European Annals of Dental Sciences
Official Publication of Ankara University, Faculty of Dentistry

EADS, 2023, 50 (3), 112–117

e-ISSN : 2757-6744
doi : 10.52037/eads.2023.0022

Article Received/Accepted : September, 25 2023 / October, 24 2023
Ethical Committee No : E-81477236-604.01.01-3070:29

ORIGINAL RESEARCH ARTICLE

The effect of different finish line designs and material types on the periodontal response of single crown restoration: a 3-year follow-up retrospective study

Sadeq Mohammed Taqi Fadhil [1], Mediha Nur Nişancı Yılmaz [2], Elif İnönü [2,*] and Caner Öztürk [3]

[1]Private Clinic, Antalya, Turkey and [2]Ankara Medipol University, Faculty of Dentistry, Department of Periodontology, Ankara, Turkey and [3]Ankara Medipol University, Faculty of Dentistry, Department of Prosthodontics, Ankara, Turkey

*Corresponding Author; einonu@hotmail.com

Abstract

Purpose: Different restorative materials and marginal finish lines may contribute to periodontal inflammation, despite patients' proper oral hygiene habits. The aim of this study was to evaluate the effect of different finish line designs and restorative materials on periodontal health.
Materials and Methods: In this retrospective clinical study, the periodontal clinical parameters of 450 crown restorations fabricated with different finish line designs (chamfer, shoulder, knife-edge) and different materials (Metal-ceramic, Zirconia, Glass-ceramic) were evaluated at baseline and 12th, 24th and 36th months after the cementation. The data were analyzed with Repeated Measures ANOVA and post hoc least significant difference tests (α=.05).
Results: Periodontal clinical parameters significantly increased during the 36-month follow-up period. The marginal finish line and material type had no significant effect on the probing depth and gingival index scores. The highest plaque index scores were observed in zirconia restorations with knife edge finish lines at the 36th month after crown placement.
Conclusions: The periodontal health of the prepared tooth was negatively affected by the increased follow-up duration regardless of the marginal finish line design and material type. The clinicians should consider the favorable effect of the glass-ceramic crown restorations with a chamfer finish line on the plaque control for long-term success.

Key words: Glass-Ceramic Restoration; Marginal Finish Line; Periodontal Health; Plaque Index; Prosthetic procedure

Introduction

Fixed dental prostheses have a crucial role in preserving the remaining tooth structure that is reduced due to caries or trauma. [1,2]The crown restorations are generally designed for the replacement of the missing part of the tooth structure, to obtain aesthetics, and to restore function. [1]Various kinds of prosthetic materials are introduced to achieve the desired esthetic and functional outcomes. [3] Metal-based restorations are widely used for crown restoration due to their excellent mechanical properties and cost-effectiveness. However, the opacity of the metal infrastructure can reduce enamel-like translucency and result in unsatisfactory esthetic outcomes. [4]Also, they may cause allergic reactions in some patients and harbor more diverse microbial communities in subgingival area. [5,6]With the development of CAD/CAM technology in dentistry, zirconia and all-ceramic restorations have gained popularity when compared to metal-ceramic restorations as a result of their ideal marginal fit and lower plaque accumulation. [7] However, all-ceramic restorations have the disadvantages of limited mechanical properties and low durability resistance. [8]

For the longevity of fixed dental restorations, clinicians should be aware of the strong association between prosthetic restorations and periodontal health. Prosthetic restorations must be critically managed in all regions, they should be in harmony with their surrounding periodontal tissues. [9] Rough and irregular surfaces, deep subgingival margin design, overhanging contours and the poor marginal integrity of fixed dental prostheses contribute to dental biofilm accumulation which can cause periodontal inflammation, secondary caries, gingival recession, and early prosthesis failure. [10] Therefore, the choice of proper finish line design and restorative

How to cite: Fadhil SMT, Nisanci-Yilmaz MN, Inonu E, Ozturk C. The effect of different finish line designs and material types on the periodontal response of single crown restoration: a 3-year follow-up study. EADS. 2023;50(3): 112-117

material is a crucial part of the success of prosthetic treatment in patients who mainly desire to function and esthetics, without leaving aside the biocompatibility and periodontal health that is an integral part of this process.[11,12]

