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Research Article

Prevalence of Submucous Fibrosis and Its Association with Eustachian Tube Dysfunction in Betel Nut Chewers: A Cross-Sectional Study in Pakistan

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ABSTRACT: Submucous fibrosis remains a significant oral potentially malignant disorder in South Asia, with regional data suggesting that betel nut chewing is its most consistent etiological factor. The functional implications of this disease extend beyond the oral cavity, and recent evidence indicates a plausible relationship between oral fibrosis and compromised Eustachian tube physiology due to fibrosis-induced restriction near the nasopharyngeal orifice. This cross-sectional study assessed 312 habitual betel nut chewers in Pakistan to determine the prevalence of oral submucous fibrosis and evaluate its association with Eustachian tube dysfunction using tympanometric analysis and symptom scoring. The prevalence of submucous fibrosis was 41.3 percent, with moderate to advanced disease representing the majority of clinically diagnosed cases. Eustachian tube dysfunction was identified in 34.6 percent of participants, showing a statistically significant association with disease severity ($p < 0.001$). Mean middle ear pressure values were significantly lower among individuals with advanced fibrosis compared with those without fibrosis, suggesting a functional impact on nasopharyngeal musculature. The findings include a novel observation that progressive oral fibrosis may compromise peritubal muscular coordination, contributing to middle ear aeration deficits. The study highlights the importance of early detection and risk-based otologic evaluation in habitual chewers.

Keywords: submucous fibrosis, Eustachian tube dysfunction, betel nut chewing

INTRODUCTION: Oral submucous fibrosis has long been recognized as one of the most prevalent and clinically significant oral potentially malignant disorders in South Asia. In countries such as Pakistan, India, Sri Lanka, and Bangladesh, the use of betel nut in various commercial preparations continues to fuel a widespread and persistent public health concern. Among these, Pakistan remains one of the largest consumers of processed areca nut products, with both adults and young individuals increasingly exposed to formulations containing areca nut, tobacco, slaked lime, flavoring compounds, and sweeteners. The chronic mechanical and chemical irritation caused by these mixtures initiates a cascade of inflammatory and fibrotic changes in the oral mucosa, ultimately resulting in a debilitating condition characterized by progressive

stiffness, mucosal blanching, and trismus. The disease trajectory is often insidious, and by the time symptoms become functionally concerning, a significant portion of the oral mucosa has undergone irreversible changes. This situation underscores the importance of evaluating not only the intraoral manifestations but also potential extramucosal consequences that may arise from chronic fibrosis.[1-5]

The anatomical and functional relationship between the oral cavity, soft palate, and nasopharynx introduces a clinically significant direction of investigation into the possible effects of oral submucous fibrosis on structures beyond the oral mucosa. The Eustachian tube, which connects the middle ear to the nasopharynx, depends on coordinated actions of the tensor veli palatini and levator veli palatini muscles to maintain pressure equilibrium within the middle ear. Any pathological process that affects the elasticity, mobility, or integrity of adjacent tissues may disrupt the biomechanical efficiency of these muscles. As fibrosis progresses into deeper tissues or approaches the soft palate and surrounding musculature, alterations in Eustachian tube opening mechanics become possible. Recent studies have suggested that oral submucous fibrosis may be associated with ear-related complaints such as aural fullness, impaired hearing, and recurrent otologic symptoms. These observations have prompted the need for detailed evaluation of Eustachian tube physiology in affected populations.[6-8]

The rising consumption of processed betel nut mixtures among young individuals is particularly concerning, as early and prolonged exposure intensifies the risk of developing submucous fibrosis at an earlier age. This demographic shift not only increases disease prevalence but also extends the duration of exposure to potential complications, including Eustachian tube dysfunction. The relationship between chronic fibrotic changes and middle ear ventilation remains understudied, and most available information has been based on small cohorts or descriptive observations. Comprehensive cross-sectional evaluations are necessary to determine whether individuals with oral submucous fibrosis are at greater risk of developing tympanometric abnormalities or symptomatic dysfunction. Furthermore, identifying statistical associations between fibrosis severity and middle ear pressure parameters can support targeted screening strategies in high-risk populations.[9-12]

The burden of submucous fibrosis in Pakistan cannot be fully understood without examining its systemic and functional implications. While the malignant potential of the disease remains a major concern, functional deficits affect quality of life at earlier stages. Restricted mouth opening, difficulty swallowing, impaired speech, and altered mucosal integrity are frequently observed among patients. When symptoms extend to the ear, individuals may experience reduced hearing clarity, episodic discomfort, or persistent aural fullness, often misattributed to simple congestion rather than functional impairment. Understanding whether these symptoms stem from structural or neuromuscular alterations associated with fibrosis provides an important foundation for integrated management approaches.

Given this background, the present study was designed to investigate the prevalence of oral submucous fibrosis in habitual betel nut chewers in Pakistan and evaluate its association with Eustachian tube dysfunction using standardized clinical and tympanometric assessments. Identifying significant correlations would support the hypothesis that oral fibrosis may influence nasopharyngeal muscular coordination, thereby affecting middle ear aeration and function. This investigation aims to contribute new clinical insight into an

underexplored relationship, offering a stronger scientific basis for early otologic evaluation in patients with progressive oral fibrosis. The findings may further support the need for preventive public health strategies targeting high-risk betel nut users, particularly adolescents and young adults.

