Research Article

JRAD Journal of Research and Advancement in Dentistry

J Res Adv Dent 2019;10:1s:193-197.

Influence of Matrix Type and Thermocycling on Surface Roughness of Three Resin Materials used for Provisional Restoration: An In Vitro Study

Girish Kumar[1*] Abhishek Sharma[2] Siddharth Narula[3] Deepak Mahla[4] Namrata Mahajan[5]

[1]Reader, Department of Prosthodontics, Crown & Bridge, and Implantology, Rajasthan Dental College and Hospital, Jaipur, Rajasthan, India.
[2]Private Consultant, Jaipur, Rajasthan, India.
[3]Professor and Head, Department of Prosthodontics, Crown & Bridge, and Implantology, Rajasthan Dental College and Hospital, Jaipur, Rajasthan, India.
[4]Senior Lecturer, Department of Prosthodontics, Crown & Bridge, and Implantology, Rajasthan Dental College and Hospital, Jaipur, Rajasthan, India.
[5]Senior Lecturer, Department of Prosthodontics, Crown & Bridge, and Implantology, Rajasthan Dental College and Hospital, Jaipur, Rajasthan, India.

ABSTRACT

Background: Surface quality of a provisional crown and fixed partial denture is a very important property in maintaining periodontal health and aesthetics. Surface roughness of the provisional crowns and fixed partial denture depends on materials used for its fabrication as well as matrices. Therefore it was found essential to evaluate the influence of matrix type on surface roughness of resins.

Materials & Method: A total 60 samples were fabricated using three different temporization materials (Protemp 4, Auto polymerising resin and Structure 2), matrix material used to fabricate sample were tropicalgin, Aquasil (Polyvinyl siloxane) and bioplast. These sample nwere subjected to thermocycling and surface roughness were recorded. The obtained data were subjected to suitable biostatic tests.

Results and Conclusion: Within the limitations of the study it was concluded that, Matrix type and thermocycling did not significantly affect the surface roughness of DPI resin, Protemp IV and Structure II. Structure II gave significantly smoother surface than Protemp IV and DPI resin regardless of the matrix used. The three matrix type revealed a difference in the surface roughness of the DPI resin but it was not statistically significant for the study.

Keywords: Surface Roughness, Provisional Restoration, Thermocycling, Matrix Type.

INTRODUCTION

The importance of interim treatment, however, is more far-reaching than is portrayed by this procedural necessity. Vahidi and others identified multiple areas of critical concern with provisional restorations including aesthetics, comfort, speech and function, periodontal health, maxilla-mandibular relationships and continued evaluation of the fixed prosthodontic treatment plan. [1]

Provisional restorative materials are an important adjunct for a variety of indirect dental procedures, such as inlays, onlays, crowns, bridges, and implant temporization. A provisional helps to stabilize prepared teeth during occlusal function and prevents exposure of dental tissues to the harsh conditions found within the oral cavity while the permanent restoration is being fabricated.[2]

Received: May. 12, 2019**: Accepted**: July. 21, 2019
***Correspondence Dr. Girish Kumar.**
Department of Prosthodontics, Crown & Bridge, and Implantology, Rajasthan Dental College and Hospital, Jaipur, Rajasthan, India.
Email: Not Disclosed

pISSN 2278-0076
eISSN 2321-9270

The major requirements for provisional materials are an appropriate marginal adaptation, resistance to fracture, low thermal conductivity, nonirritating reaction to the dental pulp and gingival tissues, and ease of cleaning.[3] Traditionally, thermoplastic acrylic [PMMA and methyl methacrylate(MMA)] materials have been used as the provisional material of choice and have, to certain degree, met many of these mechanical and physical requirements. The more modern bis-acryl composite temporization materials, however, have become an increasingly popular choice, due in part to their improved mechanical properties, lower exothermic reaction and ease of handling.[2] Surface quality of a provisional crown and fixed partial denture is a very important property in maintaining periodontal health and aesthetics because smooth surfaces offer little retention for food debris, epithelial cells and bacteria facilitating oral hygiene, thus reducing the plaque formation.[3,4] Surface roughness of the provisional crowns and fixed partial denture depends on materials used for its fabrication as well as matrices. Therefore it was found essential to evaluate the influence of matrix type on surface roughness of resins.[4] Also there is not much of literature available regarding the effect of thermocycling on the surface of provisional restorative materials which simulates the intraoral conditions. Therefore, this study carried out to evaluate the effect of matrix type and thermocycling on the surface roughness of three resins used to make interim crowns and FPDs by the custom fabrication technique

MATERIALS AND METHOD

The in-vitro study was conducted in the Department of Prosthodontics, Rajasthan Dental College & Hospital, Jaipur. Materials used for the study are(Tab 1)

