

Evaluation of Papillary Deficit Between Dental Implant-Supported Crown and Adjacent Natural Tooth

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Submitted for Publication: 30-10-2024
Accepted for Publication 30-12-2024

How to Cite: Khan AA, Afzal M, Khan DA, Amjad A, Hussain S, Paiker S. Evaluation of Papillary Deficit Between Dental Implant-Supported Crown and Adjacent Natural Tooth. APMC 2025;19(1):15-19. DOI: 10.29054/APMC/2025.1694

ABSTRACT

Objective: To evaluate the mean peri-implant papilla height adjacent to a natural tooth and assess any association of peri-implant papillary deficit with implant location. **Study Design:** Cross-sectional descriptive study. **Settings:** Prosthodontics Department, Armed Forces Institute of Dentistry, Rawalpindi Pakistan. **Duration:** Six months, from January 2023 to July 2023. **Methods:** 100 patients with dental implants replacing central incisors or first premolars, adjacent to natural teeth, were included. After crown placement (T0), the distance between the interproximal papilla tip and contact point was measured using the CPITN periodontal probe. After 3 months (T1), the measurement was repeated to assess papillary deficit. Data were analyzed using SPSS version 24. Descriptive statistics were calculated, and the paired sample t-test was used to compare papillary deficit at T0 and T1. Stratification and independent sample t-test were employed for effect modifiers ($p < 0.05$). **Results:** The mean papilla height between the implant and tooth was 2.92 ± 0.72 mm. The mean papillary deficit at T0 was 2.73 ± 0.44 mm, while at T1, it was 0.85 ± 0.52 mm. The difference in papillary deficit at T0 and T1 was statistically significant ($p = 0.001$). No significant difference was found in papillary deficit based on implant location ($p = 0.14$). **Conclusion:** A statistically significant improvement in papillary height was observed from crown placement to 3 months, indicating progressive papilla growth. However, the implant location did not affect the papillary deficit.

Keywords: Crown, Dental implant, Gingiva, Interproximal papilla, Papillary height.

INTRODUCTION

Restoration is considered successful when it closely mimics the appearance and function of a natural tooth. Patients' expectations for aesthetic outcomes following rehabilitation with dental implants, particularly in the anterior region, have risen.^{1,2} While successful osseointegration of dental implants is important, patient satisfaction is more significantly influenced by the aesthetics of the restoration and the surrounding soft tissue architecture. Key factors include the height, thickness, color, and texture of the soft tissue around the implant, as well as the emergence profile of the crown, all of which are crucial to the overall success of prosthetic rehabilitation.^{3,4}

A papillary deficit that arises from a reduction in the height of the papilla between a dental implant and an adjacent natural tooth can lead to unsightly "black triangles", thereby, negatively impacting the dentofacial aesthetics.⁵ These open embrasures are not only unesthetic, but they may also impair speech and cause food impaction, thereby affecting soft-tissue health.⁶ A multitude of factors appear to affect papillary height including the type of surgical procedure involved location of implant placement, inter-proximal space morphology, distance from the alveolar crest and restoration's contact point, residual ridge dimensions especially the labial/buccal plate, gingival phenotype as well as the material of the dental implant.^{3,6-9}

Despite continuous research, the exact role of various factors affecting the stability of interproximal papillary height between a dental implant and a natural tooth is rather vague.¹⁰ Moreover, the interaction of these factors that may result in soft-tissue compromise around the dental implant is also poorly understood. This creates a need for further research on papillary height around dental implants and the factors affecting papillary architecture to achieve a better understanding and to avoid this problem in hospital settings.

The current research aimed to determine the mean peri-implant papilla height adjacent to the natural tooth and to investigate any association of peri-implant papillary deficit with the location of the dental implant (anterior versus posterior) in the general population. The knowledge thus obtained will help in optimizing soft-tissue architecture around dental implants, thereby enhancing aesthetic outcomes.

