

Occurrence Of Caries In Natural Tooth Surfaces Adjacent To Fixed Dental Prosthesis – A Descriptive Cross-Sectional Study

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Abstract

Background: Caries contiguous to FDPs is a major biological complication that can compromise the longevity of restorations. Limited evidence is available from the Lahore population, where variations in clinical technique, laboratory quality, and patient hygiene may influence outcomes.

Objectives: To assess the frequency of caries in natural tooth surfaces adjacent to fixed dental prostheses.

Materials and Methods: This descriptive cross-sectional study was conducted at the Department of Prosthodontics, Fatima Memorial Hospital, Lahore. A total of 246 patients aged 18–65 years with porcelain-fused-to-metal crowns or bridges in place for at least six months were included. Clinical and radiographic examinations were performed to assess caries and contact status (acceptable, open, tight). Chi-square/Fisher's exact tests were run.

Result: The mean age was 37.7 years (SD = 13.5), with 56.5% males. Bridges (56.5%) were slightly more frequent than crowns (43.5%). Caries were observed on the mesial side in 32.1% and on the distal side in 28.9% of adjacent teeth. No significant association was found with age, gender, or prosthesis type. However, caries were significantly higher in open contacts compared with acceptable or tight contacts ($p < 0.001$).

Conclusion: Caries adjacent to FDPs were common, with one-third of patients affected. Open contacts were the strongest risk factor, underscoring the importance of precise clinical and laboratory procedures to ensure proper contact formation and minimize biological complications.

Keywords: Fixed dental prosthesis; Proximal caries; Adjacent tooth surfaces; Proximal contact integrity; Secondary caries;

Introduction

Fixed dental prostheses (FDPs) have been commonly used to rehabilitate functions, retain occlusions, preserve the remnant tooth structures and enhance dental aesthetics. The success of FDPs in the long run, does not solely rely on the type of restorative material and prosthesis design, but also the accuracy of clinical and laboratory practices especially marginal adaptation and proximal contact integrity. Poor performance of these technical aspects may pre dispose the patients to biological complications that weaken the survival of the restorations.^{1,2}

The number of secondary caries near FDPs is one of the most commonly reported biological causes of failure in fixed prosthodontic treatment. Marginal differences that are more than what is clinically acceptable enables the build up of plaque and microleakage that could lead to secondary caries, pulpal inflammation and periodontal breakdown.³ Some

studies have established that even the advances in restorative materials and fabrication have failed to enhance the restorative materials, yet, biological failures, and not mechanical failures, continue to dominate as the cause of replacement of the fixed prostheses.^{4,5}

Besides the marginal integrity, the proximal contact quality is also a most important aspect in ensuring periodontal and caries-free adjacent tooth surfaces. Shaped and tight proximal contacts are necessary that contributes to food impaction and effective interdental cleaning. On the other hand, open or poorly located contacts form places that allow the formation of plaque which heightens the caries related to proximal caries in the teeth adjacent to FDPs.⁶ A perfect proximal contact ought to allow dental floss flow with slight resistance, and this is very close to natural dentition and promotes overall oral health in the long run.^{7,8}

Whereas the marginal discrepancies have been well assessed in the literature in the past, relatively few studies have given development to proximal contact integrity's role as an independent and modifiable risk factor of secondary caries. The evidence indicates that malfunctioning proximal contacts can also play a consonant role in the progression of adjacent caries; this aspect is also under examined especially in developing nations, where inconsistency in clinical skill and laboratory procedures is a usual occurrence.^{3,9}

Lahore population is a distinctive clinical environment with a large number of patients, a significant range of practitioners' experience, and a diverse range of laboratory fabrication processes, i.e., both conventional and semidigital. Such factors can have a great impact on the quality of FDP fabrication and,

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accordingly, on the presence of biological complications. Although this region has a prominent prevalence of the fixed prosthodontic restorations, there is a paucity of local data assessing the caries prevalence in natural tooth surfaces neighbouring FDPs, that is, in terms of proximal contact status.^{10, 11}

Thus, the current research was carried out to determine the occurrence of proximal caries in the natural tooth surface that are near fixed dental prostheses and the linkage that exists between proximal caries and contact integrity, proximal. The creation of context specific evidence could assist prosthodontists to determine which technical aspects can be altered and use preventative measures to decrease the occurrence of biological complications and enhance the overall performance of FDPs.

