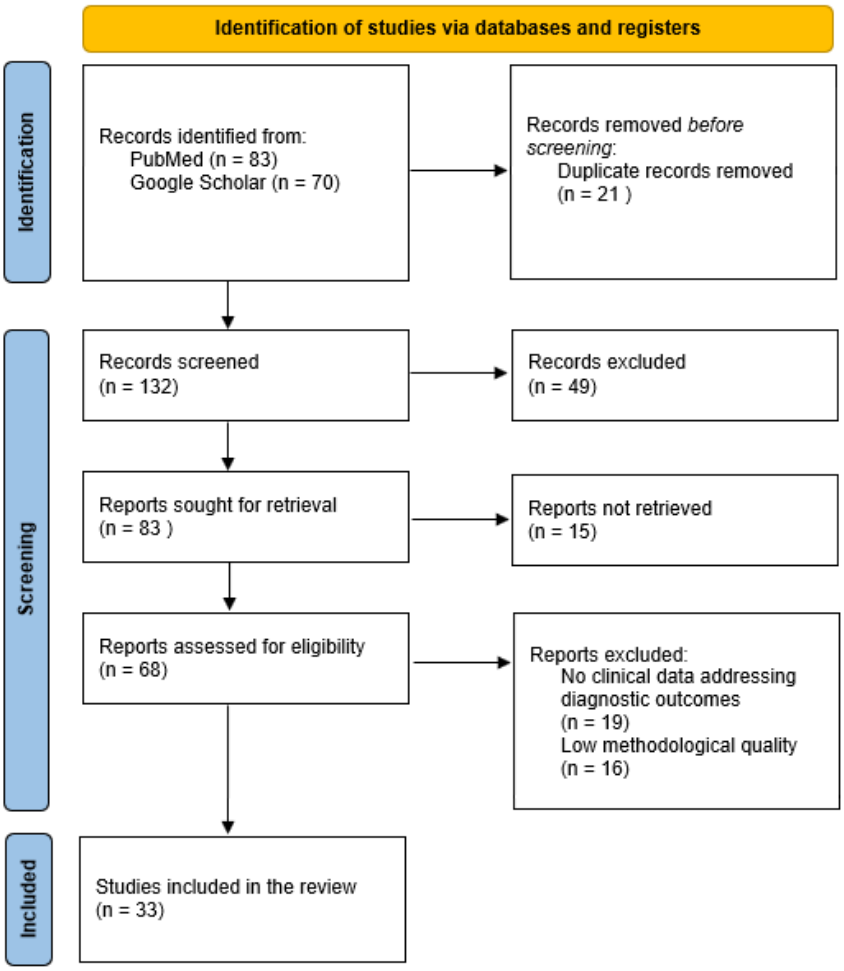

Figure 1. PRISMA flowchart

2. REVIEW METHODS

We conducted this review between March and July 2025. We performed a systematic search in PubMed and Google Scholar using terms “adenoid hypertrophy”, “enlarged adenoid”, “lateral neck radiograph”, with the phrases “pediatric” or “children”. We limited the search to studies involving the pediatric population (0-18 years) published between January 2000 and July 2025, but also included some historical publications that we considered helpful in understanding the topic. We selected systematic reviews, meta-analyses, prospective and retrospective studies written in English that reported on diagnostic accuracy, reproducibility, or clinical utility of lateral neck radiography. We excluded case reports, abstracts, and studies that did not address diagnostic outcomes. We initially

assessed 68 articles; we excluded 35 that did not meet our criteria, while the remaining 33 were considered relevant and useful (Figure 1).