METHODS

A cross-sectional descriptive study was designed and conducted at the Department of Prosthodontics, Armed Forces Institute of Dentistry in Rawalpindi over a period of six months, from January 2023 to July 2023. Approval was obtained from the institute's ethical committee (Letter Ref No 918/ Trg Dated 13/May/2020). The sample size was determined using the WHO calculator, setting the confidence level ($1-\alpha$) at 95% and the absolute precision (d) at 0.216, based on a mean papillary deficit of 0.8 ± 1.1 mm¹. Ultimately, a total sample size of 100 was calculated. Non-probability consecutive sampling was done. Patients, either gender, aged between 20-60 years with implants, replacing missing central incisors or first premolar, placed in a sterile environment (6-7 months before crown placement), and having natural abutment present next to the implant were included in the study. They had good periodontal health (absence of gingival and bone recession, absence of bleeding) and good oral hygiene (absence of dental caries, plaque, calculus, and gingival bleeding and absence of gingival or bone recession). Patients with uncontrolled diabetes, coagulation issues, or any other systemic illness that may cause implant failure those with evidence of an acute infection at the surgery site, or those with poor oral hygiene were excluded from the study. Smokers, alcoholics, and pregnant women were also excluded. Patients were appointed for crown placement as per routine protocol. After the crown was placed (T₀), the distance between the tip of the interproximal papilla and the contact point was measured using a CPITN periodontal probe (Figure 1) and recorded in a pre-designed pro forma. The patient received hygiene instructions and was scheduled for a follow-up appointment after three months to assess the papillary deficit. At follow-up (T₁), the distance between the tip of

the interdental papilla and the contact point was measured again and documented. Additionally, the total height of the interproximal papilla was recorded.

Figure 1: Papillary deficit – the distance between the interproximal papilla to the contact point between a dental implant and adjacent natural tooth



Data were analyzed using the Statistical Package for Social Sciences (SPSS) version 24. Descriptive statistics were calculated, with mean $\pm$ standard deviation computed for quantitative variables like age and papillary deficit. Qualitative variables such as gender, frequency, and percentages were determined. The mean papilla height at the three-month follow-up was also calculated. The papillary deficit at crown placement and at the three-month follow-up was compared using a paired sample t-test. Stratification was performed to account for potential effect modifiers, such as gender and implant location, and an independent sample t-test was applied after stratification. A significance level of $p < 0.05$ was set for all statistical tests.

RESULTS

Among 100 study subjects, 47% were female and 53% were male. The mean age of the study sample was 38.89 ± 13.181 years (range: 20-80 years). Dental implants replacing central incisors were 38% ($n=38$) of the sample while those replacing first premolars were 62% ($n=62$). The mean papilla height between the dental implant and the tooth was 2.92 ± 0.72 mm (Table 1). The mean distance from the interdental papilla tip and the contact point between the natural tooth and implant-supported crown at T₀ was 2.73 ± 0.44 mm while at T₁, it was 0.85 ± 0.52 mm (Table 2). The difference in the mean papillary deficit between the dental implant and the adjacent natural tooth, measured at two-time points (T₀ and T₁), was found to be statistically significant ($p = 0.001$), as shown in Table 3.

Table 1: Mean papilla height between the dental implant and adjacent natural tooth

Location	Papillary Height (mm) Mean $\pm$ SD
Central Incisor	3.1 $\pm$ 0.78
First premolar	2.75 $\pm$ 0.66
Total	2.92 $\pm$ 0.72

Table 2: Interproximal papillary deficit at the time of crown placement (T₀) and 03-months follow-up (T₁)

Papillary deficit	Minimum (mm)	Maximum (mm)	Mean $\pm$ SD (mm)
At time of crown placement (T ₀)	1.90	3.58	2.73 $\pm$ 0.44
At 03-months follow-up (T ₁)	0.02	1.83	0.85 $\pm$ 0.52

Table 3: Comparison of the mean papillary deficit between the dental implant and the natural tooth at the time of crown placement (T₀) and at 03-months follow-up (T₁) (n=100)

Time	Papillary deficit Mean $\pm$ SD (mm)	P
at the time of crown placement (T ₀)	2.73 $\pm$ 0.44	0.001
at 03-months follow-up (T ₁)	0.85 $\pm$ 0.52	

The mean papillary deficit between the natural tooth and implant crown at 03-months follow-up did not differ significantly based on gender ($p=0.082$). Likewise, no significant difference in mean papillary deficit could be seen at the 03-months follow-up for different implant locations ($p=0.14$). However, a significant difference in the mean papillary deficit was seen in different age groups, with decreasing papillary height with increasing age (Table 4).

Table 4: Comparison of mean papillary deficit at 03-months follow-up between gender groups and age groups

Effect-modifier		N	Papillary deficit Mean $\pm$ SD (mm)	P
Gender	Male	53	0.74 $\pm$ 0.55	0.082
	Female	47	0.97 $\pm$ 0.46	
Location	Central Incisor	38	0.83 $\pm$ 0.44	0.14
	First Premolar	62	0.98 $\pm$ 0.52	
Age	<40 years	49	0.74 $\pm$ 0.02	0.01
	$\geq$ 40 years	51	0.95 $\pm$ 0.57	

