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Evaluation and comparision of the accuracy of laboratory scanners: An Invitro Study

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Abstract

Background: In This in-vitro study, the purpose was to evaluate the marginal fit of PMMA copings fabricated and scanned by two different CAD/CAM scanners and compare the precision of the two scanners used.

Materials and methods: A sample size of 30 was selected, and fabricated PMMA copings fabricated using two different scanners for each die by CAD/ CAM technology (Group A) (n=10) and (Group B) (n=10) using were fabricated using two different scanners for each die. The marginal fit of copings was recorded using a replica technique with light body silicone material stabilized with putty. Each replica was sectioned mesiodistally then evaluated at six pre-determined sites. The points measured were VMS for the vertical marginal gap, AIS for axial internal space, IOS for internal occlusal space using a stereomicroscope at 40 × magnifications. To evaluate significant differences between the two groups in terms of marginal fit Paired Sample (t) test was made

(α= 0.05).

Results: The mean for the marginal gap was 83µm for vertical marginal space, for axial internal space 73 µm, and internal occlusal space 183µm. Group A compared with Group B, Mean values for scanners precision were 6.45mm for Group A and 6.49mmfor Group B. Between both the groups, significant differences were observed for scanner accuracy.

($p<0.05$ Significant)

Conclusions: The PMMA copings scanned and milled by scanner UPCERA U2 demonstrated a better accuracy of marginal fit, and also the precision was also more than MEDIT 300 when compared.

Keywords: PMMA, UPCERA U2, CAD.

Introduction

Computer aided design computer aided manufacturing (CAD-CAM) technology is in routine use by dental technicians. A complete digit workflow has many more advantages compared to the analogic approach as it might eliminate tray selection, material dispencing, material setting, material disinfection, and impression packing and shipping in the dental office and plaster pouring, die cutting, trimming and articulation. Farmore, clinicians should keep plaster casts of patient for years which requires a considerable storage space. On the other side digital impression files need just a hard disk drive and a backup machine. Several studies showed that extra-oral scanners have reached an acceptable level of accuracy. The accuracy is the "closeness of agreement between a quantity value obtained by measurement and true value of the measure" and consists of trueness and precision. Trueness is defined as" the closeness of agreement between the average value obtained from a large series of test results and an accepted reference value" and precision is defined as" the closeness of agreement between independent test results obtained under stipulated condition".

Therefore this study is intended to find out the accuracy of the different CADCAM systems available in the local dental laboratories.

Materials and Methods

Materials Used

1. DENTSPLY SIRONA AQUASIL SOFT PUTTY
2. DENTSPLY SIRONA AQUASIL ULTRA-SMART WETTING IMPRESSION MATERIAL (TYPE III LIGHT BODY CONSISTENCY)
3. KALROCK (KALABHAI) CLASS IV DIE STONE
4. PMMA BLANK/DISC

(SAGEMAX 98* 16MM PMMA DISC, A2 SHADE)

EQUIPMENT USED

1. CAD CAM-ARUM 5x150

MILLING SOFTWARE-HYPODENT

2. SCANNERS
   - MEDIT 300
   - UPCERA U2

DESIGNING SOFTWARE-EXOCAD 2.2

3. STEREOMICROSCOPE 40X

(SOFTWARE- IMAGE VIEWER)

INSTRUMENTS USED

CARTRIDGE GUN

SURGICAL BLADE

METAL GAUZE

Methods

In the study, we decided to make 30 PMMA copings, 15 for group A and 15 for group B, using two different laboratory scanners, MEDIT300& UPCERA U2 of 2018, and CAD-CAM with a milling unit ARUM 5x150, which is of 5-axis. The 30 PMMA copings were manufactured on the metal master die by scanning the surface of the master dies using two scanners, one on each group. They were analyzed from different perspectives:

- Vertical marginal space at the preparation limit
- Axial internal length at the middle of the axial wall height
- Internal occlusal space in 2 distinct points

A CAD/CAM system with a milling unit and two different scanners were used in the study. They have selected according to the following inclusion criteria:

- Model manufactured after 2014.
- PMMA milling capacity.
- Open system with Modules allowing the users to work with open.STL files, compatibility with Exocad dental CAD 2016.

