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Original Research Article

Frequency of Velopharyngeal Insufficiency in Patients After Adenoidectomy, Tonsillectomy, and Adenotonsillectomy

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Abstract: *Velopharyngeal insufficiency (VPI) is an uncommon but clinically relevant complication following adenoidectomy, tonsillectomy, and adenotonsillectomy. It may result in hypernasality, nasal air escape, and impaired speech, thereby affecting postoperative recovery and quality of life. Despite the high frequency of adenotonsillar surgeries in children, local data regarding postoperative VPI in Pakistan remain limited.* ***Objective:*** *To determine the frequency of velopharyngeal insufficiency in paediatric patients after adenoidectomy, tonsillectomy, and adenotonsillectomy, and to assess its association with selected demographic and clinical factors.* ***Methods:*** *This descriptive case series was conducted in the Department of ENT Teaching Hospital, Gujranwala, from September 2024 to March 2025. A total of 92 children aged 5 to 16 years undergoing adenoidectomy, tonsillectomy, or adenotonsillectomy were enrolled through non-probability consecutive sampling. Patients with previous adenotonsillar surgery, cleft palate, congenital craniofacial anomalies, or pre-existing speech and language problems were excluded. All procedures were performed under general anaesthesia by the same consultant ENT surgeon. Patients were followed three weeks postoperatively, and VPI was assessed using nasometry and nasoendoscopy. Data were analysed using SPSS version 25. Quantitative variables were expressed as mean ± SD, while qualitative variables were reported as frequencies and percentages. Stratified analysis was performed using the chi-square test, with $p<0.05$ considered statistically significant.* ***Results:*** *The mean age of the participants was 9.84 ± 3.12 years. There were 54 (58.7%) males and 38 (41.3%) females. The mean body mass index was 18.21 ± 2.64 kg/m², and the mean duration of symptoms was 8.73 ± 3.91 months. Adenotonsillectomy was the most frequently performed procedure in 39 (42.4%) patients, followed by tonsillectomy in 31 (33.7%) and adenoidectomy in 22 (23.9%). At three weeks after surgery, VPI was identified in 8 (8.7%) patients. A comparatively higher frequency of VPI was observed among children aged 5-10 years, those with BMI <18 kg/m², those with symptom duration ≥9 months, and those undergoing adenotonsillectomy. The highest proportion of VPI was seen after adenotonsillectomy, where 6 (15.4%) patients developed postoperative VPI. However, no statistically significant association was found between VPI and age, gender, BMI, duration of symptoms, or type of surgical procedure ($p>0.05$).* ***Conclusion:*** *Velopharyngeal insufficiency was observed in 8.7% of paediatric patients three weeks after adenotonsillar surgery in this tertiary care setting. Although VPI appeared more frequent after adenotonsillectomy and among younger children, these associations were not statistically significant. Early postoperative surveillance is advisable to identify affected patients promptly, while larger multicentre studies with longer follow-up are needed to distinguish transient from persistent VPI and to clarify associated risk factors.*

Keywords: Adenoidectomy; Tonsillectomy; Adenotonsillectomy; Velopharyngeal Insufficiency; Child

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Introduction

The velopharyngeal mechanism is a complex three-dimensional muscular valve situated at the junction of the oropharynx and nasopharynx, responsible for separating the oral and nasal cavities during speech production, swallowing, and other physiological activities. This mechanism comprises three principal anatomical components: the soft palate (velum), the lateral pharyngeal walls, and the posterior pharyngeal wall (1). The muscles governing velopharyngeal closure include the levator veli palatini, which serves as the primary elevator and retractor of the soft palate; the musculus uvulae, which adds bulk to the dorsal velar surface during closure; the palatopharyngeus and palatoglossus, which form the posterior and anterior faucial pillars respectively; and the superior pharyngeal constrictor, which mediates the inward movement of the lateral pharyngeal walls (2). The levator veli palatini forms a muscular sling across the velum and is considered the most critical muscle for achieving velopharyngeal competence. Growth-related changes in these structures have been demonstrated through magnetic resonance imaging studies, with the velar length, levator muscle thickness, and pharyngeal depth undergoing significant dimensional changes from childhood to adulthood (1). Four recognized patterns of velopharyngeal closure have been characterized: coronal (the most prevalent, observed in 55–75% of individuals), sagittal, circular, and circular with Passavant's ridge, each reflecting varying contributions of velar elevation and lateral wall medialization (2).