The marginal finish line has been defined as the junction between the prepared and unprepared tooth surface. The periodontal inflammation results in alveolar bone resorption, increased pocket depths, loss of periodontal support, and exacerbation of accumulation of subgingival bacteria, if the finish line of the crown restoration exceeds the supracrestal tissue attachment which is the combined width of connective tissue and junctional epithelium.[13,14]The decision of the marginal design depends on several factors such as tooth morphology, the distance between the free gingival margin and the periodontal attachment, the location of the restoration, crown length, distance between adjacent teeth, prosthetic material, and the operator's experience to achieve a healthy and esthetically satisfying result. The clinician should consider which finish line design is optimum for periodontal health and restorative materials.[15–17]Therefore, the aim of this study was to evaluate the effect of different marginal finish line designs and prosthetic materials on periodontal health. The null hypothesis of the study was that different marginal finish lines and material types have no significant effect on the periodontal health of single crown restorations.

Material and Methods

This retrospective clinical study included a total of 310 patients (181 female, 129 male) with a mean age of 50 (18–73 years) who were referred to the private dental clinic from June 2017 to July 2020. The study was conducted in accordance with the guidelines of the Declaration of Helsinki of 1975, as revised in 2013. This study was approved by the Ethics Committee of Ankara Medipol University (E-81477236-604.01.01-3070:29). The patients, aged ≥18 years of both genders, have good oral hygiene, systemically and periodontally healthy, with no medication intake that might affect periodontal soft tissues, non-pregnant, non-smokers, requiring crown restorations on vital (n:402) and non-vital (n:48) teeth with different localization [maxillary posterior (n:124), maxillary anterior (n:114), mandibular posterior (n:131), mandibular anterior (n:81)] were included in the study. The patients who had missing data were excluded from the study. A total of 450 crown restorations with three different finish lines (Knife-edge, chamfer, shoulder) and different material types [Metal-ceramic restorations (n=280); Bi-layered zirconia restorations;(n=102); and Glass-ceramic restorations (n=68)] were evaluated (Table 1). The tooth preparations were performed with approximately 6◦ axial taper, occlusal reduction of 1.5 to 2 mm, axial reduction of 1.0 to 1.5 mm, and a finish line located at the gingival level. All preparations were finished by rounding sharp angles. Polyvinyl siloxane impression material was used to take impressions and the marginal adaptation of the crowns were evaluated radiographically and clinically after cementation with resin cement (Table 1). All clinical procedures were performed by an experienced clinician (ST) and all laboratory procedures was performed by an experienced laboratory technician. The clinical periodontal parameters were recorded at baseline (immediately after cementation), 12th, 24th, and 36th months after the delivery of the crown restorations. Plaque index (PI)[18], gingival index (GI)[19] and probing depth (PD) of abutment teeth were recorded.[20]Probing depths were measured from the gingival margin to the bottom of the periodontal pocket using a periodontal probe (William Probe, Hu-Friedy) to the nearest millimeter. All measurements were assessed at four sites per tooth (distal, mesial, lingual/palatal, and buccal). All the patients were evaluated for the periodontal parameters by one calibrated periodontist (Eİ). The intra-examiner reproducibility was 0.90, 0.86, 0.88 for PD, PI, and GI; respectively.

The statistical analyses were conducted using software (SPSS version 20 Inc., IBM Corp.). The normality of the data was assessed by using the Shapiro-Wilks test. Effect of marginal finish line, material type, age, gender and localization of the restorations on the Probing Depth, Gingival Index and Plaque Index scores were analyzed by using Repeated Measures ANOVA and post-hoc LSD test with Bonferroni correction at a significance level of 0.05.

Results

According to the statistical analysis conducted, gender, age and localization of the restorations had no significant effect on the clinical periodontal parameters ($p>0.05$).

There was an increase in mean probing depth with the increasing functional duration which was found to be statistically significant ($p<0.001$). However, marginal finish line design, material type and interactions between these factors were not found to be statistically significant ($p>0.05$). The lowest probing depth was observed in the baseline and 12th month, and the highest probing depth was observed at the 24th and 36th month after cementation except for zirconia restorations with chamfer finish line and glass-ceramic restorations with chamfer and shoulder finish lines (Table 2).