3. RESULTS & DISCUSSION

Anatomy and physiology of the Adenoid

The adenoid, or pharyngeal tonsil, consists of a collection of lymphoid tissue located in the posterior part of the nasopharynx. It is part of Waldeyer's ring – a collection of mucosa-associated lymphoid tissue (MALT), that also includes the palatine tonsils, tubal tonsils, and lingual tonsils – and plays a role in mucosal immune defense in the upper respiratory tract (Fossum et al., 2017). Ciliated pseudostratified columnar epithelium covers the adenoidal surface, which also contains numerous crypts that enlarge the mucosal surface area for antigen exposure. The adenoids have local immune function as they can obtain airborne pathogens and initiate local immune responses. They serve an important function in the development of immunological memory and help shape adaptive immunity in early life (Niedzielski et al., 2023). Evidence from several studies has confirmed that adenoids are largest at the age of 4-8 years, then slowly regress with advancing age, and may regress completely by adulthood (Fujioka et al., 1979). Understanding the structure, growth dynamics, and immunological function of the adenoid is essential for interpreting both clinical signs and radiological findings in pediatric patients. It also provides the basis for the appropriate selection of diagnostic tools and therapeutic interventions in cases of suspected adenoidal pathology.

Clinical Presentation and Indications for Diagnostic

Clinicians commonly look for symptoms that may suggest adenoid hypertrophy, such as mouth breathing and rhinorrhea. A patient's history of chronic or recurrent sinusitis, as well as frequent middle ear inflammation, should also prompt clinicians to consider AH (Marcus et al., 2012). Due to the anatomic location of the adenoids near the Eustachian tube orifices, hypertrophy can also cause hearing problems, which can result in transient hearing loss and delayed speech development (Niedzielski et al., 2023). In most severe cases, adenoidal enlargement leads to upper airway obstruction and is one of the causes of pediatric obstructive sleep apnea syndrome (OSAS). The diagnosis of OSAS in children can be complex due to the subtlety of its presentation and age-specific differences from those in adults (Marcus et al., 2012). Unlike adults, children with OSAS do not typically report excessive daytime sleepiness; instead, they often present with comparatively normal levels of daytime activity. The symptoms that most often prompt parents of children under five years old to seek pediatric assessment, other than those involving the respiratory system, include behavioral disturbances, which tend to present as irritability or emotional lability. More traditional complaints, which are easier to associate with adenoid hypertrophy, such as fragmented sleep, night sweats, and unusual sleeping postures (e.g., hyperextension of the neck), are more typical for older children. Long-term consequences include poor physical growth, neurocognitive impairment, and delayed development of the psychomotor functions (Hunter et al., 2016; Marin et al., 2005).

Some pediatric populations demonstrate an increased risk for adenoidal hypertrophy and its complications. Children with Down syndrome, in particular, are extremely prone to nasopharyngeal obstruction due to the outcome of midfacial hypoplasia, macroglossia, and generalized hypotonia and frequently require early surgical intervention (Marcus et al., 2012). Additional high-risk groups include children who are obese, have allergic rhinitis, or have neuromuscular disorders like cerebral palsy. They are highly predisposed to upper airway obstruction and usually require more frequent assessment (Niedzielski et al., 2023; Sharifkashani et al., 2015). Persistent or severe clinical symptoms, especially in children from high-risk groups, require further diagnostic evaluation, typically initiated with either lateral neck radiography or flexible nasoendoscopy, depending on the availability and patient cooperation.

Lateral neck radiography - Technique and interpretation

The most popularly applied radiographic measurement method is the Adenoid/Nasopharynx ratio (A/N ratio), first introduced by Fujioka et al., (1979). This method calculates the ratio between the most significant thickness of the adenoid shadow (A) and the distance extending from the posterior edge of the soft palate to the anterior-inferior edge of the basiocciput (N). Clinically significant adenoid enlargement is generally recognized as correlating with an A/N ratio threshold of 0.65 to 0.67 and shows a high correlation with endoscopic and intraoperative findings. The A/N ratio is reliable in children aged 6-12 years; in younger children, physicians should be cautious due to lower correlation with endoscopic grading (Caylakli et al., 2009; Fujioka et al., 1979; Soldatova et al., 2020)