Velopharyngeal insufficiency (VPI) is defined as the structural or anatomic inadequacy of the velopharyngeal mechanism to achieve complete closure of the velopharyngeal port during oral sound production, resulting in hypernasality, audible nasal air emission, and impaired speech intelligibility (3). It is important to distinguish VPI from velopharyngeal incompetence, which denotes a neurophysiological impairment of velopharyngeal movement despite structurally adequate anatomy, and velopharyngeal mislearning, wherein patients produce incorrect articulatory patterns despite having both structurally and neurologically normal velopharyngeal function (2,3). These distinctions carry significant therapeutic implications, as VPI typically requires surgical or prosthetic intervention, incompetence may benefit from neurological management, and mislearning is addressed primarily through speech therapy (3).

The aetiology of VPI is multifactorial. Cleft palate, both overt and submucous, remains the most common cause worldwide (3). Among non-cleft patients, iatrogenic VPI following adenoidectomy constitutes a well-recognized entity, occurring when surgical removal of the adenoid pad enlarges the velopharyngeal port beyond the compensatory capacity of the velum (4,5). Other structural causes include congenital short soft palate, deep pharynx, and nasopharyngeal disproportion (5). Genetic conditions, particularly 22q11.2 deletion syndrome (velocardiofacial

syndrome), are identified in a notable proportion of non-cleft VPI cases, while neurological disorders such as cerebral palsy, muscular dystrophy, and traumatic brain injury can also impair velopharyngeal function (7). In a tertiary-centre review of 139 children with non-cleft VPI, Mushi et al. found that 13 patients developed VPI following adenoidectomy, and notably, only three of these had any identifiable predisposing factor, underscoring that post-adenoidectomy VPI can occur in otherwise healthy children with no detectable risk (4). The estimated incidence of persistent VPI following adenoidectomy ranges from 1 in 1,500 to 1 in 10,000 procedures, though transient hypernasality in the early postoperative period may be substantially more common (5).

Adenoidectomy, tonsillectomy, and adenotonsillectomy are among the most frequently performed surgical procedures in paediatric otolaryngology worldwide (6). Adenoidectomy involves the removal of hypertrophied lymphoid tissue from the nasopharynx and is indicated for nasal obstruction, recurrent adenoiditis, otitis media with effusion, chronic rhinosinusitis, and sleep-disordered breathing. Tonsillectomy entails the complete excision of the palatine tonsils and is primarily performed for recurrent tonsillitis meeting Paradise criteria or for obstructive sleep apnoea. Adenotonsillectomy, the simultaneous removal of both tonsils and adenoids, is the first-line surgical treatment recommended by the American Academy of Otolaryngology–Head and Neck Surgery for paediatric obstructive sleep apnoea associated with adenotonsillar hypertrophy (6). These procedures are generally considered safe, with common complications including postoperative haemorrhage, pain, dehydration, and infection; however, VPI represents a rarer but potentially debilitating complication that warrants clinical attention.

VPI as a postoperative complication of adenotonsillar surgery has gained increasing recognition in recent literature. While the majority of patients who develop hypernasality following surgery experience transient symptoms that resolve spontaneously within three to six months, a clinically important subset develops persistent VPI that may require speech therapy or secondary surgical intervention such as sphincter pharyngoplasty or pharyngeal flap procedures (5). Identified risk factors for persistent post-adenoidectomy VPI include the presence of an occult submucous cleft palate, poor preoperative palatal mobility, deep pharynx, low birth weight, family history of hypernasality, and history of preoperative speech difficulties (5). Recent prospective evidence suggests that the rate of early postoperative hypernasality may be higher than traditionally cited, with one study documenting transient hypernasality in up to 26.7% of children at one month following adenoidectomy, of whom only 1.4% had symptoms persisting beyond three months (8). The magnitude of adenoid tissue removed, reflected by preoperative adenoid grade, appears to correlate with the likelihood and severity of transient hypernasality (8).

