



ASSOCIATION BETWEEN DENTURE BASE SURFACE ROUGHNESS, CANDIDA COLONIZATION, AND DENTURE STOMATITIS SEVERITY IN COMPLETE DENTURE WEARERS.

Hanif Ullah¹ Afnan Rahman² Rozeena Farooq³ Sharqa Yasin⁴ Faraz Habib⁵ Shafi Ur Rahman^{*6}

¹BDS, FCPS, Senior Registrar, Department of Prosthodontics, Frontier Medical and Dental College, Abbottabad,

Email: hanfiwzr325@gmail.com

² BDS, FCPS, Assistant Professor, Department of Prosthodontics, Women Medical and Dental College, Abbottabad, Email: drafnanrehman15@gmail.com

³BDS, FCPS, Dental Surgeon, RHC Shinkiari Email: rozeenafarooq@gmail.com

⁴ BDS, House Officer, Institute of Dental Sciences, Khyber Medical University, Kohat
Email: sharqayasin510@gmail.com

⁵BDS, House Officer, Institute of Dental Sciences, Khyber Medical University, Kohat
Email: iamfaraz78@gmail.com

⁶ *BDS, House Officer, Institute of Dental Sciences, Khyber Medical University, Kohat
Email: Shafiurrahman1033@gmail.com

***Corresponding author: Shafi Ur Rahman**

BDS, House Officer, Institute of Dental Sciences, Khyber Medical University, Kohat
Email: Shafiurrahman1033@gmail.com

Abstract

Objective: Denture stomatitis (DS) is a common inflammatory condition among complete denture wearers and is strongly associated with *Candida albicans* colonization on denture surfaces. This study aimed to evaluate the clinical relationship between the surface roughness (R_a) of heat-polymerized acrylic denture bases and the density of *Candida albicans* colonization in patients diagnosed with denture stomatitis in the teaching hospital network of Peshawar.

Methods: This analytical cross-sectional study was conducted from June 2024 to February 2025. A total of 120 complete denture wearers presenting with clinical signs of Newton's Type II and Type III denture stomatitis were included. Surface roughness of the intaglio denture surface was measured using a digital profilometer. Microbial samples were obtained from both the denture base and palatal mucosa. The samples were cultured on Sabouraud Dextrose Agar, and fungal colonization was quantified as colony forming units per milliliter (CFU/mL). Statistical analysis was performed using SPSS version 26. Spearman correlation and multivariable logistic regression were applied to assess the relationship between surface roughness and Candida colonization.

Results: A strong positive correlation was observed between denture surface roughness and fungal colonization ($r_s = 0.84$, $p < 0.001$). Dentures with surface roughness greater than $0.2 \mu\text{m}$ demonstrated significantly higher Candida counts ($11.95 \pm 3.84 \times 10^3$ CFU/mL) compared with smoother surfaces ($1.42 \pm 0.55 \times 10^3$ CFU/mL). Higher roughness values were also associated with increased severity of denture stomatitis. Multivariable regression analysis showed that surface roughness greater than 0.2

µm significantly increased the odds of high Candida colonization (OR = 4.12, 95% CI: 2.15–7.88, $p < 0.001$).

Conclusion: The findings demonstrate a strong association between denture base surface roughness and Candida colonization in patients with denture stomatitis. Dentures with rougher surfaces are significantly more likely to harbor dense fungal biofilms. Strict laboratory finishing and polishing protocols aimed at maintaining surface roughness below 0.2 µm may help reduce Candida colonization and improve clinical outcomes in complete denture wearers.