Material and Methods

This cross-sectional descriptive study was conducted in the Department of Prosthodontics, Fatima Memorial Hospital, Lahore, following the approval of the institutional review board under **FMH-21/07/2025-IRB- 1687**, using a non-probability consecutive sampling technique. Informed consent was obtained from all participants, or from their guardians in the case of individuals below 16 years of age, in accordance with the Declaration of Helsinki. Confidentiality of patient data was strictly maintained.

Several studies conducted on Pakistan reported the presence of caries on teeth adjacent to fixed dental prostheses. However, those studies had a small sample size and restricted geographic representation. Furthermore, the focus of those studies was on marginal discrepancy rather than proximal contact.

The current study provides new evidence by systematically categorized the proximal contact status into an acceptable, open, and compact using clinical and radiographic evaluation, and assessing its association with mesial and distal caries in a larger urban population. This research goes beyond mere prevalence reporting to localize existing knowledge and provide clinically useful evidence that prosthodontists can use by treating contact integrity as a modifiable technical variable. In addition, performance of the study in Lahore, being a major referral centre using different clinical and laboratory workflows, will allow for an efficient assessment of prosthesis related biological complications in a non homogeneous treatment setting. As a result, the findings of this research are expected to enhance the clinical performance and laboratory fabrication standards in the prevention of secondary caries of fixed dental prostheses.

The sample size was 246 at 5% margin of errors and 95% confidence level using 20% frequency of caries adjacent to FDP on distal side.⁽¹⁾ The inclusion criteria comprised Pakistani nationals (based on NIC), of both genders, aged between 18 and 65 years. Patients with porcelain-fused-to-metal (PFM) crowns, either as a single unit or part of a bridge with at least one natural tooth adjacent to the crown, were included. Both adjacent root canal treated teeth and adjacent vital teeth were considered. Only fixed dental prostheses that were at least six months old, provided by a qualified dental practitioner, and fabricated by a qualified dental technician were included. Patients with acceptable, open, or tight contacts adjacent to the fixed prosthesis were eligible.

Exclusion criteria included fixed dental prostheses with no adjacent tooth or with a badly broken down tooth root, partially erupted, extruded, or intruded adjacent teeth, and patients with mental or physical disabilities that compromised their ability to maintain oral hygiene. Patients fulfilling the inclusion

criteria were selected from the OPD of the hospital. A single trained examiner performed all clinical and radiographic examinations. Before collecting any data, calibration of the examiner was done on 25 patients not included in the final sample to standardize the assessment of proximal contact status and detection of caries. The tests were repeated after two weeks to check on intra examiner reliability.

The evaluation of intra examiners agreement was achieved by means of Cohen's kappa statistics. The kappa results demonstrated a good reliability ($\kappa > 0.80$). This means that none of the chosen radio graphs was rejected by the assessors for caries and contact status. Data analysis was conducted using R Software version 4.3.3. For numerical data such as age, the mean with SD (or median with IQR for skewed data, assessed through the Shapiro Wilk test) was reported. Frequencies and percentages of caries (mesial and distal), gender, type of contact (acceptable, open, tight), and type of prosthesis (crown or bridge) were computed. The outcome variable (caries on both sides) was stratified by gender, age group, contact type, and type of prosthesis. Post-stratification, the chi-square test was run. If there were fewer than 5 counts per cell, Fisher's exact test was used instead of the chi-square test. A significance level of $p < 0.05$ was applied.

Results

Among the 246 patients, the mean age was 37.65 years (SD = 13.50). The most common age group was 31–65 years with 153 patients (62.2%), followed by 18–30 years with 93 patients (37.8%). of the 246 participants, 139 (56.5%) were male and 107 (43.5%) were female (**Table 1**).

Caries in Teeth Adjacent to Fixed Dental Prosthesis Bridges were more frequent ($n = 139, 56.5\%$) than crowns ($n = 107, 43.5\%$). Contact points were most often acceptable ($n = 143, 58.1\%$), followed by open ($n = 70, 28.5\%$) and tight ($n = 33, 13.4\%$). Mesial caries was observed in 79 participants (32.1%), whereas distal caries were identified in 71 participants (28.9%) (**Table 2**). No significant difference in mesial caries was found between females ($n = 35, 32.7\%$) and males ($n = 44, 31.7\%$) ($p = 0.86$), or between patients aged 31–65 years ($n = 49, 32.0\%$) and those aged 18–30 years ($n = 30, 32.3\%$) ($p = 0.97$).