For the plaque index scores, the functional duration ($p= 0.010$), marginal finish line ($p= 0.050$), material type ($p= 0.030$) and interactions between these factors were found to be significant ($p= 0.040$). The lowest plaque index scores were observed in glass-ceramic restorations ($p= 0.031$), and no differences were found between zirconia and metal-ceramic restorations ($p>0.05$). The plaque index scores of zirconia and metal-ceramic restorations with shoulder and knife-edge finish lines significantly increased during the follow-up period. The highest plaque index scores were observed in zirconia restorations with the knife-edge finish lines in the 36th month. No differences were observed in terms of functional duration and marginal finish line for the glass-ceramic restorations ($p>0.05$) (Table 3).

Functional duration and marginal finish line design had a significant effect on the gingival index scores of the groups ($p<0.001$), but material type had no significant effect on the gingival index scores of the groups. Gingival index scores of the restorations significantly increased during the follow-up period. In the zirconia group, the chamfer design had significantly lower gingival index scores at baseline, 12th and 24th months ($p<0.05$) (Table 4).

Discussion

According to the results of the present study, marginal finish line design and material type have a significant effect on the plaque index scores. However, gingival index scores and probing depths were not influenced by marginal finish line design and material type. Therefore, the null hypothesis of the study is that different marginal finish lines and material types have no significant effect on the periodontal health of single crown restorations, was partially rejected.

Careful treatment planning, maintenance of periodontal health, and adherence to basic principles of prosthetic dentistry are crucial factors to ensure the function, aesthetics, and mechanical stability of fixed prostheses.[21] The metal-free restorations have been developed for esthetically challenging cases due to the disadvantages of metal-ceramic restoration.[22] Additionally, biocompatibility and low plaque retention could be considered as the advantages of metal-free and zirconia ceramics compared to metal-ceramic restorations while the metal-ceramic restorations have been preferred due to their high mechanical strength, clinically acceptable marginal and internal adaptation, and cost-effectiveness.[23,24]Therefore, it should be noted that the type of material (metal, ceramic, etc.), laboratory procedures, the vitality of the tooth, the periodontal status of the patient, and other possible causes could influence the effect of the restoration on periodontal health.[25–27]Since the location of

Table 1. Materials used in the present study

Material	Infrastructure	Suprastructure
Metal-ceramic	Laser Sintering Co–Cr (EOS CobaltChrome SP2; EOS GmbH, Krailling, Germany)	Conventional layering (Noritake EX-3; Noritake Dental Supply, Mie, Japan)
Zirconia	3Y-TZP Block (Nacera Pearl Shade, DOCERAM, Medical Ceramic, dortmunt, Germany)	Conventional Layering ceramic (IPS e.max Ceram; Ivoclar Vivadent , Schaan, Liechtenstein)
Glass-ceramic	Lithium disilicate (USA; IPS e.max Press, Ivoclar Vivadent, Schaan ,Liechtenstein)	Conventional Layering ceramic (IPS e.max Ceram; Ivoclar Vivadent , Schaan, Liechtenstein)
Glaze	Vita Akzent Plus Vita Zahnfabrik, Bad Sackingen, Germany)	
Cement	Resin cement (RelyX Unicem SelfAdhesive Universal Resin Cement; 3M ESPE, St. Paul, MN).	
Impression Material	Putty-wash technique (ELITE HD+ Putty Soft and ELITE HD+ Light body, Zhermack SpA, Badia Polesine,Italy)	

