

“Comparative assessment of marginal accuracy of copings fabricated with zirconia and peek materials: An vitro study”

Mishra SK , Rajnikanth AV

Rama Dental College, Hospital & Research Centre, Rama University, Mandhana, Kanpur
(UP)- 209217,

Abstract:

Purpose: The aim of this *in vitro* study was to evaluate and compare the Marginal accuracy and internal adaptation of copings fabricated with Zirconia and polyetheretherketone (PEEK) materials.

Materials and Methods: Maxillary first premolar was prepared to receive all ceramic restoration. It was duplicated using addition silicon impression material for fabricating Cobalt–Chromium metal die, which is used as a master die. Using the master die, 30 heat cure acrylic samples were fabricated for the heat cure acrylic tooth models on which 15 PEEK and 15 zirconia copings were made. Field Scanning Electron Microscopic study analysis for evaluating marginal fit and internal adaptation of two groups were observed. The values were then analyzed using one-way ANOVA (post hoc) followed by Dunnet *t*-test.

Results: Among those two groups, the zirconia copings group showed a mean value of (50.26 ± 16.02) for marginal gap and (32.8 ± 5.2) for internal gap whereas PEEK copings group materials showed the lowest mean value of (30.3 ± 5.1) , and (29.1 ± 5.8) respectively.

Conclusion: Among these two groups, comparatively less marginal fit and internal adaptation is seen in zirconia copings when compared to the PEEK copings. While the marginal fit and internal adaptation of both PEEK and zirconia copings were in the acceptable clinical range.

KEYWORDS: *Copings, internal adaptation, marginal fit, polyetheretherketone, zirconi*

INTRODUCTION

Today the computer-aided design/computer-aided machine (CAD/CAM) techniques dominated the old technologies for manufacturing crown and bridges. The CAD/CAM techniques employed in dentistry for the production which involve both the controlled machining

and layered manufacturing (AM) like rapid prototyping improved the standard and propitious of this prosthesis when compared to old fabrication methods.[1] CAD/CAM materials at present provide very good durability and resistance against fracture. During this recent times, it furnished with computerized production, precise, visually pleasing restorations with longtime durability and functionally strong enough to withstand the masticatory forces. It helps the clinician to achieve successful treatment outcome in the field of crowns and bridges in aesthetic fixed restorations by practicing the application of CAD/CAM technology.[2,3] These technologies which help to improve the patient comfort and satisfaction make them confident toward the clinician which improves their quality and professionalism. Among those materials, Polyetheretherketone (PEEK) and zirconia show excellent resistance to chemical, thermal, postirradiation degradation low solubility, and water absorption due to its structure, when it is compared with other currently available esthetic CAD/CAM polymers.[4] The weakest link in the fixed partial denture treatment is the tooth-restorative margin interface. For any dental restoration there should be proper marginal fit and internal adaptation.[5] The main reason for any successful restoration depends on proper fit and adaptation when it fails which leads to deposition of plaque followed by perio and endo involvement finally leads to failure of the whole treatment therefore, the fit and adaptation of the dental restoration plays a crucial importance for the highest form of long-term success in treatment outcome.[6,7] Advanced recent CAD-CAM technology using three-dimensional scanning and Mechanised processing produces an accurate fit and adaptation. In the present study, purpose is to evaluate the marginal fit and internal adaptation of (PEEK) and zirconia copings.

MATERIALS AND METHODS

In the current study, freshly extracted human maxillary first premolars were selected (orthodontic purposes). The crown size of 8 mm (mesiodistally) was selected which are free from carious, restoration, and no apparent defects. The selected tooth was prepared for all-ceramic crowns with ideal dimension. The preparation depths were 1 mm axially and 2 mm occlusally. The shoulder finish line margins were supra-gingival and the tooth preparation had a convergence angle of six degrees. Using additional silicone putty (AQUASIL) an impression of prepared maxillary first premolar was made and wax tooth model was fabricated from the impression. The wax tooth model was invested and casted to fabricate cobalt-chromium metal tooth model and then it duplicated using additional silicone to fabricate 30 heat cure acrylic models. The samples were divided into two groups. Each group consists of fifteen copings (15

PEEK copings and 15 Zirconia copings). A dual cure resin luting agent (Rely X U200 Self-Adhesive resin, 3M, Germany) was used to cement the copings to each model, an equal length of the luting resin is dispensed on the mixing pad, was done according to the manufacturer instructions, the mixed cement was painted on the internal surfaces of the copings. Copings were luted on the prepared tooth model with finger pressure for 10 min and the excess cements from the margins are removed.