Table 1. Demographic Characteristics of the Study Participants (N = 246)

Characteristic	pH ± SD, n=3
Age(years), Mean (SD)	37.65(13.50%)
Gender	
Female	107 (43.50%)
Male	139 (56.50%)
Age Group (years)	
31-65	153 (62.20%)
18-30	93 (37.80%)

Table 2. Distribution of prosthesis type, contact status, and presence of proximal caries (N = 246)

Characteristic	pH ± SD, n=3
Type of prosthesis	
Bridge	139 (56.5%)
Crown	107 (43.5%)
Status of contact points	
Acceptable	143 (58.1%)
Open	70 (28.5%)
Tight	33 (13.4%)
Mesial caries	
Absent	167 (67.9%)
Present	79 (32.1%)
Distal caries	
Absent	175 (71.1%)
Present	71 (28.9%)

= 30, 32.3%) (p = 0.97). Similarly, no significant difference in distal caries was found between females (n = 30, 28.0%) and males (n = 41, 29.5%) (p = 0.80), or between the older group (n = 47, 30.7%) and the younger group (n = 24, 25.8%) (p = 0.41) (Table 3).

The frequency of mesial caries was similar between bridges (n = 44, 31.7%) and crowns (n = 35, 32.7%) with no significant difference (p = 0.86). Distal caries also showed comparable rates between bridges (n = 40, 28.8%) and crowns (n = 31, 29.0%) (p = 0.97). By contact status, mesial caries was significantly higher in open contacts (n = 61, 87.1%) compared with acceptable (n = 16, 11.2%) and tight contacts (n = 2, 6.1%) (p < 0.001). Similarly, distal caries were higher in open contacts (n = 57, 81.4%) compared with acceptable (n = 12, 8.4%) and tight contacts (n = 2, 6.1%) (p < 0.001) (Table 4). After stratifying, Pearson's chi-square test was applied for the association of categorical variables while Fisher's exact test was executed for expected counts less than five. Exact p-values were reported when possible, and p < 0.05 was regarded as statistically significant.

Table 3. Comparison of Mesial and Distal Caries by Gender and Age Group

Characteristic	Female (N=107)	Male (N=139)	p-value	Age 31–60 years (N=153)	Age 15–30 years (N=93)	p-value
Caries on Mesial side			0.86			0.97
No	72 (67.29%)	95 (68.35%)		104 (67.97%)	63 (67.74%)	
Yes	35 (32.71%)	44 (31.65%)		49 (32.03%)	30 (32.26%)	
Caries on Distal side			0.80			0.41
No	77 (71.96%)	98 (70.50%)		106 (69.28%)	69 (74.19%)	
Yes	30 (28.04%)	41 (29.50%)		47 (30.72%)	24 (25.81%)	

n (%), Pearson's Chi-squared test

Table 4. Association of prosthesis type and contact status with mesial and distal caries

Characteristic	Type of Prostheses			Status of Contact			
	Bridge (N=139)	Crown (N=107)	p-value	Acceptable (N=143)	Open (N=70)	Tight (N=33)	p-value
Caries on Mesial side				0.86			<0.001
No	95 (68.35%)	72 (67.29%)	127 (88.81%)		9 (12.86%)	31 (93.94%)	
Yes	44 (31.65%)	35 (32.71%)	16 (11.19%)		61 (87.14%)	2 (6.06%)	
Caries on Distal side				0.97			<0.001
No	99 (71.22%)	76 (71.03%)	131 (91.61%)		13 (18.57%)	31 (93.94%)	
Yes	40 (28.78%)	31 (28.97%)	12 (8.39%)		57 (81.43%)	2 (6.06%)	

n (%), Pearson's Chi-squared test

Discussion

This study examined the occurrence of proximal caries adjacent to fixed dental prostheses (FDPs) with respect to prosthesis type and the integrity of proximal contact points. Carious lesions on both the mesial and distal surfaces were observed in nearly onethird of cases, with no significant variation across gender, age groups, or types of prostheses. In contrast, the condition of proximal contacts proved to be a critical determinant: open contacts were significantly associated with a higher prevalence of mesial and distal caries compared with acceptable or tight contacts.