Customisation of aluminium master die

A master model was fabricated with a die and two guiding pins using aluminium alloy with a total diameter of 60mm. The die was placed by the exact center of the total diameter. The central die with two guiding pins adjacent to it on either side is 10 mm away from the die in the center. The die with an occlusal diameter of 6mm and a height of 5mm from the finish line. Guiding pins were fabricated to position the counter die in the exact place; the counter was manufactured so that the master die could pass easily through it with the base of the die with two cylindrical projections on two sides which helped in the precise orientation of the counter die.

Fabrication of stone dies:

The aluminium die was duplicated in type IV die stone of kalrock by using polyvinylsiloxane impression material of Dentsply aquasil putty and light body materials. Thirty die stone replicas were fabricated and checked for the fitting of aluminium counter die.

Preparation of stl file & fabrication of copings:

The stone dies, after being made, were then sent to be scanned with two different scanners with CAD/CAM system to be scanned, thus producing virtual casts of the same physical working cast. Then sent the virtual models to design the copings using the CAD with software Exocad 2.2.

Sagemax PMMA discs, 16 mm in width and A2 shade batch no. HL190829 was used for milling.

The scanned copying data from GROUP A and GROUP B from their respective scanners MEDIT 300 and UPCERA U2 with Exocad software version 2.2 then transferred to CAM (computer-aided milling) machine that is ARUM 5x150 for milling with software Hypodent that processed copings of PMMA which were developed for use in dental prostheses.

We manufactured PMMA (poly methyl methacrylate) copings. Copings were designed for each of the virtual models, abiding by the same criteria and set parameters during the design stage: 20 µm cement gap and coping thickness of 1 mm evenly following the contour of the preparation, which decreases towards the marginal area depending on the thickness required by the marginal design.

The Exocad version 2.2 software was used by the same operator, on the same computer simultaneously, and on the same day. Thus, virtual copings were designed and saved.STL files originating from the physical cast and identically designed under the same circumstances; the only difference between the 30 copings of two groups of Group A and Group B, was that the virtual cast came from different scanners. Virtual copings from two scanners were sent to the milling unit, so each laboratory scanner in part received all the 15.STL files for milling. Consequently, the milling unit made 15 copies of all virtual copings, that is, 15 virtual copings x 2 scanners = 30 copings.

Impression making for the internal gap of copings:

In order to evaluate how the copings fit on the physical cast, a replica of the internal and marginal space was made using light body Polyvinyl Siloxane from a cartridge with two components, later fixed with putty Polyvinyl Siloxane. Materials used: a lid for stabilizing the light body silicone into the putty silicone, which has two markings on it, providing the reference points for precise cutting in the next stage. In practice, a set quantity of light body silicone was used to make an impression of the internal and marginal space for each coping.

Next, the putty silicone was put in the same application lid. After removing the application lid, the fluid silicone was attached and stabilized into the putty silicone. The silicone replicas were sectioned in buccal-lingually with the cutting reference points marked on the inner side of the stabilizing lid. We used a surgical blade for cutting the silicone replica according to the markings kept for reference on the lid.

Assessment of marginal fit:

The copings of Group A and Group B were seated on their respective dies and evaluated for marginal fit. A stereomicroscope at × 40 magnifications and image view software was used to evaluate the marginal fit in Systems.

The inspection of the milled copings did not reveal any significant differences in surface finishing, milling quality, or marginal area integrity. Therefore, we can assert that all the tested systems displayed similar qualitative surface and marginal integrity parameters. In the first fitting on the abutment, without light body silicone, all the copings showed good, equal, adequate marginal adaptation, being seated on the marginal preparation without any distancing or visually detectable VMS oscillations. An inspection of the internal and marginal space of the light body silicone replicas of all the copings on the abutment immediately after their removal endorsed the conclusion of other studies, namely that the internal space is not uniform should ideally be according to the CAD design. There were several more transparent silicone zones areas with thinner silicone layers, and the transparent zones/areas were not in the same region at each impression.

The marginal fit was determined as the maximum distance between the margin of the die and the most apical part of the coping margin; the values were noted in µm. The mean values were calculated by marking each prepared specimen at 6 points on the margins of the replica.

Each silicone replica was cut into slices, and each was scanned from the same direction using a stereomicroscope 40X scanner. The digital images thus acquired were imported into the image viewer software program, which measures the distances between 2 points of the image on the silicone replica in the analysis window using the units of its measurements (data units) in µm.