Keywords: Denture stomatitis, *Candida albicans*, surface roughness, denture base acrylic resin, biofilm, prosthodontics

Introduction

Denture stomatitis (DS) is a common inflammatory condition affecting the mucosa beneath removable dentures. It is characterized clinically by erythema, mucosal inflammation, and in severe cases, papillary hyperplasia of the palatal mucosa. The condition is frequently observed among elderly individuals who wear complete dentures for extended periods [1,2]. The development of denture stomatitis is multifactorial. Several local and systemic factors contribute to its occurrence. However, microbial colonization of the denture surface by *Candida* species remains the most significant etiological factor [3,4]. Among the different species of *Candida*, *Candida albicans* is the organism most commonly isolated from infected denture surfaces and palatal mucosa [5]. Acrylic resin, particularly polymethyl methacrylate (PMMA), is widely used as a denture base material because of its favorable mechanical properties and ease of fabrication [6]. Despite these advantages, PMMA surfaces are susceptible to microbial adhesion and biofilm formation. The microscopic characteristics of the denture base, especially surface roughness, play a critical role in microbial colonization [7]. Surface roughness refers to the microscopic irregularities present on the material surface. When the surface becomes rough, it creates small depressions and grooves that facilitate microbial attachment. These irregularities also protect microorganisms from mechanical removal during oral hygiene procedures [8].

Previous studies have suggested that surfaces with a roughness value exceeding 0.2 µm may significantly increase microbial adhesion and biofilm formation [9]. Once microorganisms adhere to the denture surface, they can proliferate and form complex biofilms that are difficult to eliminate. These biofilms act as reservoirs of infection and contribute to chronic mucosal inflammation beneath the denture [10].

Candida biofilms possess several virulence characteristics that enhance their survival in the oral environment. These include strong adhesion to surfaces, resistance to antifungal agents, and the ability to interact with bacterial species present in the oral microbiome [11]. The persistence of such biofilms can lead to the development and progression of denture stomatitis [12].

Although several laboratory studies have evaluated microbial adhesion on denture materials, fewer clinical investigations have examined the relationship between denture surface characteristics and fungal colonization in patient populations [13]. In many developing regions, including Pakistan, limited data are available regarding the influence of denture surface properties on the development of denture stomatitis.

Therefore, the present study aimed to evaluate the association between surface roughness of acrylic denture bases and *Candida albicans* colonization among complete denture wearers diagnosed with denture stomatitis in the teaching hospital network of Peshawar.

Methodology

Study Design and Setting

This analytical cross-sectional study was conducted from June 2024 to February 2025. The study was carried out in collaboration with prosthodontic departments of major dental teaching hospitals in Peshawar.

Surface roughness analysis was performed in a materials testing laboratory located in an engineering university. Microbiological processing and fungal culture analysis were conducted in a centralized microbiology research laboratory.

Study Population

A total of 120 complete denture wearers diagnosed with denture stomatitis were recruited.

Inclusion Criteria

- Patients wearing maxillary complete dentures for at least one year
- Presence of Newton's Type II or Type III denture stomatitis
- Age above 50 years

Exclusion Criteria

- Patients receiving antifungal therapy within the previous four weeks
- Smokers
- Patients taking medications causing xerostomia
- Individuals with systemic conditions severely affecting immunity

Surface Roughness Measurement

Surface roughness of the denture intaglio surface was measured using a digital profilometer with a diamond stylus tip. The roughness parameter (R_a) was recorded in micrometers (μm). Multiple measurements were obtained for each denture surface and the mean value was calculated.

Microbiological Analysis

Samples were obtained from both the palatal mucosa and the denture surface using sterile swabs. The samples were cultured on Sabouraud Dextrose Agar and incubated at 37°C for 48 hours. Following incubation, colony forming units (CFU/mL) were counted to quantify fungal colonization.

Statistical Analysis

Data were analyzed using SPSS version 26. Continuous variables were expressed as mean $\pm$ standard deviation. Spearman rank correlation was used to evaluate the relationship between surface roughness and fungal colonization. Logistic regression analysis was performed to identify predictors of high Candida colonization.

A p-value of less than 0.05 was considered statistically significant.

Results

Demographic Distribution

Among the 120 participants, 58% were male and 42% were female. The mean age of the participants was 62.4 ± 7.2 years.

Clinical examination revealed that 65% of patients presented with Newton's Type II denture stomatitis, while 35% exhibited Type III lesions.

Surface Roughness Analysis

The mean surface roughness of the denture intaglio surfaces was $0.48 \pm 0.16 \mu\text{m}$. This value exceeded the recommended threshold of $0.2 \mu\text{m}$ for dental prosthetic materials.