In Pakistan, diseases of the ear, nose, and throat constitute a substantial and growing burden on the healthcare system, with chronic tonsillitis and adenoid hypertrophy ranking among the most prevalent paediatric otolaryngological conditions (9,10). Adenoidectomy and tonsillectomy are routinely performed across tertiary care hospitals and district-level facilities throughout the country; however, the demand for surgical management of adenotonsillar disease far exceeds the available specialist otolaryngological infrastructure (10). Despite this high volume of adenotonsillar surgery, there is a conspicuous paucity of local data regarding the frequency and risk factors of postoperative VPI in the Pakistani paediatric population. The existing literature is predominantly derived from Western and Middle Eastern cohorts, and the generalizability of these findings to the South Asian demographic and clinical context remains uncertain. This study was therefore designed to determine the frequency of velopharyngeal insufficiency following adenoidectomy, tonsillectomy, and adenotonsillectomy in paediatric patients presenting to a tertiary care hospital in Pakistan, and to evaluate the association of VPI with potential risk factors including age, gender, body mass index, symptom duration, and type of surgical procedure.

Methodology

This descriptive case series was conducted in the Department of ENT Teaching Hospital, Gujranwala, over a period of six months after approval of the synopsis from September 2024 to March 2025. The study was designed to determine the frequency of velopharyngeal insufficiency in pediatric patients undergoing adenoidectomy, tonsillectomy, or adenotonsillectomy. The sample size was calculated as 92 patients using an anticipated frequency of velopharyngeal insufficiency of 2.2% after tonsillectomy, with a 95% confidence level and a margin of error of 3%. Patients were enrolled using a non-probability consecutive sampling technique.

Eligible participants included male and female patients aged 5 to 16 years who were scheduled to undergo surgery for adenoids and/or tonsils according to the predefined clinical indications, including enlarged or inflamed tonsils or adenoids causing obstructive sleep apnea, recurrent infections, or failure to thrive. Patients were excluded if they had a history of previous adenoid or tonsillar surgery, cleft palate or prior cleft palate repair, congenital deformities of the head and neck region, pre-existing speech or language problems, or if the patient or guardian was unwilling to participate or unable to cooperate with the study protocol.

After approval from the institutional ethical committee, patients fulfilling the inclusion criteria were recruited from the outpatient department of the Otolaryngology Department at DHQ Hospital, Gujranwala. Written informed consent was obtained from the patients' parents or guardians before enrollment. For each participant, demographic and clinical information was recorded on a structured proforma. A detailed history was obtained, followed by clinical examination and relevant laboratory investigations. All patients then underwent pre-anaesthesia assessment before surgery. The surgical procedures were performed under standard general anaesthesia by the same consultant ENT surgeon in order to maintain procedural consistency. Perioperative and postoperative management was carried out according to the routine hospital protocols.

All enrolled patients were followed in the outpatient department three weeks after surgery. The primary outcome was velopharyngeal insufficiency, which was assessed by the consultant ENT surgeon using nasometry and nasoendoscopy in accordance with the operational definition provided in the synopsis. Velopharyngeal insufficiency was defined as inadequate velopharyngeal closure after surgery and was recorded as present or absent on follow-up evaluation. All study-related information was documented by the researcher himself using the predesigned data collection form.

Data were entered and analyzed using SPSS version 25 for Microsoft Windows. Quantitative variables, including age, body mass index, and duration of symptoms, were summarized as mean and standard deviation, while qualitative variables such as gender, type of surgery, and presence of velopharyngeal insufficiency were presented as frequencies and percentages. To explore the effect of potential modifiers, stratification was planned for age, gender, body mass index, duration of symptoms, and type of surgery. Post-stratification associations were assessed using the chi-square test, and a p-value of less than 0.05 was considered statistically significant.