In the image viewer software program, we determined the thickness of the light body silicone layer in 6 points for each section, as follows: -

Vertical marginal space at the preparation limit, both at region 1and region 2 (2 measurements), using the abbreviations VMS (VMS1and VMS2);

Axial internal space at the middle of the axial wall height, both region 1and 2; the measurement was carried out perpendicularly on the axial wall (2 measures), using the abbreviations AIS (AIS1 and AIS2);

Internal occlusal space in 2 distinct points, an occlusal side of the abutment at regions 1 and 2, abbreviated IOS1and IOS2. The resulting values were expressed in data unit's µm.

Results

The data was subjected to attest to determine the marginal fit, which was used to compare the accuracy of different laboratory scanners and to test the degrees of significance between Group A and B.

Data were analyzed using SPSS version 2.0 for intra-group comparison with dependent t-test; intergroup comparison with one-way ANOVA test for scanner precision.

The null hypothesis in this study asserts that when comparing marginal fit and scanner precision with no significance in difference between Group A and B. Both groups copings had marginal fit values that were clinically acceptable (0.05). The marginal vertical space was 83m, the axial internal space was 73m, and the internal occlusal space was 183m on average. When comparing Group A and Group B, the mean scanning precision for Group A was 6.45mm and 6.49mm, respectively. Scanner accuracy was found to be significantly different between the two groups. (Significance: p0.05)

Inference

On conducting a comparative evaluation of marginal fit and accuracy for scanner MEDIT 300 AND UPCERA U2 at total of six points two at each vertical margin, internal occlusal and axial internal regions for fit and three parameters as height, width, and length on scanning of PMMA copings for scanners, t-test and ANOVA TEST obtained statistically significant results for GROUP B that is for UPCERA U2 scanner.

Discussion

Smaranda buduru et al. used an internal replica for internal and marginal space with light body Polyvinyl Siloxane that was fixed with putty Polyvinyl Siloxane to determine how well the copings fit on the physical cast. The fluid Silicone is attached to and stabilized in the putty silicone after removing the application lid. Cutting reference points were used to section the silicone blocks buccolingually and mesially-distally. [3]The same technique was used in the study to remove a light body replica onto putty in the same lid by recording the already present material on the abutment as a single piece and sectioned bucco-lingually.[1]

Ala omar ali, in their study, proposed a novel method of taking digital impressions, fabricating the master model, and producing the final restoration using Computer-Aided Design/ Computer-Aided Manufacturing (CAD/CAM) technology. As a result, the goal is to overcome some physical limits of traditional methods, such as dimensional changes in impression materials, expansion of dental stone, and human errors connected with final restoration fabrication, resulting in a reduction in processing time and cost.[2]

Ece tamac and others stated that essential criteria for caps and F.D.P. clinical success are marginal gap adaptation and internal fit. Lack of good fit can be poor because of the degradation of cement, which causes loss of marginal seal and increases retention of plaque and food debris. It is impossible to prescribe a correct technique since many variables, and environmental conditions are involved.[3]

Sakura shimizu et al. Examined marginal fit of the constructed copings using two different scanners later comparing the accuracy of the two scanners used was done; thus, the same was done in the research for comparing the accuracy of the scanners used and the evaluation of the marginal fit of the copings fabricated.[4]

In their study, Kyu-bok lee et al stated that this study used the metal die as an abutment. Several investigators have used metal or acrylic resin die to measure marginal fit. Merits for metal die were standardized preparation and lack of wear during manufacturing and measurement. Thus aluminum metal was selected for the fabrication of the master die in the study because of its advantages over stainless steel.[5]

In their study, Bhushan satish gaikwad et al. used stainless steel master die.[6]The used Aluminium dies to fabricate the master die in the study for its easily machinable and castable properties**.** It is the most flexible material than stainless steel, can be molded in desirable shapes than any other materials, and is also more economical than stainless steel. This metal also can be recycled and also the economically friendly metals on the planet.

Matts Andersson in their study, explained the manufacturing errors in the milling operation were small and were primarily due to bending of the cutting tool and bending of the titanium blank; thus, errors in the study may also be due to molding of the aluminium metal.[7]

JB da costa et al explained that the optical scan was made intraorally or extra orally from gypsum die in this investigation. No significance of difference found between the two approaches.[8]

Estefanía aranda yus et al explained in their study that type IV stone was well recommended when high levels of strength and hardness and low setting expansion are required. Thus in this study, GYPSUM TYPE IV DIE STONE is used to fabricate stone die.[9]

In their study, JB Da costa et al. stated a 5-axis milling machine[8] produced a superior occlusal marginal gap and better axial internal gap than a 3-axis milling machine41 thus the cad cam of 5 axis that is ARUM 5x150 with milling selected on this basis.

