Dental Biofilm Accumulation and Gingival Health of Teeth with Fixed Single Prosthesis Fabricated by Various Prosthetic Materials

Pradhan A,[1] Shrestha K,[2] Aryal S,[1] Shrestha S[1]

[1]Department of Periodontics and Oral Implantology,

[2]Department of Prosthodontics,

Peoples Dental College and Hospital,

Kathmandu, Napal.

Corresponding Author

Ameena Pradhan

Department of Periodontics and Oral Implantology,

Peoples Dental College and Hospital,

Kathmandu, Napal.

E-mail: docameenapradhan@gmail.com

Citation

Pradhan A, Shrestha K, Aryal S, Shrestha S. Dental Biofilm Accumulation and Gingival Health of Teeth with Fixed Single Prosthesis Fabricated by Various Prosthetic Materials. *Kathmandu Univ Med J.* **Online First**.

ABSTRACT

Background

Periodontal health plays an important role in maintaining the health of natural teeth as well as in the success of all dental procedures. Fixed single prosthesis (dental crown) can be fabricated with different types of prosthetic restorative materials like Metal, Ceramic, Ceramic fused to metal. These different materials have different affinity for plaque accumulation leading to the development of gingival inflammation and periodontal disease.

Objective

To determine the amount of Plaque accumulation and gingival health of teeth with a fixed single prosthesis fabricated by various Prosthetic materials.

Method

This quantitative cross-sectional study was carried out from July 2021 to March 2022. The patients who visited the hospital after six months of use of the prosthesis enrolled and were categorized into three groups according to the material used for the prosthesis metal, ceramic, and metal-ceramic. The periodontal condition was assessed using the plaque index and gingival index.

Result

A total of 136 patients (78 female and 58 male) were enrolled in the study, with a mean age of 39.44 ± 16.23 years (Range 19 – 70 years). There were 47 patients with ceramic crowns, 39 patients with metallic, and 50 patients with metal ceramic crowns. The mean plaque index of metal, ceramic, and metal-ceramic crowns was found 1.15 ± 0.546, 0.86 ± 0.479, and 0.93 ± 0.498 respectively. Similarly, the mean gingival index of metal, ceramic, and metal-ceramic crown were 1.22 ± 0.56, 0.91 ± 0.48, and 1.09 ± 0.55 respectively.

Conclusion

The dental biofilm (plaque) accumulation and hence gingival inflammation is less in ceramic crowns than in metal and metal-ceramic crowns.

KEY WORDS

Dental crown, Dental plaque index, Gingival index

INTRODUCTION

Periodontal health plays an important role in maintaining the health of natural teeth as well as in the success of all dental procedures. Dental procedures if not performed properly can lead to the plaque accumulation. Dental biofilm (plaque) accumulation is considered as the main etiologic agent for the periodontal disease.[1] Therefore plaque accumulation has to be considered to have long-term success of the dental procedures with healthy periodontium.

The fixed single prosthesis (FSP) or dental crown is the one that protects the tooth from further loss of remaining tooth structure and protects it from intra-oral forces improving its clinical success. These prosthodontics treatment procedures might affect the underlying healthy periodontium leading to periodontal disease. Similarly, underlying periodontal condition might affect the longevity of prosthetic treatment, vice versa. Therefore, Periodontics and Prosthodontics share an intimate and inseparable relationship from the diagnosis to executing treatment procedures and during the maintenance phase. Various factors need to be considered while fabricating the dental prosthesis like violation of biological width, extension of dental caries, margins and contours of the crown prosthesis, and restorative materials used for fabricating it.[1-4]

Dental crown (FSP) can be fabricated with different types of prosthetic restorative materials like Metal, Ceramic, Ceramic fused to metal (Metal-ceramic). These different materials have different affinity for plaque accumulation leading to the development of gingival inflammation and periodontal disease, thus further affecting the success of prosthetic treatment.[5] Hence, the aim of this study was to determine the amount of plaque accumulation and gingival health of teeth with FSP fabricated by various prosthetic materials at six months.

METHODS

Patients of the age group eighteen years and above visiting the Periodontics and Oral Implantology Department and Prosthodontic Department of People's Dental College and Hospital for regular checkups after having FSP were enrolled in the study after getting informed consent from the patients. The study was started after getting ethical approval from the ethical committee board of People's Dental College and Hospital (Ref. No. 1.2078/2079). This quantitative cross-sectional study with a convenient sample was carried out from July 2021 to March 2022. The sample size was calculated using the formula $N = Z^2 - SD^2/d^2$ [Z= 1.96 at 95% confidence level; SD = standard deviation of plaque index; d=maximum tolerable error (10% of mean)] concerning Almotairy et al.[6]

A healthy individual with a minimum of one FSP with supra-gingival marginal fit at six months of cementation and who brushes twice daily was included. Sub-gingival margin of the crown, overcontoured crown , cheeped off crowns, lack of marginal fit of the crown, single fixed prosthesis with missing adjacent tooth or teeth, patients with smoking habits and with systemic disease or condition which will affect periodontal health like diabetes, pregnancy, medication with Phenytoin, Cyclosporine, Nifedipine were excluded.