METHODOLOGY: A cross-sectional study was carried out over twelve months among habitual betel nut chewers aged 15 to 60 years who provided verbal consent to participate, with confidentiality maintained according to institutional ethical guideline at Bolan Medical College, Quetta. Sample size was calculated using Epi-Info with an expected prevalence of submucous fibrosis of 35 percent, a 95 percent confidence level, and a 5 percent margin of error, yielding a minimum requirement of 289 participants; 312 individuals meeting the inclusion criteria were enrolled. Inclusion criteria consisted of a minimum two-year history of daily betel nut chewing, absence of prior treatment for submucous fibrosis, no history of middle ear disease, and intact tympanic membranes. Exclusion criteria included acute upper respiratory infection, prior ear surgery, chronic otitis media, cleft palate, craniofacial anomalies, or systemic fibrotic disorders. Clinical diagnosis and staging of submucous fibrosis were performed through standardized oral examination assessing mucosal blanching, palpable fibrous bands, tongue mobility, and interincisal opening. Eustachian tube function was evaluated using tympanometry, documenting middle ear pressure, compliance, and type of tympanogram, supplemented by a structured symptom scoring instrument. Participants were categorized into three groups: chewers without fibrosis, mild to moderate fibrosis, and advanced fibrosis. Statistical analyses included chi-square tests, t-tests, and ANOVA using SPSS, with p-values <0.05 considered significant.

RESULTS: TABLE 1. Demographic Characteristics of Participants

Variable	Mean ± SD / Frequency
Age (years)	28.6 ± 9.4
Sex (Male/Female)	198 / 114
Duration of Chewing Habit (years)	6.7 ± 3.1
Daily Chewing Frequency	4.9 ± 2.3

The study population represented predominantly young adults with moderate duration and frequency of betel nut use, reflecting typical regional consumption patterns.

TABLE 2. Prevalence and Severity of Submucous Fibrosis

Group	Frequency (%)	Mean Interincisal Opening (mm ± SD)	p-Value
No OSMF	183 (58.7%)	42.6 ± 3.9	—

Group	Frequency (%)	Mean Interincisal Opening (mm ± SD)	p-Value
Mild–Moderate OSMF	79 (25.3%)	31.4 ± 2.8	<0.001
Advanced OSMF	50 (16.0%)	21.8 ± 3.4	<0.001

Submucous fibrosis was present in 41.3 percent of participants, with significant reductions in interincisal opening observed across increasing severity.

TABLE 3. Association Between OSMF and Eustachian Tube Dysfunction

Group	ETD Prevalence (%)	Mean Middle Ear Pressure (daPa ± SD)	p-Value
No OSMF	12.6%	–18.4 ± 9.7	—
Mild–Moderate OSMF	38.0%	–43.2 ± 11.5	<0.001
Advanced OSMF	62.0%	–67.9 ± 13.4	<0.001

A strong, statistically significant association was identified between increasing OSMF severity and impaired Eustachian tube function, reflected by higher ETD prevalence and more negative middle ear pressures.

DISCUSSION: The findings of this study demonstrate a high prevalence of submucous fibrosis among habitual betel nut chewers in Pakistan, consistent with trends observed in regions with similar patterns of areca nut consumption. The clinical assessment revealed substantial mucosal alterations in a large proportion of users, emphasizing the accelerating public health impact of processed areca products. These findings are particularly concerning given the early age of exposure observed in the study population, suggesting that chronic mucosal damage begins at a younger age than previously documented.[13-15]

A novel dimension of the study lies in its systematic evaluation of Eustachian tube dysfunction among individuals with submucous fibrosis. Middle ear ventilation depends heavily on the coordinated action of nasopharyngeal muscles, and fibrosis-induced restrictions have the potential to disrupt these mechanisms. The significantly higher prevalence of tympanometric abnormalities in individuals with moderate to advanced fibrosis supports the hypothesis that progressive mucosal stiffening near the soft palate and surrounding musculature may impair Eustachian tube opening.[16-17]. The severity-dependent reduction in middle ear pressure further highlights the functional implications of the disease. Negative middle ear pressure often reflects inadequate tubal aeration, suggesting that fibrosis may influence both structural elasticity and neuromuscular coordination. The consistent

trend of decreasing pressure values with advancing fibrosis provides meaningful evidence of this relationship, marking a clinically significant finding that may justify routine tympanometric screening in high-risk populations.[18-20]

The observed association has important implications for early symptom recognition. Patients with submucous fibrosis frequently report vague otologic symptoms, which are often unrecognized or attributed to nasal congestion or allergy. Incorporating structured assessment of ear-related symptoms in oral health clinics may enhance early detection of functional deficits, thereby reducing the likelihood of chronic middle ear complications in susceptible individuals.

Another important observation is the high proportion of mild to moderate fibrosis, which represents a critical window for early intervention. Behavioral modification strategies, targeted physiotherapy, and medical treatment may help limit the progression of fibrosis and preserve muscular mobility. Identifying Eustachian tube dysfunction at this stage offers an opportunity for multidisciplinary management aimed at preventing long-term functional impairment.

The findings also raise important considerations for public health policy. The increasing use of commercial betel nut preparations, particularly among adolescents, places large numbers of individuals at risk for both oral and otologic dysfunction. Effective regulation, community-based education, and cessation programs are essential to address the growing burden associated with these products. The data from this study contribute meaningful evidence supporting the urgency of such initiatives.

Overall, the results illuminate a significant yet underrecognized complication of submucous fibrosis, demonstrating a clear and statistically robust association with Eustachian tube dysfunction. These findings reinforce the need for integrated medical and dental evaluations in populations with habitual betel nut consumption and highlight the broader systemic consequences of chronic oral fibrosis.

CONCLUSION: Submucous fibrosis demonstrated a high prevalence among habitual betel nut chewers, with severity significantly associated with Eustachian tube dysfunction. Progressive fibrosis was linked to increasingly negative middle ear pressures, indicating functional impairment. These findings address an important diagnostic gap and support early otologic assessment in individuals with chronic areca nut exposure.

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