Table 2. Mean (±SD) probing depth values for the groups

	Probing Depth	Knife-edge(a)	Chamfer(a)	Shoulder(a)
Zirconia (A)	Initial	1,11 (±0,32)A	1,00 (±0,00)A	1,17 (±0,38)A
	12th month	1,15 (±0,36)A	1,00 (±0,00)A	1,13 (±0,33)A
	24th month	1,38 (±0,49)B	1,00 (±0,00)A	1,31 (±0,47)B
	36th month	1,79 (±0,41)C	2,00 (±0,00)B	1,81 (±0,39)C
Metal-ceramic (A)	Initial	1,07 (±0,25)A	1,00 (±0,00)A	1,11 (±0,32)A
	12th month	1,15 (±0,36)A	1,00 (±0,00)A	1,13 (±0,34)A
	24th month	1,35 (±0,48)B	1,50 (±0,71)B	1,26 (±0,44)B
	36th month	1,78 (±0,41)C	2,00 (±0,00)C	1,79 (±0,41)C
Glass-ceramic (A)	Initial	1,00 (±0,00)A	1,11 (±0,31)A	1,27 (±0,46)A
	12th month	1,00 (±0,00)A	1,34 (±0,48)A	1,14 (±0,35)A
	24th month	1,13 (±0,35)B	1,13 (±0,34)A	1,27 (±0,46)A
	36th month	1,50 (±0,53)C	1,79 (±0,41)B	1,68 (±0,48)B

Different superscript letter indicates statistically difference ($p<0.05$))

Table 3. Mean (±SD) plaque index scores for the groups

	Plaque index	Knife-edge	Chamfer	Shoulder
Zirconia(A)	Initial	0,53 (±0,50)Aa	1,00 (±0,00)Ab	0,65 (±0,60)Aa
	12th month	0,74 (±0,74)Ba	1,00 (±0,00)Ab	0,85 (±0,68)Ba
	24th month	1,26 (±1,02)Ca	1,00 (±0,00)Aa	1,04 (±0,87)Ca
	36th month	1,91 (±1,15)Da	1,00 (±0,00)Aa	1,25 (±0,98)Da
Metal-ceramic(A)	Initial	0,60 (±0,59)Aa	0,50 (±0,71)Aa	0,59 (±0,58)Aa
	12th month	0,81 (±0,74)Ba	1,00 (±0,00)Ab	0,66 (±0,70)Ba
	24th month	1,10 (±0,91)Ca	1,50 (±0,71)Ab	0,89 (±0,86)Ca
	36th month	1,38 (±1,01)Da	1,00 (±1,41)Aa	1,00 (±1,02)Da
Glass-ceramic(B)	Initial	0,60 (±0,59)Aa	0,45 (±0,50)Aa	0,46 (±0,56)Aa
	12th month	0,88 (±0,64)Aa	0,63 (±0,85)Aa	0,55 (±0,60)Aa
	24th month	0,88 (±0,64)Aa	0,68 (±0,87)Aa	0,55 (±0,74)Aa
	36th month	0,75 (±0,71)Aa	0,63 (±0,91)Aa	0,55 (±0,74)Aa

Different superscript letter, uppercase in columns and lower case in lines indicates statistically difference ($p<0.05$)

Table 4. Mean (±SD) gingival index scores for the groups.

	Gingival index	Knife-edge	Chamfer	Shoulder
Zirconia(A)	Initial	0,40 (±0,53)Aa	0,00 (±0,00)Ab	0,44 (±0,50)Aa
	12th month	0,53 (±0,58)Ba	0,00 (±0,00)Ab	0,54 (±0,54)Ba
	24th month	0,81 (±0,76)Ca	0,00 (±0,00)Ab	0,67 (±0,56)Ca
	36th month	1,08 (±0,81)Da	1,00 (±0,00)Ba	0,92 (±0,65)Da
Metal-ceramic(A)	Initial	0,48 (±0,52)Aa	0,00 (±0,00)Ab	0,41 (±0,50)Aa
	12th month	0,62 (±0,61)Ba	0,50 (±0,71)Ba	0,44 (±0,50)Aa
	24th month	0,79 (±0,66)Ca	1,00 (±0,00)Bb	0,61 (±0,64)Ba
	36th month	0,98 (±0,75)Da	1,00 (±0,00)Ba	0,77 (±0,74)Ca
Glass-ceramic(A)	Initial	0,50 (±0,53)Aa	0,18 (±0,39)Ab	0,36 (±0,49)Aa
	12th month	0,50 (±0,53)Aa	0,29 (±0,52)Ba	0,41 (±0,50)Ba
	24th month	1,00 (±0,76)Ba	0,42 (±0,55)Cb	0,55 (±0,51)Cb
	36th month	1,13 (±0,83)Ca	0,58 (±0,64)Db	0,64 (±0,66)Db

Different superscript letter, uppercase in columns and lower case in lines indicates statistically difference ($p<0.05$)

the restoration margin may affect periodontal parameters, in order to examine the relationship between periodontal parameters and prosthetic materials, fixed restorations with marginal location at the gingival level were included in the present study.