SI No.	Provisional material	Matrix material	Purpose
1	Protemp 4(3M ESPE)	Tropicalgin(Zhermack)	To prepare specimens
2	Autopolymerising Resin(DPI)	Aquasil (Dentsply)	To prepare specimens
3	Structure 2(VOCO)	Bioplast (SCHEU)	To prepare specimens

Preparation of the specimen

1) Preparation of mold: One freshly extracted natural maxillary central incisor was used as a control specimen. The teeth selected was intact, free of cracks, the vestibular surface did not have any irregularities and was smooth enough. It was mounted in the center of a polytetrafluoroethylene box (8 cm long, 5 cm wide, 1.6 cm deep) using dental stone (kalabhai) exposing the vestibular surface(Fig 1).

2) Three lids of this box were used as trays for the three matrices evaluated in this study. All the three matrix material were manipulated according to manufacturer instructions. 1 kg weight was applied to simulate the preoperative impression of the tooth and it was used as the irreversible hydrocolloid matrix.

Specimens stored in distilled water and were subjected to profilometric analysis to evaluate the surface roughness before thermocycling and surface roughness of natural tooth was also evaluated. The lens of the optical profilometer (WYKO NT 1100, USA) was focused at the centre and the readings were recorded for all the specimens. The data obtained were subjected to appropriate biostatics tests.

RESULTS

The present study evaluated the influence of three matrix types and thermocycling on surface roughness of threeresins used for provisional crowns and fixed partial dentures.

The descriptive statistics of average surface roughness using irreversible hydrocolloid, before and after thermocycling was observed that Structure II shows least surface roughness as compared to other materials. On comparision it shows there is significant difference between structure II , Protemp and Acrylic resin. (Tab 2 and Graph1)

The descriptive statistics of average surface roughness using Polyvinyl siloxane, before and after thermocycling was observed that Structure II shows least surface roughness as compare to other materials. (Tab 3 and Graph 2)

The descriptive statistics of average surface roughness using vaccum formed matrix, before and after thermocycling was observed that Structure II shows least surface roughness as compare to other materials. (Tab 4 and Graph 3)

DISCUSSION

Three major provisional restorative materials are commercially available, These are ethylmethacrylates, methylmethacrylates and bis-acryl resin composites. Historically, ethyl methacrylates have been shown to have poor esthetics and wear resistance.[5] Thus, methyl methacrylates and bis-acryl resin composite materials are most commonly used provisional restorative material at present.[5] Hence, in this present study these three materials were used.

Literature reveals that autopolymerizing PMMA resins have several deficiencies. PMMA resins have been reported to undergo polymerization shrinkage and show marginal discrepancies. The danger of pulpal and gingival damage because of exothermic reaction of polymerization has been equally well documented.[6] To overcome such deficiencies Protemp IV and Structure II material came into play.

Though irreversible hydrocolloid has demonstrated accuracy at 1 hour after impression, but loss of accuracy is seen at 24 hours, due to evaporation of water content. The main advantage of polyvinyl siloxane and a vacuum- formed shell is that it provides long-term dimensional stability, thermal insults to pulpal tissues and helps in direct visualization of the material within the shell to avoid introduction of voids in the provisional restoration.[1,3] Thermocycling is defined as the in vitro process of subjecting a restoration and tooth to temperature extremes that conform to those found in oral cavity. The thermal cycles could produce significant strains and micro shifts on the restorations interfaces which might affect the surface topography of the restoration.[8] In present study, thermocycling was done for 2000 cycles between 5°C and 55°C with a dwell time of 6 seconds in each water bath.[7]

The surface roughness of the samples was quantitatively analyzed with an optical profilometer (WYKO NT 1100 Surface Profiler, USA). This profilometer utilizes white light interferometry for high resolution 3D surface measurements from sub-nanometer roughness to millimeter-high steps.

Results show that DPI resin showed no statistically significant difference ($p>0.05$) when polymerized against the three matrices. But when mean values were compared Tropicalgin >Aquasil > Bioplast. (graph 1) this might be because the quality of the surface depends on the interaction between the matrix and the resin and physical and chemical characteristics of the materials influence each other.[9] During polymerization the free monomer which is hydrophobic in PMMA comes on the surface and evaporates. In case of irreversible hydrocolloid which is hydrophilic[10] it stays on to the surface and this excess monomer can cause micro porosities on the surface. Poly vinyl siloxane and thermoplastic sheet both are hydrophobic so they show better contact with PMMA. Protemp IV gave significantly smoother surface ($p<0.05$) than DPI resin regardless of the matrices used. Within the matrices there was no statistically significant difference.

