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COMPARATIVE STUDY OF VERTICAL MARGINAL FIT ON IMPLANT ABUTMENT USING METAL CERAMIC CROWNS, FULL CONTOUR ZIRCONIA CROWNS (CAD/CAM) AND VENEERED ZIRCONIA CROWNS (CAD/CAM) (AN IN VITRO STUDY)

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ABSTRACT

Background*:** Marginal fitness is an important factor in success and longevity of implant – retained restoration. Poor fitness and too large discrepancy lead to seepage of debris, cement dissolution and microbial colonization which lead to peri- implant inflammation and failure of implant restoration. ***Objective: To evaluate and compare vertical marginal fit among three materials used in construction crowns in the dental implant (metal- ceramic- full contour zirconia- veneered zirconia crowns. ***Material and method:-*** Four implant abutment on maxillary cast with first premolar and first molar (right & left)on both side receive thirty crowns on were divided into three group :-Group A:-10 samples were constructed with metal ceramic crowns used lost wax technique .Group B:-10 samples were constructed with full-contour zirconia crowns used (Imes –Icore) CAD-CAM system. Group C:-10 samples were constructed with veneered zirconia crowns used (Imes –Icore) CAD-CAM system. Vertical marginal gaps were measured at four points on each tooth surface. Sixteen points per tooth sample were measured using a digital microscope at a magnification of (230X).The marginal discrepancy found by use the mean of this sixteen points the Comparison of significance among the different groups using (Kruskal-Wallis H) test showed a statistically highly significant differences ($p < 0.000$). Furthermore, comparison of significance between each pair of groups using Paired-Samples, (Mann-Whitney U) showed statistically highly significant differences ($p < 0.000$). ***Results:*** The results of this study revealed that the least marginal gaps were, recorded at full contour zirconia crowns using CORETIC 250i (Imes –Icore) CAD-CAM system (39,239 -+26,575 um) and highest marginal gap were recorded at

metal ceramic crowns using lost wax technique (92,513-+32,466 um) and veneered zirconia crowns were between of them (68,433-+40,346 um).In conclusion, full contour zirconia crowns constructed with CAD-CAM system provided better marginal fit and showed smaller marginal gap compare with metal ceramic crowns and veneered zirconia crowns.

KEYWORDS: Implant abutment, metal Ceramic, Zirconia, Vertical marginal fit.

INTRODUCTION

Implantology has become an important branch of modern dentistry; it's helping to improve the quality of patient's life. Dental implant ology is the field of dentistry that is deal with the replacement of missing teeth and supporting structures with prosthesis anchored to the jaw bone.[1] The dental implants make it prosthetic restoration provides reestablishment of phonetic, function, aesthetic in a foreseeable manner. The seating of restoration with accurate fitness with implant abutment is very important to prohibit in the failure of implant especially in the marginal area.[2] The vertical marginal defined as the vertical distance between the edge of restoration and the finishing line of implant abutment .Poor adaptation and too large gap affect to the dental implant by permit seepage of debris, fluid, and microorganisms along the connection between restoration and wall of the abutment .[3] The more rigid materials may be chosen as the superstructure for implant-retained fixed dental prostheses is Co-Cr and Ni-Cr alloy with ceramic veneer. It gives good biological and technical clinical results and may be suitable for situations with high occlusal loading. The fit of metal–ceramic prostheses may be influenced by the veneering process, the higher contraction cooling of the base metal alloy used to fabricate the conventional FPD frameworks may have influenced the accuracy achieved in these restorations.[4] Computer aided design- computer aided manufacturing (CAD- CAM) of implant frameworks is the standard procedure of use superior dental ceramic. It's three- dimensional scanning technology being used in the dentistry to increase productivity and patient satisfaction. It simplifies the use of dental zirconia has promoted the fabrication of consistent and predictable restoration in esthetic and marginal fitness and strength.[5] The high requirement for esthetic is leading to using of zirconia framework. It's more accurate and more natural appearance from the metallic alloy. Zirconia has recently been developed and introduced for application in dentistry due to the superior mechanical properties. This is attributed to a process known as transformation toughening. Zirconia is attractive for restorative dentistry and produced by computer-aided design/computer-aided manufacturing (CAD/ CAM). It can be used for anterior and posterior crowns in implant

restoration. Beside the mechanical properties and esthetics, the long-term clinical success of zirconium restorations can be influenced by marginal adaptation, which is a very important factor for the longevity of the restored teeth.[6] Zirconia ceramics have no glassy matrix that is why it appears relatively opaque, thus; required the application of porcelain veneering on their surfaces to achieve acceptable shading and characterization. Undergoes heat treatment cycles in process of the veneering porcelain firing and effect of the fitness of restoration.[7]

METHODOLOGY

Samples preparation

In the present study ,four straight implant abutment of screw –retained 4.5 Ø (Friednt system) with shoulder finish line was used to receive 3 groups of crowns inserted in a master cast in left and right first premolars and left and right first molar .Impression were made using closed custom made tray regular set of poly siloxan(Zhermack, Italy). Plaster model poured with dental stone type IV (Bego stone plus) Figure (1).