Bhushan satish gaikwaid et al. explained the problems faced by fitting for casting[6], either too large or small, which were usually be traced not following the instructions of the investment manufacturer. It is impossible to prescribe a correct technique since many variables involve environmental conditions during the conventional procedure. So, to avoid such errors, PMMA copings in the study are easy to process, low cost, and versatile materials.

Estefanía aranda yus et al. used small perforated plastic cups (diameter 30 mm, height 20 mm) were used as impression trays, and the master die was adjusted to be placed at the center of the cup. Accordingly, a plastic cup was selected based on this to fit the coping to make an impression.[9]

The manufacturer's instructions were followed for the setting time to material, and the master die was then removed from the impression. To every impression, two components of high viscosity polyvinyl siloxane material (base and catalyzer) were mixed, always in the same quantity (half of the measuring spoons), and were placed in the container. The low viscosity polyvinyl siloxane material was applied to the tip of the syringe over the metal die. After five seconds, the container full of high viscosity silicone was placed over a covered die of low viscosity silicone. After five minutes, the setting time recommended by the manufacturer, the container was removed from the die and the overflowing material cut with a scalpel. As a result, we adopted the replica approach, creating a light-body silicone replica of the abutment and coping internal gap.

Nayana paul et al.[10] explained in their study about Sorensen et al.[11] In this research, the impression technique by replica method was to analyze adaptation, considered a reliable and non-invasive method for measuring the marginal and internal fit. In this technique, the cement was replaced with impression material, and the restoration was positioned onto the abutment.

Roxana-diana vasiliu et al. in the study, filled the crowns with light body silicone. After adapting the crown on the resin abutment, for 15 seconds, finger pressure was applied. After the polymerization was completed, the crown was removed, and the light body silicon remained on the abutment for three minutes. The medium body silicone was added and placed in the crowns on the light body impression material to support silicon for another three minutes. [12] Andreas syrek et al. examined replicate therapeutic cementation of the crown. The copings were filled with a low viscosity A-silicone (ExpressTM2 Ultra-Light Body Quick), seated on the preparation, and kept in position for 3 seconds with maximal finger pressure. Copings are removed after 2:30 minutes, with the A-silicone sticking to the inner surface of the coping in all cases. Another light-bodied silicone (ExpressTM2 Light Body Flow Quick) was injected into the crown to stabilize the film and form one piece with it without distortion.[13]

Kunii et al. Explained that fit of single crown coping was excellent except for discrepancy at the occlusal surface, whereas marginal gaps on the pontic sides of 3 unit bridges were significantly smaller than those on the non-pontic side.[14]

Hyun-soon pak and others discussed that Hertlein et al. investigated adaptation of the Lava All-Ceramic System for anterior and posterior teeth with a chamfered preparation margin under a stereomicroscope the marginal adaptation was reported.[15]

Scope of The Study

In the future, other milling technologies and scanners will be reviewed and studied to compare crown fit for obtaining better accuracy which is very crucial for a prostheses to give long term success.

Conclusion

Although the digital process eliminates intrinsic imperfections associated with manual laboratory work, differing devices and parameters can display significant impact on dimensional accuracy of the finished goods as compared to traditional methods. Accordingly taking results of the study and given limitations into account, following are the conclusions:

1. Statistically significant differences were present between group A and group B for marginal fit evaluation and precision comparison of scanners when subjected to t-test and ANOVA test.
2. For vertical marginal space, when scanned, both MEDIT T300 and UPCERA U2 scanners showed statistically significant differences.
3. When scanned both with MEDIT300 and UPCERA U2 scanners for axial internal space showed statistically insignificant differences.
4. When scanned with MEDIT300, results obtained showed statistically insignificant differences for internal occlusal space, whereas when scanned with UPCERA, U2 results are statistically significant.
5. For comparing the accuracy of scanners, the results obtained were statistically significant for both scanners. Still, the slightest deviation in mean values was obtained while comparing for Precision obtained for UPCERA U2 than MEDIT T300.

It concludes that the PMMA copings of both the Groups A and B showed better accuracy for marginal fit when scanned by UPCERA U2 and compared for scanners precision.