DISCUSSION

Maintaining optimal soft tissue health around dental implants presents a significant challenge in modern dentistry. Ideally, an interproximal papilla should entirely fill the space between a dental implant and adjacent structure (tooth, implant, or poetic), extending from the alveolar crest to the base of the “contact point” of restoration.¹²

Dental implants in the present study showed a good soft-tissue profile after placement of a definitive crown. Few studies have measured papillary deficit around dental implants. The mean interproximal deficit between the implant and tooth at 03 months follow-up was found to be 0.851 $\pm$ 0.52 mm. Similar results were shown by Kinah *et al.*¹¹ with a mean papillary deficit of 0.8 $\pm$ 1.1 mm for dental implants with an adjacent tooth. The mean papilla height between the dental implant and tooth (measured at 03 months follow-up) was 2.92 $\pm$ 0.72 mm. Comparable results have been reported by Gholami *et al.* who reported a mean papillary height of 2.87 $\pm$ 0.75 mm in the implant-tooth group.⁵ Comparatively higher values have been reported by Choquet *et al.*¹³ who found a mean papillary height of 3.9 mm. However, they had a very small sample size which might have resulted in an increased variation in results.

In the current study, no obvious difference in mean papillary deficit could be observed between implants placed in different locations (anterior vs. posterior). This aligns with the findings reported by Gholami *et al.* and Cosyn *et al.* and Schropp *et al* who reported no effect of implant location on papillary height.^{5,14,15} However, Kolte *et al* reported decreasing contact point area and subsequent papilla height from anterior to posterior teeth distally.¹⁶ Souza *et al* also reported an absence of papilla around almost 50% of the dental implants placed in posterior region.¹ This high percentage has been attributed to a lack of adjacent natural tooth structures, rendering the papilla restoration rather difficult. Since the present study only focused on dental implants with adjacent natural tooth, a complete lack of interproximal papilla was not observed.

The present study identified a significant association between age and papillary deficit, with a notable increase in papillary deficit observed as age increased. This finding is endorsed by Gholami *et al* who also reported an “inverse” relation of papillary height and advancing age. Similar results have also been reported by Kolte *et al*¹⁶ and Schropp *et al.*¹⁵ who found better papilla bulk and score in younger individuals.

No significant difference in mean papillary deficit was found between males and females in this study. Gholami *et al* also did not report any association between gender

and papillary height. Kolte RA *et al.*¹⁶ also reported a lack of association of gender to papillary height. Although they did find wider proximal contact areas in males than females, but did not report on its statistical significance. Contrary to our results, Kolte RA *et al.*¹⁷ and Kolte AP *et al.*¹⁸ reported greater values of mean papillary height for females than males. However, the researchers included subjects over a very narrow age range (20-40 years) which may explain the difference in results. Our study sample consisted subjects over a wider age range, which might have led to overall insignificant results.

The present study has a few shortcomings. The sample size was relatively small. Only dental implants adjacent to natural teeth were included. Papillary height was assessed only in relation to gender, age and implant location. Other factors which may affect papillary height such as height of the residual ridge, presence of keratinized tissue, adjacent dental implant/pontic, gingival biotype, dimensions of the interproximal space, implant material and type of surgery were not considered. Future studies addressing these variables are suggested.

CONCLUSION

The mean papilla height between the dental implant and the adjacent tooth was 2.92 ± 0.72 mm. The difference in mean papillary deficit between the dental implant and the adjacent natural tooth, measured on the day of crown placement and three months later, was statistically significant, indicating progressive growth of the interdental papilla. However, the papillary deficit was not influenced by the location of the implant.

LIMITATIONS

The study's limitations include a short 3-month follow-up, a relatively small sample size, and the exclusion of factors like gingival biotype, implant material, and surgical technique. It did not consider the impact of adjacent restorations or different implant types. Additionally, patient-reported outcomes and the effect of pre- and post-surgical gingival management were not assessed.

SUGGESTIONS / RECOMMENDATIONS

Future studies should extend follow-up to 6 months or 1 year to assess long-term papillary stability. A larger, more diverse sample size is needed, along with exploration of additional factors like gingival biotype, implant material, and design. Assessing gingival thickness, contour, and emergence profile could provide a fuller understanding of soft tissue influences. Comparing surgical techniques (flapless vs. flap surgery) and implant types (titanium vs. zirconia) would also be beneficial. Additionally, evaluating the role of adjacent restorations, using 3D

imaging for accuracy, and including patient-reported outcomes would improve aesthetic outcomes. Pre- and post-surgical gingival management should also be explored to optimize papillary growth.

CONFLICT OF INTEREST / DISCLOSURE

None.

ACKNOWLEDGEMENTS

Faculty and staff of Armed Forces Institute of Dentistry.

FUNDING

Nil.

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