Figure 1: Master cast with implant abutments.

The sample of the study: Thirty crowns were divided into three groups: -

Group A:-10 samples were constructed with metal ceramic crowns used the lost wax technique.

Group B:-10 samples were constructed with full-contour zirconia crowns used CORETIC 250i (Imes –Icore) CAD-CAM system.

Group C:-10 samples were constructed with veneered zirconia crowns used CORETIC 250i (Imes –Icore) CAD-CAM system.

Metal ceramic crowns:- Fabrication of metal coping (kera NH)from metal - ceramic crown was done using lost wax technique spruing & investing and casting done in conventional

way, finishing and sandblast of metal coping was done .When complete the finishing of the metal coping build up the coping performed using the VITA VMK Master 2m2 opaque and dentin and enamel applied after mixing the powder and liquid using bristle brush ,all porcelain layer steps were done following manufacture instruction.

Full- contour zirconia crowns and zirconia copings use (Imes- Icore) CAD- CAM system:-The implant abutment was covered by the scan spray to reduce the problem during the scan process due to the high reflective material of the implant abutment and give clear scan image of abutments.[8] Put the cast with four abutments (right first premolar, right first molar, left first premolar, left first molar) inside the scanning machine. The optical scanner was scanned the cast and a three- dimensional image was displayed on a computer monitor with aid of Imes- I core 3D in software. (In lab version 4.6) **Figure (2),** the optical scanner scanned the master cast and a three-dimensional image was displayed on the computer monitor with the aid of the 3D In Lab Software, so the finishing line and all the surfaces were appeared clearly. The full contour crowns (group B) and copings (group C) were designed through the software with the following parameters: the type of restoration and cement gap, the finishing line was automatically drown, the undercut and the path of insertion was determined. After applying the information of the final design to the milling center in the software. A suitable zirconium block was selected and placed in the blank holder inside the milling machine and fixed with the screwdriver, and then the milling process was started. After the completion of milling procedure, the zirconia blank was removed from the holder and the crowns and copy frame were separated from the blank by a laboratory hand piece with a disk bur. The crowns were placed in sintering jar and the sintering was carried out in the furnace according to the suitable sintering program of each system.

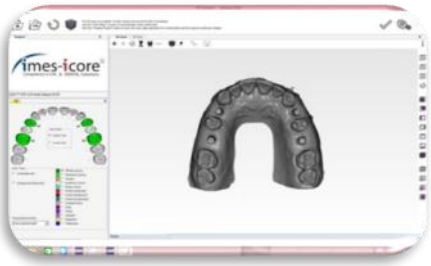


Figure 2: Scanning of the master cast in CORETIC 250 Imes–Icore CAD–CAM machine.

Porcelain veneering of the zirconia coping: The zirconia coping were placed on their implant abutment and then the porcelain procedure was performed by the same technician.

VITA Zhanfabrik VM 9 2m2 dentine and enamel were used by mixing their powder and liquid and then applied on the coping with bristle brush ,all porcelain layering steps performed following manufacture instruction.

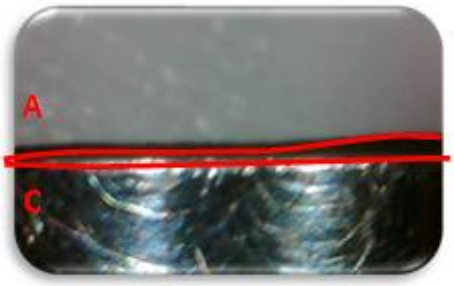
Measurement of the vertical marginal gap: Separated the implant abutment from the cast by key (screw driver).Plastic mold was fabricated so the abutment placed on it. Each crown measured on four surfaces, evaluates 4 points in each surface and was determined (1mm) distance among each point. (16) Points were measured on each crown, the reason of selected the midpoint areas because the dimensional shrinkage occurs in this areas to bulk of porcelain materials.[9,10] The marginal gap value of each crown was the arithmetic mean of these16 measurements on four surfaces. The crown with abutment held by specimen holding device. The specimen holding device was designed to fix the crown on implant abutment on the stage of the digital microscope during the measurement procedure. This device designed to applied uniform loading for all samples and for standardization and made the load that apply to the grown equal to the biting force in the patients mouth.[11] It contains to sensor holding part attached to the digital scalar, it's used to apply constant seating pressure of (5000g) between the crown and implant abutment **Figure (3-A),** A photo of one millimeter of a ruler was captured by the digital microscope at a magnification of (230X). The image was opened in (Image J) program and the straight line selection tool was selected to make a line that corresponded to a known distance that was a one millimeter, When the measurement of the one millimeter of the ruler was determined, the specimen holding device with the implant abutment and crown on it was placed under the digital microscope The calibration was 0.001mm (1um) at a magnification of 230X, a photo of vertical marginal gap between the crown and abutment was captured. The clear captured image was treated with (image J program) the measurement is done by draw line between the margin of the crown and the margin of implant abutment and selected analyze order and [set scale] at the same calibration of a digital microscope. All reading were recorded in pixel and converted to [um**] Figure (3-B).**

