Original Research Paper

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Comparative Microscopic and Radiographic Evaluation of Proximal Marginal Integrity of CAD/CAM PMMA Crown and CAD/CAM Zirconia Monolithic Crown: An In-vitro Study.

Abstract:

Aim: To evaluate and compare proximal marginal integrity radiographically and microscopically of CAD/CAMPMMA crown and CAD/CAM monolithic zirconia crown.

Materials and methods: Fifteen maxillary or mandibular molar teeth with standardized anatomic preparation for provisional crown and monolithic zirconia crown were scanned witha 3-dimensional laboratory scanner. CAD/CAM crowns were designed 3-dimensionally usingexocad software and then milled from presintered blocks in a milling machine. The proximal marginal integrity of CAD/CAM PMMA and monolithic zirconia crown were evaluated radiographically and microscopically. For radiographic evaluation, radiopaque dye is used to measured proximal marginal discrepancies on six reference points on PMMA crown. A digital microscope was used to measure the marginal discrepancies on six reference points on PMMA and zirconia crown. Photographs of the proximal marginal areas were captured at six reference lines at standardized orientation and placement of the samples. In all photographs margin was traced with the help of Hi View Setup soft ware. The mean marginal discrepancies for each group were analysed using chi-squaretest and man whitney Utest.

Results: the test result shows there were no significant differences in radiographic and microscopic evaluation of CAD/CAM PMMA crown and CAD/CAM monolithic zirconia crown.

Conclusion: It is found that radiographically, PMMA crown had greater marginal discrepancy as compared to the Zirconiacrown. Microscopically, PMMA crown and the CAD/CAM monolithic zirconia crown had almost similar marginal discrepancy (statistically non-significant).

Key-words: .....

Introduction:

According to the Glossary of Prosthodontic Terms, "interim prosthesis or provisional or restoration is a fixed or removable dental or maxillofacial prosthesis designed to enhance esthetics, stabilization and/or function for a limited period of time, after which it is to be replaced by a definitive dental or maxillofacial prosthesis."[1]

Provisional restoration can be fabricated through conventional method or by CAD/CAMtechnology. Several types of acrylic resins are frequently used for custom provisional-fixedrestorations, including (1) polymethyl methacrylate(PMMA)resin,

(2) Polyethyl methacrylate (PEMA) resin

(3) Polyvinyl methacrylate resin,

(4) Bis-acryl composite resin, and

(5) Visible light cure dure than edimethacry late. [1]

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PMMA is a synthetic polymer prepared by the polymerization of methyl methacrylate to polymethyl methacrylate and free radical addition. [2] Today's PMMA resins are radiolucent and can not be scanned using conventional radiographic methods.[3] The development of radiopaque dental resinsmightraise the safety margin for millions of dental patients. Radiopacity is an essential property of all dental restorative materials in order to assess restorations for marginal defects and overhangs, and to evaluate the proximal contour and integrity of the restoration at subsequent recall appointments.[3]

However, the ultimategoal of dentistry is to restore the for mand function of teeth permanently. Currently, zirconia-based ceramics are most commonly used to restore tooth permanently. Mostcrucially, CAD/CAM technology enables the precise fabrication of zirconia restorations for dental applications. Zirconia (zirconium dioxide, ZrO2), of ten known as "ceramic steel," is ideal for dental usage due to its exceptional strength, hardness, and fatigue resistance, as well as its out standing biocompatibility and wear qualities.[4]

A major requirement for the long-term survival of dental prosthesis is the accuracy of fit. [5]The marginal fit is defined as the distance between the tooth and the restoration measured at numerous places. Marginal gaps can result in a buildup of plaque, cement disintegration, secondary caries, and periodontal infection. In fixed prosthesis, proximal margins are more susceptible to spread infection and caries because of difficulty in evaluation, clean ability, difficulty in removing excess cement, and capturing impression.

Theradiographictechniqueprovedtobepreferablemethodasradiographcandetectoverhang or under hang restoration, marginal discrepancies, and fault in the proximal areas.[6] In the laboratory, marginal gap between the margin of the restoration and finish line can be checked under magnification. Stereo microscope can be valuable quality control equipment in laboratory but microscopic evaluation cannot be used as clinical method for evaluation of marginal integrity].