Clinical Utility and Limitations of Lateral Neck Radiography

Lateral Neck Radiography is one of the most commonly used non-invasive imaging methods for evaluating adenoidal hypertrophy in children. The main advantages highlighted in the studies are wide availability, low cost, and good tolerability among young patients. It has been demonstrated to have excellent inter- and intra-observer agreement, particularly when employing standardized approaches, such as those pioneered by Fujioka (Moideen et al., 2019). The A/N ratio has been found to correlate significantly with endoscopic assessment ($r = 0.33–0.64$, $p < 0.05$) and can therefore be a reliable method for evaluation in settings where endoscopy is not available (Adedeji et al., 2016; Caylakli et al., 2009; Moideen et al., 2019).

Correlations between radiographic A/N ratios and clinical symptom severity are strongest for symptoms related to sleep-disordered breathing, such as snoring and mouth breathing (Adedeji et al., 2016; Kondekar et al., 2020). The severity of clinical symptoms does not always match radiographic findings, which highlights the importance of integrating radiological findings with clinical symptoms when evaluating adenoid hypertrophy (Orji & Ezeanolue, 2008; Zwierz et al., 2022).

To improve diagnostic accuracy and aid the decision-making process, researchers should develop standardized clinical scoring tools in the future. This type of multi-modality assessment, prepared to be used by primary care physicians and pediatricians in combination with radiological evaluations, may provide a systematic and objective basis for evaluating the need for further referral or intervention, especially in settings where endoscopy is not feasible (Kondekar et al., 2020; Moideen et al., 2019).

Evidence from meta-analyses and systematic reviews shows that lateral neck radiography has moderate sensitivity and specificity for detecting mild adenoid hypertrophy (sensitivity ~0.75, specificity ~0.89). However, the accuracy of diagnosis decreases with cases of moderate to severe hypertrophy (Alqutub et al., 2025; Ishman et al., 2023). Being a static imaging modality that works along a two-dimensional axis, it presents limited anatomical information. Importantly, it only visualizes the adenoid without assessing the palatine tonsils. Cumulative evidence from various investigations reveals that radiographs can both underestimate and overestimate the degree of hypertrophy, regardless of the severity of the patient's symptoms. Additionally, the accuracy of the radiographic assessment may vary depending on the patient's head positioning and respiratory phase during the assessment (Peedikakkal et al., 2023). Although radiation exposure during imaging is low, it remains a concern primarily for patients who are expected to undergo repeated imaging sessions.

Despite all the mentioned limitations, lateral neck radiography combined with A/N ratio measurement remains a reliable, practical, and reproducible method for evaluating adenoidal hypertrophy in children. Radiography is generally accepted by caregivers and causes less distress in children during examination. Such qualities make it an optimal first-line diagnostic tool in settings where nasal endoscopy is not accessible (Adedeji et al., 2016; Kondekar et al., 2020; Moideen et al., 2019; Peedikakkal et al., 2023).

Artificial Intelligence and the Evolving Role of Lateral Neck Radiography

With the development of artificial intelligence (AI), researchers have attempted to improve the use of lateral radiography as a diagnostic tool for AH. Properly trained deep learning algorithms may have the potential to identify and classify AH on standard lateral radiographs accurately (Wu et al., 2025). These types of models can enhance inter-observer agreement, increase reproducibility, and aid clinicians in making an early diagnosis. Automated image analysis tools could also aid triage decisions in overburdened environments, offering an objective and scalable method for initial screening (Guo et al., 2024). Combining AI-assisted radiographic evaluation with clinical symptom scoring tools might be a practical and reproducible approach for guiding referrals and reducing diagnostic delay.