A B

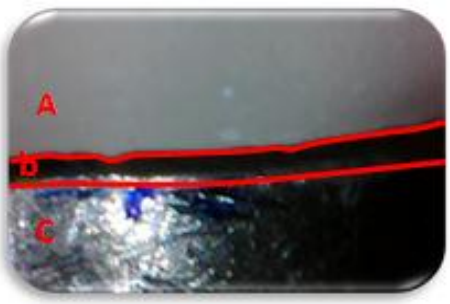
Figure 3: A:-the sample with the specimen holding device, B:- The sample with specimen holding device under the digital microscope and connect with the computer .

The marginal gap of metal- ceramic crowns was measured first, while the full contour zirconia crowns second and the veneered zirconia crowns third.

Marginal gap in the metal ceramic crown



Marginal gap of the full contour zirconia crown



Marginal gap of the veneered zirconia crown

Figure 4: comparison of the marginal gaps among three crown.

A. The crown B. Vertical marginal gap C. Implant abutment.

Data analysis:- The descriptive statistics of the difference in values of 3 groups including arithmetic mean ,standard deviation ,maximum and minimum of the samples are shown in Table(1).

Table 1: Present the results of vertical marginal fit pf three types of crowns evaluated in this study.

Groups	No.	Mean	S.D.	Range	
Group A	10	92.513	32.466	Max	Min
				190.476	14.939
Group B	10	39.239	26.575	141.923	3.735
Group C	10	68.433	40.346	209.150	11.204

Steam –leaf plot for exploring observation of vertical marginal gap of 3 groups shown in **Figure (5).**

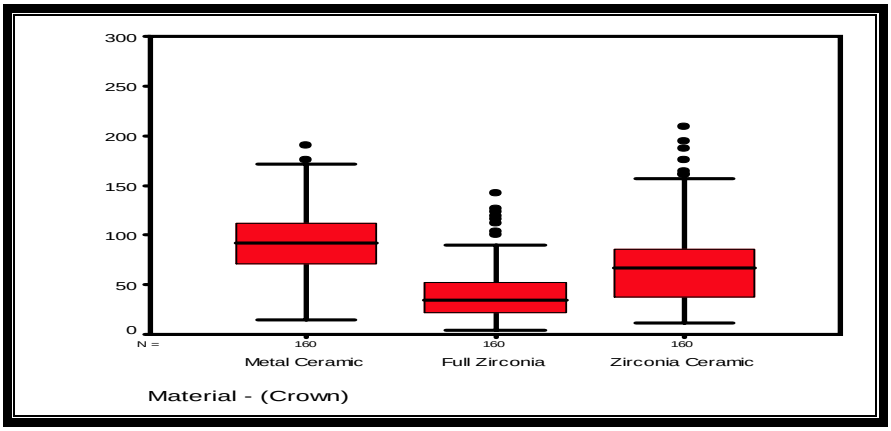


Figure 5: Stem-Leaf plot for exploring observed observations of (Length due to Vertical Marginal Fit) at the studied groups.

A highly gaps are accounted among studied groups, and that shows the mean of (Full Zirconia Crown) group had recorded too short a vertical marginal gap (39.239), then followed with increasing in mean of vertical marginal gap in (veneered zirconia Crown) group (71,279), and finally location estimates shows that (Metal Ceramic Crown) group had recorded too high increasing of mean in a vertical marginal gap(93,353).

Inferential statistics:- Table (2) shows an overall comparison significant among different groups by using (Kruskal-Wallis H) test, a nonparametric equivalent to one-way ANOVA. Tests whether several independent groups are from the same population. In addition to that, (Mann-Whitney U) test, a nonparametric test equivalent to LSD are used to perform all pair wised comparisons between group means of different materials.

Table 2: Comparisons Significant among different (Length due to Vertical Marginal Fit) Parameter at the studied groups.