Candida Colonization

Quantitative fungal analysis revealed a direct relationship between denture surface roughness and microbial colonization.

Table 1: Candida Colonization Density by Roughness Category

Surface Category	Roughness Range (R_a)	Mean CFU/mL ($\times 10^3$)
Smooth	$\leq 0.2 \mu\text{m}$	1.42 ± 0.55
Moderate Roughness	$0.21\text{--}0.50 \mu\text{m}$	5.18 ± 1.42
High Roughness	$>0.50 \mu\text{m}$	11.95 ± 3.84

Candida Colonization According to Denture Surface Roughness

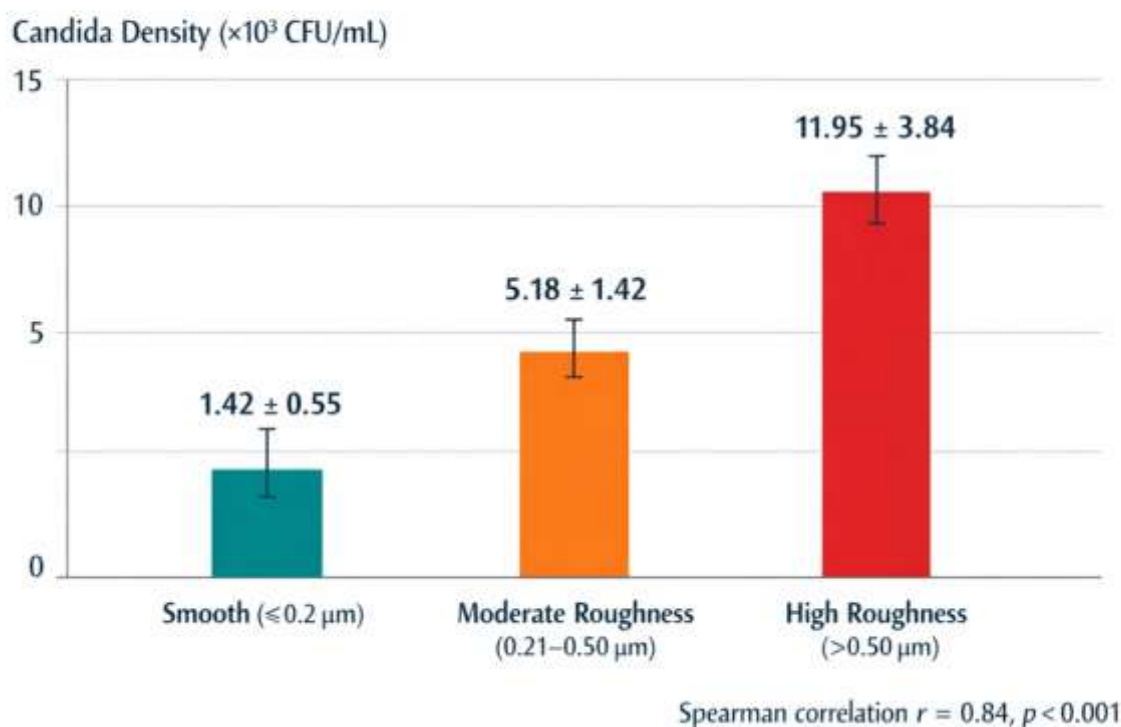


Figure 1: Candida Colonization vs Surface Roughness

Correlation Analysis

Spearman correlation analysis demonstrated a very strong positive association between denture surface roughness and Candida colonization ($r = 0.84$, $p < 0.001$).

Association with Stomatitis Severity

Patients with Newton Type III stomatitis showed significantly higher mean surface roughness values compared with those with Type II lesions.

