CLINICAL AND ACOUSTIC FEATURES OF VOCAL FOLD NODULES IN CHILDREN WITH CHRONIC PHARYNGEAL DISEASES

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Abstract. Pediatric vocal fold nodules (VFNs) represent a multifactorial pathology accounting for 40–60% of childhood dysphonia cases, adversely impacting cognitive development and social adaptation. Beyond mechanical phonotrauma, chronic upper respiratory inflammatory foci and chemical irritants disrupt the immature pediatric lamina propria, altering fibronectin and hyaluronic acid distribution and increasing epithelial viscosity. Recent studies also emphasize the role of systemic inflammatory markers (such as elevated neutrophil-to-lymphocyte ratios) and vocal tract narrowing in exacerbating pediatric phonotrauma. This study aimed to evaluate the prevalence of comorbid pharyngeal pathologies, elucidate pathogenetic mechanisms, and objectively quantify vocal biomechanical disturbances using computerized acoustic voice analysis in children with VFNs.

Keywords: pediatric dysphonia, vocal fold nodules, acoustic analysis, Jitter, Shimmer, videolaryngostroboscopy, adenoid vegetations, laryngopharyngeal reflux disease, maximum phonation time.

Materials and Methods. A prospective clinical study was conducted at the Republican Specialized Scientific and Practical Medical Center of Otorhinolaryngology and Head and Neck Diseases from January 2025 to March 2026, enrolling 52 children aged 6–14 years: a main group with videolaryngostroboscopically confirmed VFNs and persistent dysphonia >3 months (n=26), and a vocally healthy control group (n=26). Objective acoustic analysis was performed in a sound-treated booth (<30 dB) using a Shure SM58 microphone and Praat (v. 6.3) / MDVP software to assess fundamental frequency (F_{0}), Jitter local (%), Shimmer local (%), Noise-to-Harmonic Ratio (NHR), and Maximum Phonation Time (MPT). Instrumental diagnostics included 70° rigid videolaryngostroboscopy (VLS) to evaluate mucosal wave dynamics and endoscopic examination of the nasopharynx and posterior laryngeal wall, with statistical analysis executed in SPSS 26.0 ($p < 0.05$).

Results and Discussion. In the main group, boys predominated (61.5%), and the peak incidence occurred in early school-aged children aged 6–9 years (69.2%). Comorbid chronic pharyngeal pathologies were identified in 88.5% of VFN patients, distributed as grade II–III adenoid vegetations (42.3%), laryngopharyngeal reflux disease (LPRD, 34.6%), and chronic tonsillitis (23.1%). Acoustic parameters demonstrated severe biomechanical imbalance compared to controls: F_{0} significantly decreased (215.3 ± 12.4 Hz vs. 248.5 ± 10.2 Hz, $p<0.01$), while Jitter ($2.85 \pm 0.91\%$ vs. $0.42 \pm 0.15\%$, $p<0.001$), Shimmer ($7.14 \pm 1.45\%$ vs. $1.95 \pm 0.48\%$, $p<0.001$), and NHR (0.29 ± 0.06 vs. 0.11 ± 0.02, $p<0.01$) markedly increased, accompanied by a nearly twofold reduction in MPT (8.2 ± 1.5 s vs. 14.5 ± 2.1 s, $p<0.01$). Adenoid hypertrophy induced secondary muscle tension dysphonia and the lowest F_{0} values (205 ± 8.2 Hz) due to nasal resonator obstruction and mouth-breathing desiccation, whereas pepsin-mediated tight-junction degradation in LPRD strongly correlated with elevated Shimmer ($r=0.72$, $p<0.05$) and

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edematous nodules (54% of VLS cases). Fibrous nodules (46%) exhibited absent mucosal waves and peak NHR levels. Notably, Jitter >2.5% combined with MPT <10 s predicted organic laryngeal lesions with 92% accuracy. Following targeted upper airway sanitation (adenoidectomy, proton pump inhibitors, anti-reflux diet) combined with voice therapy, 3-month follow-up revealed dramatic improvements: Jitter dropped to 1.2%, Shimmer to 3.5%, and \(F_{0}\) normalized, confirming that resolving underlying pharyngeal pathology restores vocal biomechanics by 45–50% and minimizes the need for surgical excision.

Conclusion. Pediatric VFNs rarely occur as an isolated condition and are pathogenetically driven by chronic adenoiditis, LPRD, and chronic tonsillitis in 88.5% of cases. Integrating computerized acoustic analysis with endoscopy and VLS provides a highly sensitive, non-invasive diagnostic and prognostic protocol, where primary sanitation of pharyngeal foci combined with phonopedic rehabilitation ensures full vocal recovery without invasive phonosurgery.

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