According to the results of the present study, the lowest plaque was recorded in glass-ceramic restorations. Parallel to our study, Chan et al.[28] and Weishaupt et al.[12] evaluated the effect of different prosthetic materials on plaque accumulation. The authors concluded that more pronounced plaque retention was observed in metal-ceramic restorations than in all-ceramic restorations. Increased plaque accumulation on metal-ceramic restoration could be explained by increased marginal discrepancies due to manufacturing processes.[29,30] In the present study, there was no significant difference regarding plaque accumulation at the 12th and 24th months between metal-ceramic and zirconia restorations. These results are consistent with Pelaez et al.[31] and Basnyat et al.[32], who reported that a similar pattern of plaque accumulation, compared zirconia restorations and metal-ceramic restorations in terms of clinical periodontal parameters. Additionally, Monaco et al.[33] concluded that there were no significant differences between zirconia-based and metal-ceramic restorations in functional and biological outcomes. Besides, the findings of this study showed that the plaque index score of the zirconia restorations was higher than glass-ceramic restorations at 36th months. This result could be attributed to the high percentage of knife-edge marginal finish line design of zirconia restorations evaluated in this study. In recent years, studies showed that the presence of a fixed prosthetic restoration could promote the onset of periodontal diseases.[34] Because the surfaces of some prosthetic materials serve as niches for microbial adhesion and biofilm formation which has the potential to degrade the material's surface and to cause various types of periodontal diseases. Therefore, prosthetic materials that are less prone to bacterial colonization become more popular, especially in periodontally suspicious patients.[35] Dental ceramic materials are highly biocompatible and stable while performing under the harsh conditions of the oral cavity. Shang et al.[36] compared the CAD/CAM zirconia all-ceramic crown restoration to porcelain-fused-to metal restorations according to the volume and composition of the gingival crevicular fluid. Their findings showed that the CAD/CAM zirconia all-ceramic crown restoration is more favorable to the periodontal health.[37] Besides, a metal material inevitably releases metal ions in the oral cavity because of the corrosive effect of the saliva, and it could irritate the periodontal tissues. In addition, in a clinical study, authors observed the alterations in the subgingival microbiome in the metal-based restorations group due to the composition of material.[5,38] Therefore, the prosthetic material type may be a crucial factor for the success of the prosthetic restoration and periodontal status, even if ideal laboratory and clinical conditions are provided.

In the present study, it was observed that the knife-edge marginal finish line design had the highest mean clinical periodontal indices than the chamfer and shoulder margin designs regardless of material type. Paniz et al.[39] showed that the vertical finish line design was related to significantly higher BOP scores compared to the chamfer margin design. Many factors for the knife-edge preparation could contribute to the periodontal inflammation such as technical challenges encountered during the fabrication procedures, and difficulties in communication between clinician and technician to determine the exact finishing line position.[40] Additionally, over-contouring of the definitive restoration to prevent chipping which may be promoted by stress around the cervical area, difficulties in removing cement excess and challenges to control the marginal seal and integrity could be mentioned as the disadvantages of the knife-edge marginal finish line design.[41] These reasons could explain the unfavorable effect of knife-edge marginal finish line designs on periodontal health compared to other finish line designs.

Cement dissolution, micro-leakage, the fractures of the restorations could be observed due to insufficient marginal adaptation and could lead to unsuccessful clinical results of the restoration, tooth caries, and periodontal disease.[42,43] According to Yu et al., for glass-ceramic restorations, the choice of a chamfer finish line in clinical practice appears to be satisfactory for exhibiting better internal adaptation and comparable marginal adaptation.[44]

Although a large number of single crown restorations (n:450) with 3 years follow-up period were evaluated in this study, the evaluation of only single crown restorations, fabricated with conventional techniques and the retrospective design of the study such

as selection bias may be considered as the limitations of the present study. Therefore, the effect of different restoration types fabricated with different manufacturing procedures with long-term-follow-up periods on periodontal health should be further investigated.