This difference in baseline surface roughness may be due to differences in chemical and physical interaction between the material and matrix sheet. After polishing with an abrasive disk or acrylic bur, surface roughness of composites increases; this may be because of the filler particles harder than resin matrix. During polishing resin matrix may undergo a preferential loss exposing large filler particles on the surface which will produce higher surface roughness.[11]

It was inferred that Protemp IV and acrylic resin had more surface roughness and colour instability, compared to structure II, but, the variations were clinically non- significant.[13] and vacuum formed matrix evaluate the smoothest surface compared to polyvinylsiloxane and irreversible hydrocolloid.

LIMITATIONS OF THE STUDY

1) In vitro study.

2) In this study only effect of thermocycling was evaluated. Other factors like dietary habits or tooth brushing which can influence surface roughness of restorative materials were not evaluated.

3) Surface roughness evaluated by profilometer should have been confirmed with SEM.

SUMMARY & CONCLUSION

The aim of this in-vitro study was to compare and evaluate the influence of matrix type and thermo-cycling on surface roughness of three commercially available contemporary provisional restorative materials- auto polymerizing resin, protemp IV and structure 2. DPI resin showed no statistically significant difference ($p>0.05$) when polymerized against the three matrices. But when mean values of the matrices were compared specimens fabricated with Tropicalgin showed roughest and Bioplast showed smoothest surface.

Within the limitations of the study it was concluded that:

1. Matrix type and thermocycling did not significantly affect the surface roughness of DPI resin, Protemp IV and Structure II.
2. Structure II gave significantly smoother surface than Protemp IV and DPI resin regardless of the matrix used.
3. The three matrix type revealed a difference in the surface roughness of the DPI resin but it was not statistically significant for the study.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

REFERENCES

1. Burns DR, Beck DA, Nelson SK. A review of selected dental literature on contemporary provisional fixed prosthodontic treatment: Report of the Committee on Research in Fixed Prosthodontics of the Academy of Fixed Prosthodontics. J Prosthet Dent 2003;90:474-497.
2. Givens EJ, Neiva G, Yaman P, Dennison JB. Marginal adaptation and color stability of four provisional materials. J Prosthodont 2008;17:97-101.
3. Ayuso-Montero R, Martinez-Gomis J, Lujan-Climent M, Salsench J,Peraire M. Influence of matrix type on the surface roughness of three resinsfor provisional crowns and fixed partial dentures. J Prosthodont 2009;18 141-144
4. Bollen CM, Lambrechts P, Quirynen M: Comparison of surface roughnes of oral hard materials to the threshold surface roughness for bacterial plaque retention review of the literature. Dent Mater 1997;13:258-269.
5. Diaz-Arnold AM Et AL, Dunne JT, Jones AH. Microhardness of provisional fixed prosthodontic materials. J Prosthet Dent 1999;82:525-528
6. Jo LJ, Shenoy KK, Shetty S. Flexural strength and hardness of resins for interim fixed partial dentures. Indian J Dent Res. 2011:22(1):71-76.
7. Young HM, Smith CT, Morton D. Comparative in vitro evaluation of two provisional restorative materials. J Prosthet Dent 2001;85:129-132.
8. Marwa Eltayeb I Elagra, Yousria Shalaby, Moustafa Fakhry Khalil, Nagiub El Fawal. Comparative study of marginal adaptation and mechanical properties of CAD/CAM versus dual polymerized interim fixed dentalprosthesis. S J Oral Sci 2014, 1 : 2,71-76
9. Vahid Rakhshan. Marginal integrity of provisional resin restoration materials: A review of the literature. The Saudi Journal for Dental Research 2015;6:33–42
10. 10.SOP: Veeco NT1100 Optical Profilometer. [computerprogram]. Available from url:http//www.ece.umd.edu/MEMS/resources/sop/VEECO_SOP.pdf.
11. Maalhagh-Fard A, Wagner WC, Pink FE, Neme AM. Evaluation of surface finish and polish of eight provisional restorative materials using acrylic bur and abrasive disk with and without pumice. Oper Dent 2003;28:734-739.
12. Sarac D, Sarac S, Kulunk S, Ural C, Kulunk T. The effect of polishing techniques on the surface roughness and color change of composite resin. J Prosthet Dent 2006;96:33-40.
13. Buergers R, Rosentritt M, Handel G. Bacterial adhesion of Streptococcus mutans to

provisional fixed prosthodontic material. J Prosthet Dent 2007;98

14. Nejatidanesh F, Momeni G, Savabi O. Flexural strength of interim resin materials for fixed prosthodontics. J Prosthodont. 2009;18:507-511.