Other diagnostic modalities for adenoid hypertrophy

Flexible nasal endoscopy (also known as rhino-nasopharyngoscopy - RNE) is still a priceless instrument in the diagnostic assessment of adenoidal hypertrophy. Its main advantage is three-dimensional, direct, and dynamic visualization of the nasopharynx. It is the gold standard because of its superior correlation with clinical symptoms presented by patients compared to radiographic methods (Peedikakkal et al., 2023; Zwierz et al., 2022) and more accurate assessment of the adenoid size (Kindermann et al., 2008; Peedikakkal et al., 2023; Yilmaz et al., 2008). RNE also allows assessment of surrounding anatomical structures, such as the choanae and Eustachian tube orifices, as well as the degree of airway obstruction (Kindermann et al., 2008). Researchers have developed several endoscopic grading systems, with the Adenoid-to-Choana ratio (A/C ratio) being one of the most widely used. This method estimates the percentage of choanal obstruction caused by adenoid mass (Varghese et al., 2016; Zwierz et al., 2022). However, most grading systems

are based almost exclusively on subjective measures, which may reduce inter-observer reproducibility when assessing borderline cases (Caylakli et al., 2009).

Flexible endoscopy is an accurate method of evaluation, but it has some practical limitations to consider. Patient acceptability is another vital consideration. Endoscopy is not always well tolerated in younger children and may provoke anxiety in patients or caregivers (Narang et al., 2022). The procedure is invasive; many children, especially younger ones or those with disabilities, may not tolerate it well or cooperate, which can make the assessment impossible. Nasal endoscopy is not yet routinely available in primary care; it is also more expensive, which limits its feasibility as a universal first-line diagnostic tool (Adedeji et al., 2016). Clinicians should consider using endoscopy in complex or surgical cases, or when dynamic assessment is an essential part of the diagnostic evaluation. Pediatricians may consider nasopharyngoscopy when the clinical picture is unclear or further assessment is needed (Moideen et al., 2019).

Over the years, clinicians have started to explore ultrasonography as an alternative approach to assessing AH in children. As a non-invasive and radiation-free modality, it has the potential to become a standard diagnostic method. Transcervical ultrasonographic evaluation showed a statistically significant correlation with the A/N ratio obtained from the lateral radiograph. Ultrasound might serve as a valid alternative to radiographic assessment, especially in younger patients or in cases where repeated imaging is required (Kaur et al., 2025; Wang et al., 2020).

Advanced methods, such as CT or MRI, are reserved for strictly defined cases. MRI offers higher accuracy in volumetric assessment, but it requires specialized equipment, patient cooperation, and often sedation, which limits its usage in general pediatric care. These modalities are not used for routine pediatric screening due to higher radiation exposure, as well as greater cost and limited availability (Pirilä-Parkkinen et al., 2011).

To summarize, flexible nasal endoscopy is the gold standard for assessing AH; however, no single diagnostic tool is fully sufficient in all cases. It is essential to select the most suitable method based on availability and patient needs; a comparative overview is provided in Table 1.

Table 1: Comparison of diagnostic modalities for adenoid hypertrophy in children

Method	Advantages	Limitations	Clinical applications
Lateral neck radiography	Inexpensive, widely available, well tolerated by children, standardized A/N ratio measurement	Limited accuracy in moderate and severe hypertrophy, static 2D image, radiation exposure	First-line evaluation in primary care, useful in resource-limited settings
Flexible nasoendoscopy (RNE)	Gold standard, direct and dynamic 3D visualization, assessment of choanae and Eustachian tube orifices	Requires advanced equipment and trained specialists, higher cost, poor tolerance in younger children	Specialist evaluation, surgical qualification, complex cases
Ultrasonography	Radiation-free, non-invasive, correlates with A/N ratio, suitable for repeated use	Still limited availability, operator-dependent, less standardized	Alternative to radiography, follow-up in children requiring repeated assessment
CT/MRI	Provides detailed anatomical information, accurate volumetric assessment (MRI)	High cost, radiation exposure, need for sedation or cooperation, limited availability	Reserved for atypical presentations, preoperative planning selected cases