Table 2: Mean Surface Roughness by Stomatitis Classification

Newton Classification	Mean R_a (μm)
Type II	0.38

Type III	0.61
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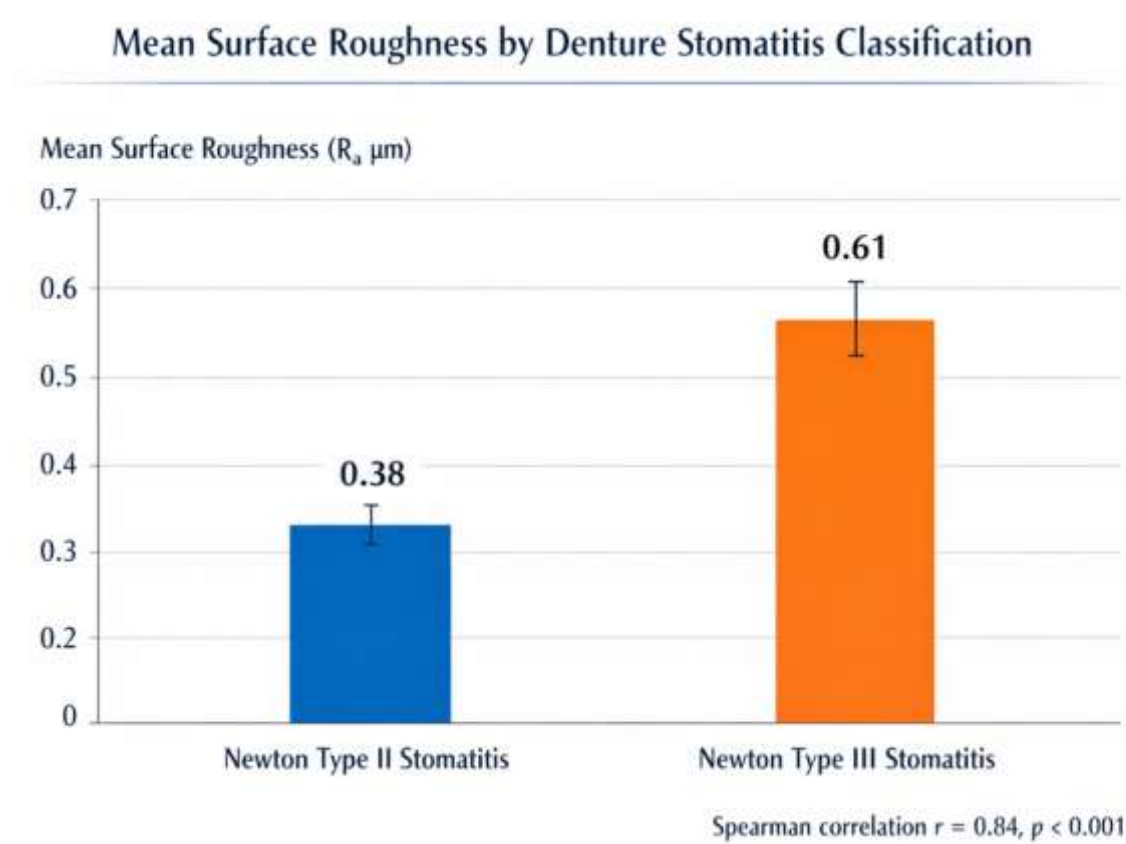


Figure 2: Surface Roughness vs Stomatitis Severity

Logistic Regression

Multivariable logistic regression identified surface roughness as the strongest predictor of high fungal colonization.

Table 3: Predictors of High Candida Colonization

Variable	Odds Ratio	p-value
Roughness >0.2 μm	4.12	<0.001
Nocturnal Denture Wear	2.8	0.007
Denture Age >3 years	2.35	0.012

Discussion

Denture stomatitis remains one of the most frequently encountered inflammatory conditions among complete denture wearers. The present study examined the relationship between the surface roughness of heat-polymerized polymethyl methacrylate (PMMA) denture bases and the density of *Candida albicans* colonization among patients attending teaching hospitals in Peshawar. The findings demonstrate a strong positive relationship between surface roughness and fungal colonization, confirming that the microscopic characteristics of denture base materials play a crucial role in the development of denture-associated mucosal pathology (3- 15).