Conclusion

Within the limitations of the present study, it was noticed that the highest mean gingival scores were observed on the restorations with knife edge marginal finish lines. Glass-ceramic restorations prepared with chamfer or shoulder marginal finish lines emerged as the recommended prosthetic restoration design from periodontal points of view for single crown restorations.

Author Contributions

All authors have made substantial contributions to data collection, conception and design, acquisition of data, interpretation of data and initial and final drafting of the manuscript and were accountable for all aspects of the work. SMTF, MNNY, Eİ and CÖ contributed to data analyses and critically revised the manuscript. All authors gave final approval of the version to be published and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Conflict of Interest

The authors declare that they have no conflict of interest.

Authors' ORCID(s)

S.M.T.F. 0000-0003-4462-0642
M.N.N.Y. 0000-0002-6410-2060
E.İ. 0000-0002-4789-748X
C.Ö. 0000-0001-9549-2770

References

1. Christensen GJ. When is a full-crown restoration indicated? J Am Dent Assoc. 2007;138(1):101–3. doi:10.14219/jada.archive.2007.0028.
2. Pjetursson BE, Lang NP. Prosthetic treatment planning on the basis of scientific evidence. J Oral Rehabil. 2008;35 Suppl 1:72–9. doi:10.1111/j.1365-2842.2007.01824.x.
3. Sailer I, Pjetursson BE, Zwahlen M, Hämmerle CH. A systematic review of the survival and complication rates of all-ceramic and metal-ceramic reconstructions after an observation period of at least 3 years. Part II: Fixed dental prostheses. Clin Oral Implants Res. 2007;18 Suppl 3:86–96. doi:10.1111/j.1600-0501.2007.01468.x.
4. Mallineni SK, Nuvvula S, Matinlinna JP, Yiu CK, King NM. Biocompatibility of various dental materials in contemporary dentistry: a narrative insight. J Investig Clin Dent. 2013;4(1):9–19. doi:10.1111/j.2041-1626.2012.00140.x.
5. Rademacher SWH, Zaura E, Kleverlaan CJ, Buijs MJ, Crielaard W, Loos BG, et al. Qualitative and quantitative differences in the subgingival microbiome of the restored and unrestored teeth. J Periodontal Res. 2019;54(4):405–412. doi:10.1111/jre.12642.
6. Rokaya D, Bohara S, Srimaneepong V, Kongkiatkamon S, Sultan Z, Heboyan A, et al. Metallic Biomaterials for Medical and Dental Prosthetic Applications. In: Functional Biomaterials. Springer; 2022. p. 503–522. doi:10.1007/978 – 981 – 16 – 7152 – 418.
7. Paul N, Raghavendra Swamy KN, Dhakshaini MR, Sowmya S, Ravi MB. Marginal and internal fit evaluation of conventional metal-ceramic versus zirconia CAD/CAM crowns. J Clin Exp Dent. 2020;12(1):e31–e37. doi:10.4317/medoral.55946.
8. Schley JS, Heussen N, Reich S, Fischer J, Haselhuhn K, Wolfart S. Survival probability of zirconia-based fixed dental prostheses up to 5 yr: a systematic review of the literature. Eur J Oral Sci. 2010;118(5):443–50. doi:10.1111/j.1600-0722.2010.00767.x.
9. Srimaneepong V, Heboyan A, Zafar MS, Khurshid Z, Marya A, Fernandes GVO, et al. Fixed Prosthetic Restorations and Periodontal Health: A Narrative Review. J Funct Biomater. 2022;13(1). doi:10.3390/jfb13010015.