Radiographic technique can be used a clinical method for detection of marginal discrepancy of restoration. So if any correlation was found between vertical marginal discrepancy measured by microscopic evaluation and by radiographic evaluation than, it can be served as reference for detection of marginal discrepancy of restoration by radiographic technique.

Thus this study is done to evaluate and compare proximal marginal integrity radiographically and microscopically of CAD/CAMPMMAcrown and CAD/CAM monolithic zirconia crown. This study canservisaged diagnostic tool for the evaluation of proximal margin of crown.

Materials and Methodology:

On the basis of previous studies and literature the sample size for the study was calculated tobe15.

Fifteen sound caries free, extracted human maxillary / mandibular molars were used in this study. An auto-polymerizing acrylic resin material was used to make a block of 12 mm x 22mm size in which each sample molartoo this embed de dinavertical position that is 2to3mm below to the enamel-cementum junction, with their long axis perpendicular to the surface of the acrylic block, with the help of a dental surveyor. The tooth was prepared to receive azirconia fullcrown. Uniformcircumferentialaxial too thre duction of 1to1.5-mm with circumferential chamfer and occlusal reduction of 1.5 to 2 mm was done in all selected samples under 3.5 x magnifications The prepared samples were sent to lab for CAD/CAMPMMA crown fabrication and for CAD/CAM monolithic Zirconia crown. Laboratory was instructedtousesimilarstandardspecificationorparameter for fabrication of both CAD/CAMPMMA and zirconia crown.

Total six reference lines were marked on the tooth over the visible portion of root, three on each proximal surface with black permanent marker, 1-2 mm below the finish line (figure 1).Barium sulphate was mixed with red oil paint as a carrier and a special metallic sharp applicator was made with the help of straight pro be for marker application.

Figure 1-Three reference lines were marked over the tooth with black permanent marker

Fabricated CAD/CAMPMMA crown were place dover respective prepared tooth and secured with rubber band bucco lingually for radiographic evaluation. On PMMA crown, two lines were marked one on each proximal surface. These lines were marked with radiopaque marker as PMMA is a radiolucent in nature (figure 2).This PMMA crown tooth assembly were placed on a digital receptor holding device for radiographic evaluation

Figure 2- line marked with a radiopaque marker

After each sequence of radiographic evaluation and recording of observation, these lines were erased with spirit swab. PMMA crown with tooth assembly were marked with radiopaque marker for ML1PR (mesial line 1 PMMA crown radiographic evaluation) and DL1PR (distal line 1 PMMA crown radiographic evaluation) line. This assembly were then placed on a digital receptor holding device for radiographic evaluation. The lines were further marked one by one and evaluated radiographically.

For the zirconia crown, fabricated CAD/CAM zirconia crown were placed over respective prepared tooth and secured with rubber band bucco lingually (figure 3). This zirconia crown toot has sembly were placed on a digital receptor holding device for radiographic evaluation.

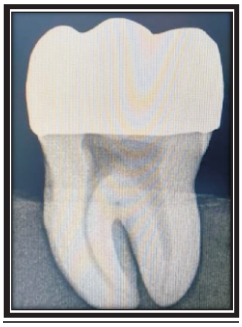


Figure3- Radiographic evaluation of CAD/CAM monolithic zirconia crown

Using a digital microscope with a 50 MP digital camera and a light-emitting diode (LED)ring lamp, the vertical marginal difference of the margin of the crowns and the finish line of the prepared tooth was measured with regard to 6 reference lines. CAD/CAM PMMA crown were placed over respective prepared tooth and secured with rubber band bucco lingually for microscopic evaluation for vertical marginal discrepancy of crown (figure4).