The similar frequency of caries observed between crowns and bridges suggests that the biological risk was determined less by the type of prosthesis and more by the technical precision in establishing proper proximal contact integrity. This supports

the well recognized principle that open contacts create plaque retentive niches, facilitating food impaction and thereby increasing susceptibility to caries in adjacent teeth. By comparison, acceptable contacts permit physiologic interdental cleaning and thus reduce this risk, while tight contacts though sometimes associated with floss shredding did not demonstrate a comparable caries burden in the present study.

A radiographic evaluation of fixed partial dentures (FPDs) in Saudi Arabia found that the prevalence of caries in adjacent teeth (both mesial and distal) was about 15%, and that optimal marginal fit and exact interproximal contacts are important for periodontal health.⁴ A survey of dental professionals indicated that food impaction related to defective fixed partial denture (FPD) design is a common cause of proximal caries and interdental bone loss. The most frequently reported design faults included inadequate contact relations, improper contouring, deficient margin adaptation, and errors in pontic design. Each of these factors contributes to the formation of plaque retentive areas, thereby increasing the risk of caries development.¹⁵

The study outcomes are relevant to the routine practice of prosthodontics. The strong correlation of open proximal contacts to adjacent caries further shows that contact integrity is a potentially modifiable technical factor and not a patient related risk.⁴ The making of precise proximal contact during the making of crown and bridge, including adjusting the contact at the tryin and final cementation should thus be given due importance by the clinician. Verification of contact adequacy using floss and radiographs should not be considered an optional refinement of cavity preparation. It is a lab fault if there are open contacts, and a proper waxing, contouring and finishing will prevent this. Furthermore, patients with existing fixed dental prostheses with open contacts should be identified early and placed on closer recall so there is no secondary caries or failure of the prosthesis.

These findings are consistent with the work of Ahmad et al.¹ who demonstrated that faulty proximal contacts of porcelain used to metal crowns were significantly associated with caries in adjacent teeth. Their results showed that both open and tight contacts increased susceptibility, with tight contacts exhibiting a stronger association (33.3% mesial, 20% distal). They further emphasized that marginal discrepancies were a significant contributing factor to caries risk (p < 0.002). Collectively, the evidence from both studies indicates that the biological complications of fixed dental prostheses are influenced less by material or design alone and more by the accuracy of marginal adaptation and the proper establishment of proximal contacts.

Our study found no significant differences in caries prevalence across age groups or between genders. This suggests that patient related factors such as age and sex play a relatively minor role in determining caries risk compared with prosthesis related factors, particularly the precision of proximal contact.³ These findings emphasize the critical importance of careful clinical and laboratory procedures during the fabrication of fixed dental prostheses, as even small technical errors in contact adjustment may lead to long term biological complications.^{2, 5}

From a clinical standpoint, these findings shows that the success of fixed dental prostheses extends beyond mechanical stability and esthetics, demanding equal attention to biologic factors such as proximal contact integrity and marginal adaptation. Achieving precise contact points at the time of placement is essential, as it can substantially lower the risk of

secondary caries and help preserve the long term function of both the prosthesis and the adjacent teeth.^{11,14}

The strength of this study was its clearly defined inclusion criteria, standardized evaluation of proximal contacts, and combined use of clinical and radio graphic assessment, all of which enhanced the validity of the findings. Nonetheless, certain limitations must be recognized. The cross sectional design restricted the ability to establish causality or monitor the temporal progression of caries. Moreover, potential confounding factors such as oral hygiene practices and dietary habits, which may influence caries risk, were not controlled. As this was a single center study, the generalizability of the results to broader populations remains limited. Future investigations should adopt longitudinal designs to monitor the incidence and progression of caries over time and assess whether corrective adjustments of contact points can mitigate

biological complications. Multi center studies involving diverse populations and incorporating additional variables such as oral hygiene status would provide a more comprehensive evidence base.

Conclusion

Caries adjacent to FDPs were common, with one- third of patients affected. Open contacts were the strongest risk factor, emphasizing the importance of precise clinical and laboratory procedures to ensure proper contact formation and minimize biological complications.

CONFLICT OF INTEREST: None

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Author Contributions

1. Maira Rafique : Conceptualization of the study, study design, fundings, materials, data collection, data analysis, literature review, and manuscript writing.
2. Zahid Iqbal : Clinical supervision, study design, data collection,data analysis, and critical review.
3. Amal Abdul Majid: Conceptualization of the study, data analysis, and critical review.
4. Hadia Jathol: Data collection,data analysis, and critical review.