References

1. Smaranda Buduru , Bogdan Culic , Daniel Talmaceanu , Adorjan Pal, A comparative study of the accuracy of five CAD-CAM systems.
2. Ala Omar Ali, Accuracy of Digital Impressions Achieved from Five Different Digital Impression Systems.
3. Ece Tamac, a Suna Toksavul, and Muhittin Toman, Clinical marginal and internal adaptation of CAD/CAM milling, laser sintering, and cast metal ceramic crowns.
4. Sakura SHIMIZU, Akikazu SHINYA, Soichi KURODA and Harunori GOMI, The accuracy of the CAD system using intraoral and extraoral scanners for designing of fixed dental prostheses 6. Marginal and Internal Fit of All-ceramic Crowns Fabricated with Two Different CAD/CAM Systems, Kyu-Bok

LEE, Charn-Woon PARK, Kyo-Han KIM3 and Tae-Yub KWON

5. Marginal and Internal Fit of All-ceramic Crowns Fabricated with Two Different CAD/CAM Systems, Kyu-Bok LEE, Charn-Woon PARK, Kyo-Han KIM3 and Tae-Yub KWON.
6. Bhushan Satish Gaikwad, Girish Nazirkar , Rajani Dable , Shailendra Singh, Comparative evaluation of marginal fit and axial wall adaptability of copings fabricated by metal laser sintering and lost-wax technique: An in vitro study.
7. Matts Andersson, Lennart Carlsson, Magnus Persson, and Bo Bergman, Accuracy of machine milling and spark erosion with a CAD/CAM system.
8. JB da Costa, F Pelogia B Hagedorn , JL Ferracane, Evaluation of Different Methods of Optical Impression Making on the Marginal Gap of Onlays Created with CEREC 3D.
9. Estefanía Aranda Yus, Josep Maria Anglada Cantarell, Antonio Miñarro Alonso, Comparison of the marginal fit of milled yttrium stabilized zirconium dioxide crowns obtained by scanning silicone impressions and by scanning stone replicas.
10. Nayana Paul, Raghavendra Swamy K.N, Dhakshaini M.R , Sowmya S 4 , Ravi M.B, Marginal and internal fit evaluation of conventional metal-ceramic versus zirconia CAD/CAM crowns.
11. A standardized method for determination of crown margin fidelity John A. Sorensen.
12. Roxana-Diana Vasiliu , Sorin Daniel Porojan and Liliana Porojan, In Vitro Study of Comparative Evaluation of Marginal and Internal Fit between Heat-Pressed and CAD-CAM Monolithic Glass-Ceramic Restorations after Thermal Aging.
13. Andreas Syrek a,, Gunnar Reich b, Dieter Ranftla , Christoph Klein a, Barbara Cernya, Jutta Brodessera, Clinical evaluation of all-ceramic crowns fabricated from intraoral digital impressions based on the principle of active wave front sampling.
14. Jun kunii, yasuhiro hotta et al, Effects of sintering on the marginal and internal fit of cad-cam fabricated zirconia frameworks.
15. Hyun-Soon Pak, Jung-Suk Han, PhD, Jai-Bong Lee, Sung-Hun Kim, Jae-Ho Yang, Influence of porcelain veneering on the marginal fit of Digident and Lava CAD/CAM zirconia ceramic crowns.
16. Thorsten Grunheid, € a Shawn D. McCarthy,b and Brent E. Larsonc, Clinical use of a direct chairside oral scanner: An assessment of accuracy, time, and patient acceptance.
17. Ting-shu Su, Jian Sun, Comparison of repeatability between intraoral digital scanner and extraoral digital scanner: An in-vitro study.
18. Pablo González de Villaumbrosia, ,a Francisco Martínez-Rus, Ana García-Orejas, María Paz Salido and Guillermo Pradíes, In vitro comparison of the accuracy (trueness and precision) of six extraoral dental scanners with different scanning technologies.
19. Priscilla Medina, Sotomayor Agustín Pascual-Moscardó, Isabel Camps, Relationship between resolution and accuracy of four intraoral scanners in complete-arch impressions,
20. Iman Shafi ei, Mehran Bahrami and Saied Nokar, Dimentional accuracy of intraoral and laboratory scanners: A literature review.

Legend Table and Figure

Table 1: Mean and standard deviation values for vertical marginal space, axial internal space, and internal occlusal space at region1&2 for medit300& upcerau2.