Preoperative Assessment and Postoperative Follow-up

Primary care physicians and pediatricians are often the first to evaluate children presenting with persistent upper airway symptoms, making them key figures in the initial evaluation of suspected adenoidal hypertrophy (Moideen et al., 2019). Although clinicians should not regard lateral neck radiography as an independent criterion for recommending adenoidectomy, it may help in deciding

whether further diagnostic evaluation is necessary, especially when clinical symptoms are unclear or endoscopy is not an option (Caylakli et al., 2009). The A/N ratio correlates with endoscopic findings and can identify clinically significant hypertrophy. An obstruction that involves approximately 65% of the airway is considered a moderate to severe obstruction that requires other, more advanced diagnostics and decision-making (Lertsburapa et al., 2010; Soldatova et al., 2020).

Regrowth of the adenoid is a known risk following adenoidectomy, particularly if there is recurrence of the clinical symptoms, especially in younger patients who have higher rates of revision surgery. Lateral neck radiography remains an accessible and practical option for detecting residual or recurrent hypertrophy (Duval et al., 2013; Senthilvel et al., 2023). In high-risk groups, such as children with Down syndrome, craniofacial anomalies, or suspected OSAS, more advanced diagnostic tests such as nasal endoscopy or polysomnography (PSG) may be necessary. These modalities offer more detailed anatomical and functional information, which can support preoperative planning and guide long-term management strategies (Marcus et al., 2012; Peedikakkal et al., 2023).

Lateral neck radiography is a practical tool and can be used in the preoperative evaluation of adenoidal hypertrophy. Its role, however, is supportive rather than definitive, as hypertrophy in lateral neck radiography is not a criterion for adenoidectomy. In situations where endoscopic evaluation is not accessible or the patient does not consent to it, the physician may opt for lateral neck radiography instead (Alqutub et al., 2025; Ishman et al., 2023; Lertsburapa et al., 2010; Senthilvel et al., 2023; Soldatova et al., 2020)

We attempted to assess the current diagnostic approach to AH using radiography in this review. Lateral neck radiography remains a first-line and affordable resource for initial adenoid hypertrophy in the pediatric population, especially in primary and resource-limited settings. Meta-analyses show moderate sensitivity and specificity for mild adenoid hypertrophy, diagnostic performance declines in moderate and severe cases, with increased risk of both false positives and negative results. The A/N ratio provides a standardized and reproducible metric, and a threshold of approximately 65% airway obstruction is clinically relevant for identifying significant hypertrophy. Radiographic findings should always be interpreted alongside clinical assessment and, when feasible, confirmed by flexible nasopharyngoscopy, which remains the diagnostic gold standard.

4. CONCLUSION

Lateral neck radiography is particularly useful when endoscopy is not available, as it can help direct surgical decision-making and postoperative follow-up care, especially in high-risk groups or symptomatic children. Recent advances in artificial intelligence and automated image analysis may help improve the speed, efficiency, and reproducibility of radiographic assessments. Lateral neck radiography remains an important adjunct in diagnosis; it should not replace endoscopic evaluation in cases where precise anatomical and functional assessment is required.

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Author contributions

Justyna Wróblewska contributed to the study conception and design, coordinated the writing process and finalized the manuscript.

Natalia Skrzypska performed the literature search, selected and analyzed relevant publications and drafted the introduction.

Hubert Ziembicki contributed to the interpretation and synthesis of the reviewed evidence, refined the discussion section and critically revised the manuscript.

Paulina Wasilewska assisted in organizing the structure of the paper, contributed to the conclusion section and reviewed the final draft for consistency.

Olga Wojtczak supported the referencing process, verified adherence to submission guidelines and carried out technical editing of the manuscript.

Kacper Zagaja provided critical feedback throughout the writing process, helped ensure clarity and coherence and reviewed the manuscript for accuracy and completeness.

Informed consent

Not applicable.

Ethical approval
Not applicable.

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Conflict of interest
The authors declare that there is no conflict of interest.

Data and materials availability
All data associated with this study will be available upon the request to corresponding author.

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