Statistical Analysis:

The data were analyzed by SPSS VERSION 16, IBM SPSS Statistics, USA. One-way ANOVA (*post hoc*) followed by Dunnett *t*-test applied to find the statistical significance between the groups. $P < 0.05$ is considered statically significant at 95% confidence interval.

DISCUSSION

During 30 years, CAD-CAM technology has picking up attention and becoming popular among the dentist as well as normal surroundings which gives advantages of providing very quick speed, accurate and confidence in the integrity of the restorations design. Restorations manufactured using computerized technology designs (CAD-CAM) facilitates the early detection and correction of design flaws when compared with the conventional restorations.[8] The final progress of any desired treatment success can be attained only with durable and marginally adaptive fixed restorations. Any marginal gap and improper fit which cause microbes to enter further lead to failure in whole treatment progress. A high chance of microleakage occurs mainly due to improper fit of restorations when they exposed to oral secretions automatically cause secondary caries.[9] Concern with the longevity of a restoration clinically acceptable marginal discrepancies have been reported in the range of 40–120 μm . [10] In this present study, all the copings experimented out in the span of 35–80 μm considered to be in acceptable standards. Variety of dental materials was used in the computerized processing of fixed partial dentures which has a great impact on firmness and snug marginal adaptiveness of the final crowns. Poor marginal fit with the marginal gaps causes food accumulation and provides pathway for oral microbes to enter and further leads to endo-perio problems which will end up in the failure of whole treatment progress. The current study was conducted to comparatively evaluate the marginal fit and internal adaptation of PEEK and zirconia copings fabricated by CAD-CAM technique. For the present study natural premolar tooth was selected for the preparation of master die on which tooth preparation was done based on the principles of tooth preparation by

Shillinberg *et al.*[11] Using master die totally thirty acrylic dies were made On that fifteen PEEK and fifteen zirconia copings made. Finally, all thirty coping cemented into their respective thirty dies by using 3MESPE resin cements. Waited for 24 h to get complete set of thee cement followed by sectioned using a Diamond wheel disc, having a disc thickness of 0.01 mm cutting at high speed using a tooth cutting lathe (RAY FOSTER, USA) (entire procedure was carried out with continuous irrigation from the three-way syringe to reduce heat production). By following this procedure in sectioning the samples prevent heat production with its inherent structure provides coolant effect.[12] Marginal fit and internal adaptations were measured in microns using a field scanning electron microscope. All values recorded in microns and subject were evaluated using one-way ANOVA test. According to the literature, marginal fit and internal adaptation play an important role in the clinical success of ceramic restorations since improper fit and adaptation lead to more dental plaque retention, recurrent caries, and bone resorption. Some *in vivo* studies of zirconia-based restorations have shown that the edge gap can cause problems in the assembly and fit of computer-made frameworks and restorations. Numerous researchers have advocated a super and perfect marginal match for restorations to gain the successful final clinical outcome. The several investigators have given totally different values for the clinically time-honored variety of marginal discrepancy. Mclean and von Fraunhofer said that the clinically desirable marginal space should be after cementation should be < 150 and 120 μm , respectively.[13]

Asif *et al.* stated mean marginal space is towards a hundred and forty μm , while Hung *et al.* recommended a range of 50–75 μm . [14] The marginal gaps of optical device laser sintering-based fabricated copings ranges around 76–93 μm and 62.6 μm , given by Quante *et al.* and Ucar *et al.* Bae *et al.* detailed essentially way better edge space in polyetherketoneketone (PEEK) copings compared to zirconia, whereas de Paula Silveira *et al.* detailed superior internal fit for composite resin compared to a ceramic group. This discussion might be attributed to distinctive sorts of scanners, milling machines, blanks, or blocks. Thus, the clinical acceptance of marginal gaps varies quite across studies. In this present study marginal fit and internal adaptation measured as values, among those two groups, PEEK copings group materials showed the lowest mean value of (30.3 ± 5.1) for marginal fit, (29.1 ± 5.8) for internal adaptation whereas zirconia copings group showed a mean value of (50.26 ± 16.02) and (32.8 ± 5.2) respectively. There was a significant relation between groups and this may be due to the effect of the resin cement. When these results were analyzed, more gap observed for zirconia (Group II) may be due to the firing