	M1(Mean)	M2(SD)	U1(Mean)	U2(SD)
VMS(M)	86	17	139	197
VMS(U)	83	27	79	30
AIS(M)	75	33	69	19
AIS(U)	73	20	79	34
IOS(M)	199	66	183	63
IOS(U)	266	162	533	985

M-MEDIT 300, U-UPCERA U2

VMS-VERTICAL MARGINAL SPACE

AIS-AXIAL INTERNAL SPACE

IOS-INTERNAL OCCLUSAL SPACE

A comparative evaluation of marginal fit for GROUP A AND GROUP B at six distinct points of PMMA copings by conducting a t-test obtained statistically significant results for GROUP B.

Graph 1: The graph between mean and standard deviation for overall height width and length of medit300 and upcera u2 scanners.

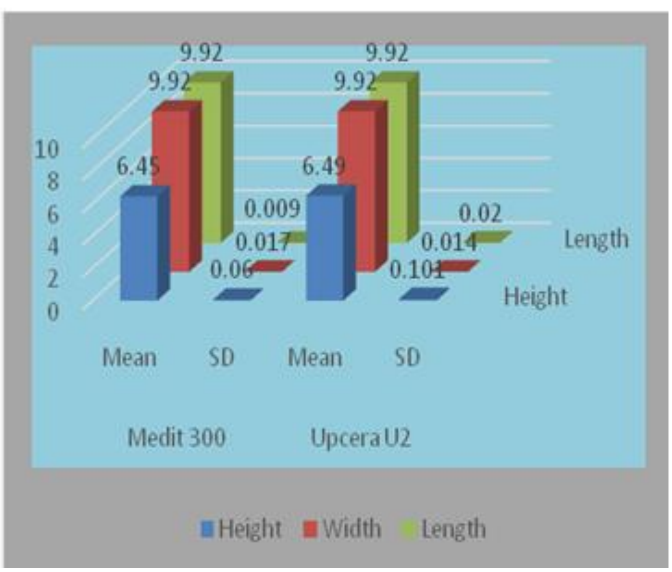

Figure 1

Figure 2

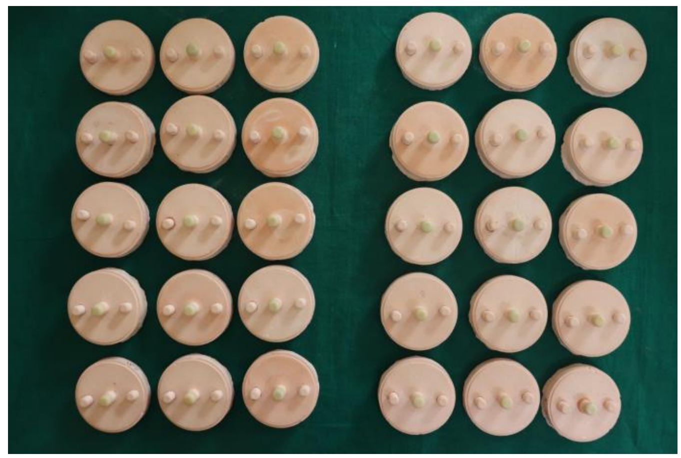

Figure 3

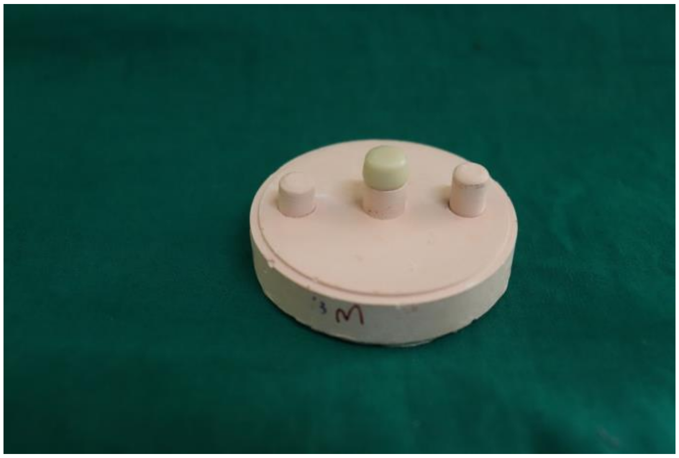

Figure 4

Figure 5