The patients were examined with the help of the mouth mirror and explorer. The patients were categorized into 3 groups according to the material used for FSP as metal, ceramic, and metal-ceramic prosthesis. The periodontal condition was assessed using the Plaque Index as given by Silness J. and Loe H.1964 modified by Loe H. in 1967 and the Gingival Index given by Loe H. and Silness J.[7] Plaque index was scored as 0 when there is no plaque, 1- A film of plaque adhering to the free gingival margin and adjacent area of the tooth. The plaque may be seen only by running a probe across the tooth surface; 2- Moderate accumulation of soft debris within the gingival pocket, on the gingival margin and/or adjacent tooth surface, which can be seen by the naked eye; 3- Abundance of soft matter within the gingival pocket and/or on the gingival margin and adjacent tooth surface.

Gingival index was scored as 0- when there is an absence of inflammation/normal gingiva; 1- Mild inflammation, slight change in color, slight edema; no bleeding on probing; 2- Moderate inflammation; moderate glazing, redness, edema, and hypertrophy, bleeding on probing; 3- Severe inflammation; marked redness and hypertrophy, ulceration, tendency to spontaneous bleeding.[7] For both indices (PI and GI) the average score of six surfaces (mesiobuccal, buccal, distobuccal, disto-lingual, lingual, and mesial lingual) of the specific tooth was taken and divided by six.

The statistical analysis was done using SPSS version 16. The plaque index and gingival index of each group with the use of three different types of crown material were analyzed using ANOVA to analyze the differences between the means of the three groups. The level of significance was set at p-value < 0.05.

RESULTS

A total of 136 patients (78 female and 58 male) were enrolled in the study, with a mean age of 39.44 ± 16.23 years (Range 19-70 years). There were 47 patients with ceramic crowns, 39 patients with metallic, and 50 patients with metal ceramic crowns (Table1).

Table 1. Frequency distribution and Age distribution of three groups.

Groups	N	Age	F	P
Metal	39	43.89 ± 15.61	2.49	0.087
Ceramic	47	36.17 ± 16.07		
Metal-ceramic	50	39.06 ± 16.37		

Table 2. **Statistical analysis of plaque index and gingival index.**

Groups	N	Plaque Index Mean±SD	F-value	p-value	Gingival Index Mean±SD	F-value	p-value
Metal	39	1.15±0.546	3.77	**0.025**	1.22±0.56	3.93	**0.022**
Ceramic	47	0.86±0.479			0.91±0.48		
Metal-ceramic	50	0.93±0.498			1.09±0.55		

The mean plaque index of metal, ceramic, and ceramic fused with metal crown was found 1.15 ± 0.546, 0.86 ± 0.479, and 0.93±0.498 respectively. There was a significant difference in the plaque index between the groups. (F=3.77 and p-value 0.025) In post hoc analysis (Tukey HSD Q-statistic) significant difference was observed between the metal and ceramic group (P= 0.024) for the plaque index.

Table 3. **Post hoc analysis (Tukey's) between the groups.**

Group Pair	Plaque Index p-value	Gingival Index p-value
Metal vs Metal-ceramic	0.103	0.457
Metal vs Ceramic	**0.024***	**0.017***
Metal-ceramic vs Ceramic	0.763	0.211

The mean of gingival index of metal, ceramic and metal-ceramic crown were 1.22 ± 0.56, 0.91 ± 0.48, 1.09 ± 0.55 respectively. A statistically significant difference was observed in the gingival index between the groups (F=3.70 and p-value 0.03) (Table 2). Post hoc analysis (Tukey's) showed a significant difference between the metal and ceramic group (P= 0.017) for the Gingival index (Table 3).