cycles than that for PEEK (Group I). The consequences of the present study have a look at display that the material composition of CAD/CAM-made PEEK and zirconia copings have no statistically massive influence on retention however notably affects marginal and internal adaptation. While the marginal gap and internal fit of both PEEK and zirconia copings were in the acceptable clinical range. Among these two groups, less marginal fit and internal adaptation are seen in zirconia copings when compared to the PEEK copings. The existing observation of this study suggests that the properties of new ceramic materials have to be similarly investigated to understand their properties therefore it is able to be utilized in various long-term definitive aesthetic restorative materials. There are some limitations to this study. Standardized acrylic dies had been used for measuring marginal healthy and inner version however; the use of human tooth would be the right for simulating a medical procedure. For future research encompasses marginal fit and internal gap assessment of copings solid from CAD-CAM fabricated wax patterns following various amounts of simulated die spacer to determine if there has been the most appropriate quantity of simulated die spacer. Moreover, clinical trials with extraordinary enamel preparations are had to verify the prevailing result also by way of introducing speedy prototyping strategies; it is feasible to conquer all the subtractive method shortcomings. Further research is needed to find a better opportunity for older substances with these more modern materials.

CONCLUSION

Restricted to this observation from this study, PEEK coping presented statistically exquisite marginal perfection and internal merge compared with zirconia coping. However, the statistical ranges documented for PEEK and Zirconia copings are both clinically desirable. Marginal snug fit and inner adaptation are the important elements in providing the success in the longevity of the restoration.[19] Newer and reasonably priced CAD-CAM systems are delivered claiming higher marginal healthy fit and adaptation. The future research on Field Scanning Electron Microscopy can be done on these variables to get the better results.

REFERENCES:

1. Beuer F, Schweiger J, Edelhoff D. Digital dentistry: An overview of recent developments for CAD/CAM generated restorations. *Br Dent J.* 2008;204:505–11.

2. Marchack BW, Futatsuki Y, Marchack CB, White SN. Customization of milled zirconia copings for all-ceramic crowns: A clinical report. *J Prosthet Dent*. 2008;99:169–73.
3. Koutayas SO, Vagkopoulou T, Pelekanos S, Koidis P, Strub JR. Zirconia in dentistry: Part 2. Evidence-based clinical breakthrough. *Eur J Esthet Dent*. 2009;4:348–80.
4. Skirbutis G, Dzingute A, Masiliūnaitė V, Šulcaitė G, Žilinskas J. A review of PEEK polymer's properties and its use in prosthodontics. *SBDMJ*. 2017;9:19–23. [
5. Vagkopoulou T, Koutayas SO, Koidis P, Strub JR. Zirconia in dentistry: Part 1. Discovering the nature of an upcoming bioceramic. *Eur J Esthet Dent*. 2009;4:130–51.
6. Rosenstiel SF, Land MF, Fujimoto J. 4th edition. St Louis: Elsevier; 2016. Contemporary fixed prosthodontics.
7. Li RW, Chow TW, Matinlinna JP. Ceramic dental biomaterials and CAD/CAM technology: State of the art. *J Prosthodont Res*. 2014;58:208–16.
8. Baig MR, Tan KB, Nicholls JJ. Evaluation of the marginal fit of a zirconia ceramic computer-aided machined (CAM) crown system. *J Prosthet Dent*. 2010;104:216–27.
9. Korkut L, Cotert HS, Kurtulmus H. Marginal, internal fit and microleakage of zirconia infrastructures: An *in-vitro* study. *Oper Dent*. 2011;36:72–9.
10. Moldovan O, Luthardt RG, Corcodel N, Rudolph H. Threedimensional fit of CAD/CAM-made zirconia copings. *Dent Mater*. 2011;27:1273–8.
11. Shillingberg HT, Hobo S, Whitsett L, Jacobi R, Brackett SE. *Fundamentals of Fixed Prosthodontics*. 4th ed. Chicago: Quintessence Publishing Co; 2012.
12. Arora A, Yadav A, Upadhyaya V. Comparison of marginal and internal adaptation of copings fabricated from three different fabrication techniques: An *in vitro* study. *JIPS*. 2018;18:102–9.
13. McLean JW, von Fraunhofer JA. The estimation of cement film thickness by an *in vivo* technique. *Br Dent J*. 1971;131:107–11.
14. Assif D, Rimer Y, Aviv I. The flow of zinc phosphate cement under a full-coverage restoration and its effect on marginal adaptation according to the location of cement application. *Quintessence Int*. 1987;18:765–74.
15. Quante K, Ludwig K, Kern M. Marginal and internal fit of metal-ceramic crowns fabricated with a new laser melting technology. *Dent Mater*. 2008;24:1311–5.

Conflicts of interest: No conflict of interest with other people or organizations that inappropriately influence (bias) their work.

Acknowledgement: Authors had support in form of grants provided by the Rama Research Foundation, Rama University, Mandhana, Kanpur, U.P., India.