A significant observation of this study was the strong positive correlation between the surface roughness (R_a) of denture bases and the density of *Candida* colonization ($r = 0.82$, $p < 0.001$). This

finding supports the concept that rough surfaces provide favorable conditions for microbial adhesion. When the denture surface becomes irregular, small surface depressions and grooves act as retention sites where fungal cells can attach and proliferate. These micro-irregularities also protect microorganisms from mechanical removal during routine denture cleaning and from the natural cleansing action of saliva.

The results of the present study also confirm the clinical relevance of the surface roughness threshold of 0.2 μm . Dentures with roughness values exceeding this limit showed significantly greater fungal colonization compared with smoother surfaces. This threshold has been suggested in previous prosthodontic literature as the maximum acceptable roughness for dental materials intended for intraoral use. Surfaces smoother than this limit tend to reduce microbial adhesion, while rougher surfaces promote biofilm accumulation.

The quantitative findings further strengthen this relationship. Dentures categorized within the high-roughness group ($>0.50 \mu\text{m}$) demonstrated markedly higher fungal loads compared with those in the smooth group ($\leq 0.2 \mu\text{m}$). This gradient pattern suggests that the relationship between surface texture and fungal colonization is not merely qualitative but increases progressively with surface irregularity. Another important observation was the relationship between surface roughness and the severity of denture stomatitis. Patients presenting with Newton's Type III stomatitis exhibited significantly higher mean roughness values compared with those with Type II lesions. This finding indicates that surface topography may not only influence microbial colonization but may also contribute to the progression of mucosal inflammation.

The biological explanation for this phenomenon is consistent with the known characteristics of *Candida albicans*. The yeast cells typically measure approximately 3–5 μm in diameter. When the denture surface contains microscopic depressions, these niches allow fungal cells to attach firmly and initiate biofilm formation. Once established, the biofilm structure provides protection against environmental stresses and allows continued colonization of the mucosal surface beneath the denture. The logistic regression analysis conducted in the present study further confirmed that surface roughness is an independent predictor of fungal colonization. Dentures with roughness values greater than 0.2 μm were more than four times more likely to demonstrate high levels of *Candida* growth compared with smoother surfaces. Importantly, this association remained significant even after controlling for other contributing factors such as nocturnal denture wearing and denture age. This indicates that surface roughness is a dominant factor in determining fungal adherence to denture bases. The findings also provide insight into clinical prosthodontic practice in the region. The mean roughness value observed in this study (0.48 μm) is considerably higher than the recommended threshold. This suggests that many dentures may be delivered with insufficient finishing and polishing or may undergo surface degradation during long-term use. Over time, repeated cleaning, chemical exposure, and mechanical wear can increase surface irregularities, thereby promoting microbial accumulation.

These observations emphasize the importance of proper laboratory finishing procedures and regular clinical maintenance of dentures. Achieving a smooth denture surface during fabrication may significantly reduce the risk of microbial colonization. Additionally, periodic polishing or surface refinement may be beneficial for long-term denture wearers who develop recurrent stomatitis.

The findings of this study also highlight the importance of patient education. In addition to proper denture fabrication, patients should be instructed regarding appropriate hygiene practices, overnight denture removal, and regular dental check-ups. These preventive strategies may help reduce the microbial load on denture surfaces and improve mucosal health.

Limitations

This study has several limitations that should be acknowledged. First, the cross-sectional design does not allow causal relationships to be established between surface roughness and fungal colonization. Second, the study population was limited to patients attending teaching hospitals in Peshawar, which may limit generalization to other populations. Third, although *Candida albicans* was quantified, other

Candida species that may contribute to denture stomatitis were not specifically identified. Future longitudinal studies with larger populations and species-level identification may provide further insight into the relationship between denture surface characteristics and fungal biofilm development.

Conclusion

The present study demonstrates a strong association between denture base surface roughness and *Candida albicans* colonization among complete denture wearers. Increased surface irregularities significantly increase fungal biofilm formation and contribute to the development and severity of denture stomatitis.

Improved denture finishing techniques and regular denture maintenance may help reduce fungal colonization and improve oral health outcomes among edentulous patients.

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