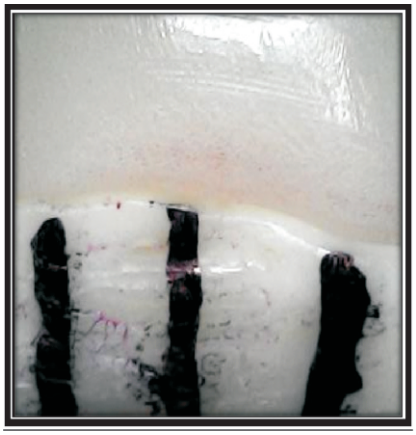


Figure 4. Microscopic evaluation of CAD/CAMPMMA crown

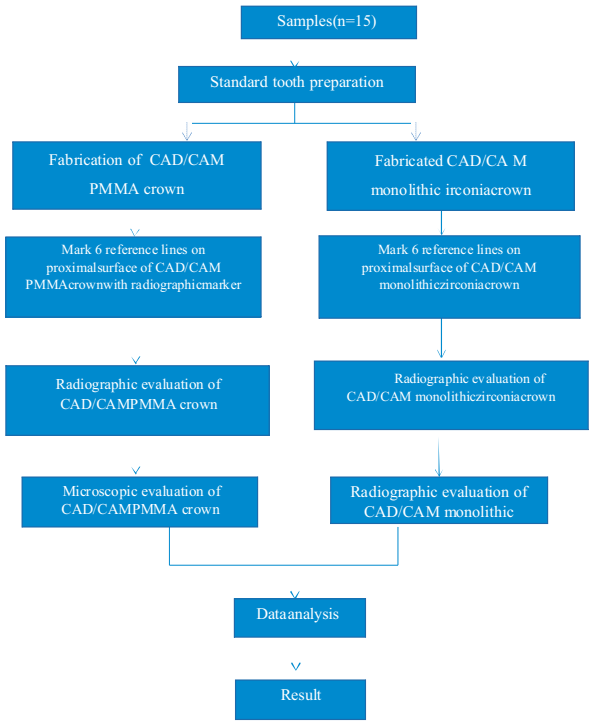
For all measurements, the crowns were fixed on the tooth and are secured by using rubberb and. The vertical distance between margin of the crown and finish line were measured. Ateach zone, photographs of the peripheral regions were taken with the samples oriented and placed in a regular manner. The margins of all pictures were traced using the HiView Setup programme.

In every image, three values were recorded for each specimen at three reference lines. The average vertical distance between the traced finish line of the tooth and the traced line of the crown margin was computed using software provided by the maker of the digital microscope while keeping the tooth finish line at the horizontal line

Further, CAD/CAM zirconia crown were placed over respective prepared tooth and secured with rubber band bucco lingually for microscopic evaluation for vertical marginal discrepancy of crown. For all measurements, the crowns were fixed on the tooth and are secured by using rubberb and. The vertical distance between margin of the crown and finish line were measured. Photographs of the peripheral regions were taken at six reference lines to ensure that the samples were oriented and placed consistently. The margins of all pictures

were traced using the HiView Setup programme. In every image, three values were recorded for each specimen at three reference lines. Keeping the tooth finish line at the horizontal line the average vertical distance between the traced finish line of tooth and the traced line of crown margin was calculated by the software which is provided by the manufacturer of digital microscope.

The data was entered into an excel spreadsheet. The data was analysed using SPSS 20.0(Statistical Package for Social Sciences). When the data were examined for normality, a pvalueof0.05 revealed that they were not normally distributed, necessitating the application of non-parametric significance tests. Descriptive statistics were utilised. To compare categorical data between groups, the Chi-square test was performed. To compare continuous data between groups, the Man-whitney U test was utilised. A p value of 0.05 or above was considered statistically significant.



Results:

According to radiographic evaluation of Group A specimen, the marginal discrepancy was present in 15 samples whereas according to microscopic evaluation marginal discrepancy was present in 12 samples. There were 3 samples which detected to have marginal discrepancy radiographically but on microscopic evaluation, no discrepancy was found. According to radiographic evaluation of group B specimen, the marginal discrepancy was present in 9samples whereas according to microscopic evaluation marginal discrepancy was present in 12samples. The rewere 3 sample which was detected to have marginal discrepancy radiographically but on microscopic evaluation, no discrepancy was found.

The kappa correlation coefficient revealed no significant correlation between the radiographic and microscopic findings. All the samples in Group A (CAD/CAM PMMA crown) were found to have marginal discrepancy on radiographic evaluation, whereas in GroupB (CAD/CAM monolithic zirconia crown) 60.0% samples were found to have marginal discrepancy. The number of specimen with proximal marginal discrepancy was significant lymorein GroupA (CAD/CAMPMMA crown) as compared to GroupB (CAD/CAM monolithic zirconia crown). The median marginal discrepancy observed in Group A(CAD/CAM PMMA crown) was more than that the marginal discrepancy seen in Group B(CAD/CAM monolithic zirconia crown). Although, this difference was not statistically significant.