Results

Table 1 presents the baseline demographic characteristics of 230 HF A total of 92 patients were included in the study. The mean age of the participants was 9.84 ± 3.12 years, with 54 (58.7%) males and 38 (41.3%) females. The mean BMI was 18.21 ± 2.64 kg/m², while the mean duration of symptoms was 8.73 ± 3.91 months. Adenotonsillectomy was the most commonly performed procedure in 39 (42.4%) patients, followed by tonsillectomy in 31 (33.7%) and adenoidectomy in 22 (23.9%) patients (Table 1).

At three weeks after surgery, velopharyngeal insufficiency was observed in 8 (8.7%) patients, whereas 84 (91.3%) patients did not develop VPI (Table 2).

Table 1: Demographic and baseline clinical characteristics of the study population (n = 92)

Variable	Value
Age (years), mean ± SD	9.84 ± 3.12
BMI (kg/m²), mean ± SD	18.21 ± 2.64
Duration of symptoms (months), mean ± SD	8.73 ± 3.91
Male, n (%)	54 (58.7)
Female, n (%)	38 (41.3)
Adenoidectomy, n (%)	22 (23.9)
Tonsillectomy, n (%)	31 (33.7)
Adenotonsillectomy, n (%)	39 (42.4)

On stratified analysis, VPI was more common among children aged 5–10 years than those aged 11–16 years, 6 (12.2%) versus 2 (4.7%). According to gender, VPI was detected in 5 (9.3%) males and 3 (7.9%) females. Similarly, a comparatively higher proportion of VPI was noted among patients with BMI <18 kg/m² and those with symptoms lasting 9 months or longer. With respect to surgical procedure, the highest frequency of VPI was observed in the adenotonsillectomy group, where 6 (15.4%) patients developed postoperative VPI, compared with 1 (4.5%) in the adenoidectomy group and 1 (3.2%) in the tonsillectomy group. However, none of these associations reached statistical significance on post-stratification analysis (Table 3).

Table 2: Overall frequency of velopharyngeal insufficiency after surgery (n = 92)

VPI after 3 weeks	Frequency	Percentage
Yes	8	8.7
No	84	91.3

Table 3: Combined stratification of velopharyngeal insufficiency with effect modifiers (n = 92)

Variable	Category	Total n	VPI Yes n (%)	VPI No n (%)	p-value
Age group (years)	5–10	49	6 (12.2)	43 (87.8)	0.201
	11–16	43	2 (4.7)	41 (95.3)	
Gender	Male	54	5 (9.3)	49 (90.7)	0.812
	Female	38	3 (7.9)	35 (92.1)	
BMI (kg/m²)	<18	37	5 (13.5)	32 (86.5)	0.183
	≥18	55	3 (5.5)	52 (94.5)	
Duration of symptoms	<9 months	51	3 (5.9)	48 (94.1)	0.287
	≥9 months	41	5 (12.2)	36 (87.8)	
Type of surgery	Adenoidectomy	22	1 (4.5)	21 (95.5)	0.094
	Tonsillectomy	31	1 (3.2)	30 (96.8)	
	Adenotonsillectomy	39	6 (15.4)	33 (84.6)	

Discussion

The present study determined the frequency of velopharyngeal insufficiency at three weeks following adenotonsillar surgery in 92 paediatric patients, reporting an overall VPI rate of 8.7%. This figure is higher than the historically cited incidence of persistent VPI (1 in 1,500 to 1 in 10,000 adenoidectomies) but must be interpreted in light of the early assessment timepoint, which captures both transient and potentially persistent cases. Konstantinidou et al. (11) reviewed paediatric VPI following adenotonsillar surgery at a tertiary cleft centre and identified deep pharynx in 37% of affected patients, with 86.9% ultimately showing improvement after intervention. In contrast, Rao et al. (12) documented a VPI rate of only 0.6% in a retrospective review of 240 paediatric adenotonsillectomy cases with longer follow-up, suggesting that the majority of early postoperative VPI resolves spontaneously. The population-based study by Losgar et al. (14) confirmed that paediatric adenoidectomy carries a low overall complication rate in a cohort of 2,105 cases, reinforcing the view that VPI, while uncommon over the long term, remains a clinically significant early postoperative finding.