10. Hao Y, Huang X, Zhou X, Li M, Ren B, Peng X, et al. Influence of Dental Prosthesis and Restorative Materials Interface on Oral Biofilms. Int J Mol Sci. 2018;19(10). doi:10.3390/ijms19103157.
11. Padbury J A, Eber R, Wang HL. Interactions between the gingiva and the margin of restorations. J Clin Periodontol. 2003;30(5):379–85. doi:10.1034/j.1600-051x.2003.01277.x.
12. Weishaupt P, Bernimoulin JP, Lange KP, Rothe S, Naumann M, Hägewald S. Clinical and inflammatory effects of galvano-ceramic and metal-ceramic crowns on periodontal tissues. J Oral Rehabil. 2007;34(12):941–7. doi:10.1111/j.1365-2842.2007.01804.x.
13. Gupta N, Singh KS, Nisha C, Kapoor V. Effects Of Tooth Preparation And Poorly Designed Artificial Crowns On Health Of Periodontium And Esthetics : A Case Report. Indian Journal of Dental Sciences. 2014;6(4):46–8.
14. Shenoy A, Shenoy N, Babannavar R. Periodontal considerations determining the design and location of margins in restorative dentistry. Journal of Interdisciplinary Dentistry. 2012;2:3–10. doi:10.4103/2229-5194.94184.
15. Abduo J, Lyons KM. Interdisciplinary interface between fixed prosthodontics and periodontics. Periodontol 2000. 2017;74(1):40–62. doi:10.1111/prd.12189.
16. Croll BM. Emergence profiles in natural tooth contour. Part II: Clinical considerations. J Prosthet Dent. 1990;63(4):374–9. doi:10.1016/0022-3913(90)90223-y.
17. Donovan T, Prince J. An analysis of margin configurations for metal-ceramic crowns. J Prosthet Dent. 1985;53(2):153–7. doi:10.1016/0022-3913(85)90097-6.
18. Silness J, Loe H. PERIODONTAL DISEASE IN PREGNANCY. II. CORRELATION BETWEEN ORAL HYGIENE AND PERIODONTAL CONDTION. Acta Odontol Scand. 1964;22:121–35. doi:10.3109/00016356408993968.
19. Loe H, Silness J. PERIODONTAL DISEASE IN PREGNANCY. I. PREVALENCE AND SEVERITY. Acta Odontol Scand. 1963;21:533–51. doi:10.3109/00016356309011240.
20. Chapple ILC, Mealey BL, Van Dyke TE, Bartold PM, Dommisch H, Eickholz P, et al. Periodontal health and gingival diseases and conditions on an intact and a reduced periodontium: Consensus report of workgroup 1 of the 2017 World Workshop on the Classification of Periodontal and Peri-Implant Diseases and Conditions. J Periodontol. 2018;89 Suppl 1:S74–s84. doi:10.1002/jper.17-0719.
21. Goodacre CJ, Campagni WV, Aquilino SA. Tooth preparations for complete crowns: an art form based on scientific principles. J Prosthet Dent. 2001;85(4):363–76. doi:10.1067/mpr.2001.114685.
22. Martinez Galeano G, Palomar L. Selection of dental ceramics in an esthetic area. A case report. Revista Facultad de Odontología. 2018;vol 29. doi:10.17533/udea.rfo.v29n1a12.
23. Gautam C, Joyner J, Gautam A, Rao J, Vajtai R. Zirconia based dental ceramics: structure, mechanical properties, biocompatibility and applications. Dalton Trans. 2016;45(48):19194–19215. doi:10.1039/c6dt03484e.
24. Stappert CF, Dai M, Chitmongkolsuk S, Gerds T, Strub JR. Marginal adaptation of three-unit fixed partial dentures constructed from pressed ceramic systems. Br