Discussion:

CAD/CAMPMMAisalongtermtemporaryrestorativematerial thatexhibitaccuratemarginal fitting to the finish line of the prepared tooth to protect the pulp from bacterial, thermal and chemical insults. Detection of proximal marginal discrepancies are difficult to verify radiographically because PMMA crown is a radiolucent in nature. To check the proximal marginal integrity of PMMA crown, a radiopaque dye was used in this study. Bariumsul fate (BaSO4) is a standard in medical applications that is approved by the FDA and used for X-ray assisted implantation to control the position of polymer implants and drug delivery systems during biodegradation[8].

This radiopaquedye was used to mark six reference lines on CAD/CAMPMMA crown with a nib holder. In this way, we can able to evaluate the six reference locations on proximalsur faces of CAD/CAM PMMA crown.

Previously no studies have been conducted for radiographic evaluation of proximal marginal integrity of CAD/CAM PMMA crown. This scarcity of research may be due to radiolucency of crown material. A radiolucent crown isone that does not block the x-raysatall. So it would be impossible to detect the margins of the crown on the radiopaque tooth. That is why none of the restorative materials used are radiolucent because radiolucency of crown can cause the difficulty to evaluate this radiographically.

In this study, special technique developed for radiographic evaluation by marking on the PMMA crown with three reference line by radiopaque marker. This method can be helpful in radiographic evaluation of radiolucent crown. Six reference lines marked can be helpful in sectional evaluation of the proximal marginal integrity. So this method can be termed as radio graphical to mography.

On radiographic evaluation of CAD/CAM monolithic zirconia crown, we found proximal marginal discrepancies in 9 samples out of total 15 samples. **Jognil Park[**9] found clinical experience may affect radiographic evaluation of clinicians.

In the present study microscopic vertical marginal discrepancy were found within the range from 13 to 85 micron for CAD/CAM PMMA crown and from 7 micron to 30 micron for CAD/CAMZ irconia crown. This is aga in within the clinical lyacceptablerange. **Ishitaetal**[10] (2018) found that CAD/CAM provisional crowns showed better marginal adaptation. Microscopic evaluation cannot be used as clinical method for evaluation of marginal integrity but Radiographic technique can be used a clinical method for detection of marginal discrepancy of restoration. So if any correlation was found between acceptable range of vertical marginal discrepancy by microscopic evaluation and by radiographic evaluation than that can be served as reference for detection of marginal discrepancy of restoration by radiographic technique.

On comparing the radiographic evaluation of CAD/CAM PMMA crown and CAD/CAM monolithic zirconia crown, we found proximal marginal discrepancies on all CAD/CAMPMMA crown radiographically, where as in CAD/CAM monolithic zirconia crown, 60 percent crown shows proximal marginal discrepancies. It is concluded that CAD/CAMPMMA crown shows more proximal marginal discrepancies as compare to CAD/CAM monolithic zirconia crown.

This difference of radiographic evaluation between CAD/CAMPMMA and CAD/CAMZirconia crown may be due to radiolucency of CAD/CAM PMMA crown and radio opacity of Zironia crown. Zirconia crown can not be evaluate dinsections because of radio opacity.

On comparing the microscopic evaluation of CAD/CAM PMMA crown and CAD/CAM monolithic zirconia crown, the medianproximalmarginal discrepancies was observed more in CAD/CAM PMMA crown as compare to CAD/CAM monolithic zirconia crown. But this difference were statistically non-significant.

In the current study, the proximal marginalfit of the CAD/CAMPMMA crown and CAD/CAM monolithic zirconia crown were investigated. The statistical correlation between the marginal discrepancies of CAD/CAM PMMA crown and CAD/CAM monolithic zirconia crown was statistically non-significant on microscopic evaluation.

The statistical difference between the CAD/CAM PMMA crown and CAD/CAM monolithic zirconia crown was statistically significant on radiographic evaluation and so CAD/CAMPMMA crown can not be used as an absolute diagnostic tool to evaluate marginal discrepancies.

Conclusion

With the limitation of the present study, following conclusions were drawn:

Microscopically, PMMA crown and the CAD/CAM monolithic zirconia crown had almost similar marginal discrepancy but the correlation was statistically non-significant.

The statistical difference between the CAD/CAM PMMA crown and CAD/CAM monolithic zirconia crown was statistically significant on radiographic evaluation.

So, CAD/CAM PMMA crown cannot be used as an absolute diagnostic tool to evaluate marginal discrepancies

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