Kruskal-Wallis H test Asymp. Sig.	**Chi-Square = 161.785 P = 0.000 (HS)**		
Mann-Whitney – U test			
Materials (Groups)	**Metal Ceramic**	**Full Zirconia**	**Veneered zirconia**
Metal Ceramic	**-**	**Z = -12.348 P=0.000 HS**	**Z = -5.979 P=0.000 HS**
Full Zirconia		**-**	**Z = -7.388 P=0.000 HS**

Results shows highly significant differences at P<0.01 are accounted among different of studied groups (Materials) . As well as, (Mann-Whitney U) test shows that all probable pair wise of comparisons among studied groups are recorded highly significant differences at P<0.01.

DISCUSSION

The marginal integrity of the crown along the connection with implant abutment is very important factor in evaluating the success of prosthesis, reducing the marginal gap is necessary because any increase in this gap result of cement dissolution and more potential for micro- leakage, this gap allow for microbial colonization which leads to peri-implant inflammation &transmission of high stresses to the alveolar bone & implant component.[12]

In our study, the mean of the vertical marginal gap of metal ceramic crowns showed (92,513)um, the ----mean of the vertical marginal gap of full contour zirconia crowns is (39,239)um and, the mean of the vertical marginal gap of veneered zirconia crowns is (68,433)um. According to statistical analysis of this study was showed a highly significant difference between all groups, and concluded the marginal discrepancy of all groups with acceptable limit (<120 um).Several studies concluded that crown with marginal discrepancy less than 120 um are more successful (McLean and Von Fraunhofer, 1971),[13] While (Jemt, 1991)[14] suggested the vertical marginal gap less than 150 um was acceptable.

In metal ceramic crowns used lost wax technique showed a highest vertical marginal gap. The reason for this discrepancy due to steps of construction of (PFM) crowns, firstly; manual

waxing, investing, casting, finishing and finally build up, all the series of steps result in shrinkage of material especially in marginal areas.[15]

In group (B) and (C) when using CAD-CAM system showed low marginal gap than conventional metal-ceramic crowns due to the uses of computerized mechanical milling to fabricate full contour zirconia and zirconia coping on the basis of data recorded directly on abutment surface without waxing and casting and more precision technique avoiding any error occur in the casting procedure.[16] These result came in agreement with (Saraswathi et al., 2016)[17] who found that (CAD-CAM) technique affected of enhanced marginal fitness than conventional lost wax technique and exhibit butter marginal fit. And disagreement with (Zaghloul and Younis, 2013)[2] who found the CAD-CAM-milled implant –supported framework showed the highest vertical marginal gap than PFM.

The distortion of the copings during build up contribute partly a factor of increase marginal misfit, the reason of this gap is due to finishing and polishing. The technician is likely to remove even a small amount of material from restoration margin to achieve a highly polished surface.[17] Furthermore, during the porcelain veneering, some of the particles of porcelain melt and gather to fill up voids and result contraction of the porcelain mass causes the compressive force on coping result in the displacement of walls of coping. Which produce misfit and incomplete seating.[18] The deformation of the coping under stress of contracting porcelain is spread around the margin. Because of the rigidity of porcelain result in outward and upward displacement of marginal areas.[19] The higher gap occurred during the opaque firing it can be increased thickness of the oxide layer formation due to repeated porcelain firing.[20,21] (Luthardt et al., 1999)[22] reported difference in thermal expansion coefficient (TEC) of the veneering ceramic and the coping material (metal or zirconia) lead to pressure tension during cooling at room temperature which leads to enhancement in bonding strength between two material and affects to the marginal fitness.

The result of this study came in agreement with (Hmedat and Ibraheem 2013,[9] Svanborg. et. al., 2015,[23] Soliman etal, 2015)[24] who found that veneering processing influence of the marginal fit of crowns and fixed partial denture. The significant increase regarding the effect of porcelain veneering on the vertical marginal gap of this study was came in disagreement with (Vigolo and Fonzi, 2008)[25] who found that the addition of veneering porcelain not cause any significant changes in the marginal fitness.

In full-contour zirconia crowns showed lowest marginal gap when compared with conventional metal-ceramic crowns and veneered zirconia crowns, because they milled directly to the full anatomical crown without the need to porcelain veneering, thus not undergo firing cycle.[35] These result agree with (Att, et.al, 2009,[26] Al-Assadi and AlAzzawi, 2015[27] who conclude that the full contour crowns show the best marginal adaptation compared to the veneered zirconia crowns.

CONCLUSIONS

The mean marginal gap of three groups (metal ceramic , full contour zirconia. veneered zirconia) crowns on implant abutments were with in clinically acceptable limit<120 um, Full contour zirconia crowns constructed with CAD-CAM system provided better marginal fit and showed smaller marginal gap compare with metal ceramic crowns and veneered zirconia crowns.

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