Stratification by procedure type revealed that adenotonsillectomy carried the highest VPI rate (15.4%), compared with adenoidectomy (4.5%) and tonsillectomy (3.2%), although these differences did not achieve statistical significance (p=0.094). This pattern is biologically plausible, as combined procedures produce greater disruption of the velopharyngeal architecture than either procedure alone. Perry et al. (16) demonstrated through longitudinal MRI studies that the adenoid mass contributes substantially to velopharyngeal closure, particularly in younger children, and its removal combined with tonsillectomy compounds the structural deficit within the velopharyngeal port. The elevated risk associated with adenotonsillectomy has also been documented in high-risk populations; Clements et al. (20) reported a 14% VPI rate following adenotonsillectomy in children with Prader-Willi syndrome, closely paralleling our finding of 15.4% in the general paediatric population. Della Vecchia et al. (21) comprehensively reviewed adenotonsillectomy complications in children, noting that VPI, while uncommon, necessitates early identification and timely referral for optimal outcomes.

Analysis of demographic and clinical risk factors revealed trends that, while not statistically significant, merit clinical attention. Younger age (5–10 years) was associated with higher VPI rates (12.2% versus 4.7%, p=0.201), likely reflecting the proportionally greater role of adenoid tissue in velopharyngeal closure before complete velar maturation (16). The trend towards higher VPI in patients with lower BMI (13.5% versus 5.5%, p=0.183) is noteworthy; Vaughn et al. (15) examined the influence of body habitus on complications after paediatric adenotonsillectomy and demonstrated that nutritional status significantly affects postoperative outcomes, supporting the biological plausibility of this association. Katz et al. (22) similarly identified multiple patient-level predictors of postoperative complications in paediatric adenotonsillectomy, further emphasizing the multifactorial nature of surgical risk. The absence of significant gender differences in our study (males 9.3% versus females 7.9%, p=0.812) is consistent with findings reported by Konstantinidou et al. (11) and in the broader literature.

The clinical significance of VPI detected at three weeks warrants careful interpretation, as most early postoperative hypernasality is transient. Wang et al. (13) conducted a systematic review and meta-analysis of voice changes following adenotonsillectomy in 2,154 children and found that most acoustic and perceptual abnormalities normalize by three months. Jasim et al. (17) corroborated this by demonstrating significant improvement in spectral and acoustic parameters at 90 days following adenotonsillectomy. For patients with persistent VPI, however, Amer et al. (19) showed that posterior pharyngeal wall augmentation with autologous cartilage grafts significantly improves velopharyngeal closure and speech outcomes. In the Pakistani context, Banatwala et al. (18) highlighted growing research interest in optimizing adenotonsillectomy outcomes among Pakistani otolaryngologists, yet VPI-specific data from the region remain scarce.

The limitations of this study include its relatively small sample size (n=92), single-centre design, and the early follow-up timepoint of three weeks, which precludes differentiation between transient and persistent

VPI. The absence of statistically significant associations may reflect insufficient statistical power rather than true absence of effect. Future multicentre studies with larger cohorts, longer follow-up periods extending to six months or beyond, and objective assessment tools such as nasometry and nasendoscopy are warranted to more precisely characterize the incidence, natural history, and risk factors of post-surgical VPI in the Pakistani paediatric population.

Conclusion

Velopharyngeal insufficiency was an infrequent but notable early postoperative finding, with the highest occurrence after adenotonsillectomy. Careful follow-up after adenotonsillar surgery may help in early detection and timely management of affected children.

Declarations

Data Availability statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRBEC-GJWTH-734-24)

Consent for publication

Approved

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Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

HAM (PGR)

Contributed to study design, data collection and initial manuscript drafting

Assisted in data acquisition, literature review and manuscript editing

Performed statistical analysis and contributed to interpretation of results

SH (HOD)

Helped in methodology development, data organization and manuscript formatting

Contributed to patient recruitment, data entry and results compilation

Assisted in referencing, proofreading and final revisions of the manuscript

AR (SR)

Provided guidance in study execution and critically reviewed the manuscript

Supervised the research, coordinated among authors, finalized the manuscript and approved the final version

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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