DISCUSSION

There exists a robust relationship between periodontal and prosthetic dental procedures. Prosthetic factors might affect periodontal health and similarly, periodontal health might affect prosthodontics therapy. To have successful prosthodontics (prosthesis) treatment with a healthy periodontium, several factors need to be considered like biological width, trauma from occlusion, margin and contour of the crown, etc. Also prosthesis has to be fabricated only when the underlying periodontium is healthy without inflammation. Violation of these factors have been proven to affect the success of prosthesis and underlying periodontal health but there are very few studies regarding affinity for plaque accumulation of prosthetic materials. Therefore in this cross-sectional study, we have assessed dental biofilm accumulation and gingival health of teeth with fixed single prosthesis fabricated by various prosthetic materials like metal, metal ceramic and ceramic.[1-4]

In this study, plaque indices were determined for FSP of various dental materials like metal, metal ceramic, and ceramic. The determination of the plaque index according to the method of Silness and Loe, modified by Loe allows for an objective and clear evaluation of soft debris accumulation and allows for adequate comparative possibilities.[7] Plaque scores are statistically significant in this study (F=3.77 and p-value 0.025). As the statistics showed significant differences, post hoc Turkey's HSD Q-statistic was used to look for inter-group significance. The plaque index was significant (p-value=0.024) only between the metal and ceramic group but not between metal and metal-ceramic and ceramic and metal-ceramic. It means plaque accumulation is less in ceramic prosthesis than in metal prosthesis at 6 months of use of fixed prosthesis with the mean plaque index for metal and ceramic prosthesis being 1.22 ± 0.56, 0.91 ± 0.48 respectively. This may be because of the shorter duration (6 months) of crown delivery, and mixed prosthetic material tends to accumulation more plaque compared to an individual material. According to study done by Reitemeier et al. and Christensen stated that the prosthetic material has little effect on plaque accumulation which is consistent with our examination.[8,9] However, some studies have reported that the level of plaque accumulation varies according to dental materials used to fabricate FSP.[10,11] Ceramic has relatively less plaque accumulation in our study which is consistent with the study done by Clifford et al.[12]

The gingival index assesses the severity of the gingival inflammation and its location in four possible areas by examining only qualitative changes (severity of lesion) of the gingival soft tissue. As regards to means of the gingival index, statistically significant differences occurred in FSP made of metal, ceramic, and metal-ceramic materials (F=3.70 and p-value 0.03). While comparing metal FSP (mean gingival index = 1.22 ± 0.56) with the ceramic (mean gingival index = 0.91 ± 0.48), ceramic had a better gingival index (P = 0.017) which coincides with the study done by Almotairy et al. and contradict with the study by KC Basnyat et al.[6,13]

Regarding age of the patient, the values of plaque and gingival indexes were better in younger individuals, although this was not statistically significant. We believe that this is due to the higher motivation of younger patients and their better general health condition. The age distribution among the three groups is statistically not significant (p = 0.087) so bias due to age distribution is minimized.

Adequate crown contour protects gingival margin, allow cleansing action of the musculature, and facilitate access for oral hygiene whereas over contoured crown morphology may have a negative influence on periodontium since it increases plaque retention leading to inflammation of periodontal tissue.[14,15] Therefore, to standardize the samples in our study, over-contoured crown, sub-gingival

margin of the crown, cheeped-off crowns, and lack of marginal fit of the crown, were excluded from the study.

Crown margins can be placed supragingival, equigingival, or subgingival.[16] To prevent periodontal destruction supra gingival margins are preferred over others but they are highly recommended at the sites with less esthetic concerns.[17] In the case of the subgingival margin, certain principles should be followed (bear in mind including) like conservatively subgingival extension of restorative margin, sufficient width of keratinized gingiva (at least 2 mm of keratinized gingiva including 1 mm of attached gingiva), smooth restorative surfaces with proper finished margin and the avoidance of biological width violation.[15] Adequate daily home care needs to be addressed to patients and regular professional maintenance is mandatory. Therefore, to standardize samples in our study, only supragingivally placed crown margins, who brushes twice daily were included.

In our study plaque accumulation and gingival inflammation were less in Ceramic crown compared to metal and Metal Ceramic at 6 month. According to Chan et al. the chemical makeup and nature of the dental materials as well as surface charges might have affected on different affinity of plaque accumulation on these various prosthetic materials.[12] And also we cannot neglect that Crown acts as a nidus for plaque accumulation therefore patient education, motivation and proper oral hygiene maintenance instructions has to be delivered to the patients prior, during and after completion of dental procedures.

Hence, the limitation of our study is short term follow up patients ie period of our examination is at 6 month which was too short to make reliable conclusion. Similarly, FSP manufacturing technique and Patient/Operator related factors haven't been considered. Therefore incorporation of these factors with the larger sample size would have increased generalizability of the result.

CONCLUSION

The dental biofilm (plaque) accumulation and gingival inflammation is less in ceramic crown than in metal and metal ceramic crowns at 6 month which is statistically significant. Though the PI and GI scores are low in metal ceramic than in metal prosthesis, are not statistically significant.

ACKNOWLEDGEMENT

I would like to acknowledge Dr. Rabindra Bhakta Pradhananga and Dr. Sabik Raj Kayastha for their help during preparation of this article.

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