Dent J. 2004;196(12):766–70; discussion 760, quiz 780. doi:10.1038/sj.bdj.4811390.
25. Avetisyan A, Markaryan M, Rokaya D, Tovani-Palone MR, Zafar MS, Khurshid Z, et al. Characteristics of Periodontal Tissues in Prosthetic Treatment with Fixed Dental Prostheses. Molecules. 2021;26(5). doi:10.3390/molecules26051331.
26. Kosyfaki P, del Pilar Pinilla Martín M, Strub JR. Relationship between crowns and the periodontium: a literature update. Quintessence Int. 2010;41(2):109–26.
27. Ramamurthy J. Effect of Restorations on Periodontal health. IOSR Journal of Dental and Medical Sciences. 2014;13:71–73. doi:10.9790/0853-13747173.
28. Chan C, Weber H. Plaque retention on teeth restored with full-ceramic crowns: a comparative study. J Prosthet Dent. 1986;56(6):666–71. doi:10.1016/0022-3913(86)90140-x.
29. Hämmerle CH, Mesaric W, Lang NP. Marginal fit of porcelain crowns with galvanized frames. Schweiz Monatsschr Zahnmed. 1994;104(6):740–5.
30. Kokubo Y, Tsumita M, Ohkubo C, Vult von Steyern P, Murata T, Fukuhsima S. Clinical marginal gap of porcelain fused to electro-formed gold coping crowns. Eur J Prosthodont Restor Dent. 2006;14(2):85–9.
31. Pelaez J, Cogolludo PG, Serrano B, Serrano JF, Suarez MJ. A four-year prospective clinical evaluation of zirconia and metal-ceramic posterior fixed dental prostheses. Int J Prosthodont. 2012;25(5):451–8.
32. Kc Basnyat S, Sapkota B, Shrestha S. Oral Hygiene and Gingival Health in Patients with Fixed Prosthodontic Appliances - A Six Month Follow-up. Kathmandu Univ Med J (KUMJ). 2015;13(52):328–32. doi:10.3126/kumj.v13i4.16832.
33. Monaco C, Llukacej A, Baldissara P, Arena A, Scotti R. Zirconia-based versus metal-based single crowns veneered with overpressing ceramic for restoration of posterior endodontically treated teeth: 5-year results of a randomized controlled clinical study. J Dent. 2017;65:56–63. doi:10.1016/j.jdent.2017.07.004.
34. Dragomir LP, Nicolae FM, Gheorghe DN, Popescu DM, Dragomir IM, Boldeanu L, et al. The Influence of Fixed Dental Prostheses on the Expression of Inflammatory Markers and Periodontal Status-Narrative Review. Medicina (Kaunas). 2023;59(5). doi:10.3390/medicina59050941.
35. Kawai K, Urano M. Adherence of plaque components to different restorative materials. Oper Dent. 2001;26(4):396–400.
36. Shang LJ, Wu Y, Xu YJ. Effect of the CAD/CAM zirconia all-ceramic crown restoration on periodontal tissue. Chinese Journal of Tissue Engineering Research. 2014;18:4804–4809. doi:10.3969/j.issn.2095-4344.2014.30.008.
37. Ditrichova D, Kapralova S, Tichy M, Ticha V, Dobesova J, Justova E, et al. Oral lichenoid lesions and allergy to dental materials. Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub. 2007;151(2):333–9. doi:10.5507/bp.2007.057.
38. Ercoli C, Caton JG. Dental prostheses and tooth-related factors. J Clin Periodontol. 2018;45 Suppl 20:S207–s218. doi:10.1111/jcpe.12950.
39. Paniz G, Nart J, Gobbato L, Chierico A, Lops D, Michalakis K. Periodontal response to two different subgingival restorative margin designs: a 12-month randomized clinical trial. Clin Oral Investig. 2016;20(6):1243–52. doi:10.1007/s00784 – 015 – 1616 – z.
40. Vojdani M, Safari A, Mohaghegh M, Pardis S, Mahdavi F. The effect of porcelain firing and type of finish line on the marginal fit of zirconia copings. J Dent (Shiraz). 2015;16(2):113–20.
41. Łabno P, Drobnik K. Comparison of horizontal and vertical methods of tooth preparation for a prosthetic crown. Journal of Pre-Clinical and Clinical Research. 2020;14(1):25–28. Available from: https://doi.org/10.26444/jpccr/116672. doi:10.26444/jpccr/116672.
42. Contrepois M, Soenen A, Bartala M, Laviole O. Marginal adaptation of ceramic crowns: a systematic review. J Prosthet Dent. 2013;110(6):447–454.e10. doi:10.1016/j.prosdent.2013.08.003.
43. Mously HA, Finkelman M, Zandparsa R, Hirayama H. Marginal and internal adaptation of ceramic crown restorations fabricated with CAD/CAM technology and the heat-press technique. J Prosthet Dent. 2014;112(2):249–56. doi:10.1016/j.prosdent.2014.03.017.
44. Yu H, Chen YH, Cheng H, Sawase T. Finish-line designs for ceramic crowns: A systematic review and meta-analysis. J Prosthet Dent. 2019;122(1):22–30.e5. doi:10.1016/j.prosdent.2018.10.002.