Original Article

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COMPARATIVE EVALUATION OF THE ACCURACY OF MARGINS IN FIXED PARTIAL DENTURE USING DIFFERENT IMPRESSION TECHNIQUES : AN IN-VITRO STUDY

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ABSTRACT:

The purpose of this study was to compare the marginal accuracy of dies obtained from different impression techniques, to evaluate the marginal width of dies made by using different impression techniques, to compare the accuracy of marginal width using different impression techniques & to evaluate the most accurate impression technique among the three techniques used. The purpose of this study was to compare the marginal accuracy of dies obtained from different impression techniques, to evaluate the marginal width of dies made by using different impression techniques, to compare the accuracy of marginal width using different impression techniques & to evaluate the most accurate impression technique among the three techniques used. On comparison with metal die the overall discrepancies of the matrix impression technique was significantly smaller than those in the putty reline and multiple mix impression techniques. This was an *In vitro* comparative, study in which 45 impressions made by using matrix impression system, putty reline technique & multiple mix technique were measured by Travelling Microscope. On comparison with metal die the overall discrepancies of the matrix impression technique was significantly smaller than those in the putty reline and multiple mix impression techniques.

Key words: Fixed partial denture, Matrix Impression system, Putty reline technique, Multiple mix technique

INTRODUCTION:

The fixed partial prosthesis are one of the well developed and well accepted treatment modality in the field of prosthodontics. The fabrication of an accurately fitting fixed prosthesis is a highly precise work. The precise work begins right from the tooth preparation, impression making, cast/die preparation, wax pattern fabrication, casting, finishing and cementation. If any inaccuracy occurs to any step, it will be carried through to the final stage of the prosthodontic treatment.

Some authors claim that the impression materials have improved on such an extent that accuracy can be controlled by the technique rather than the material itself. [1] Others report that the technique does not affect accuracy.[1]

Impression techniques have been categorized as monophase and dual

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phase. Techniques using monophase materials are made in a single step using a medium viscosity material. Techniques that use dual phase materials such as putty and light body wash method may be accomplished in 1-step or in 2-step (1-step and 2-step putty/light body techniques). In the one step technique the putty and wash material are mixed in the same time. The light body material is syringed around the prepared teeth and the tray containing the putty is seated and stabilized with minimal pressure until the impression materials are set and polymerized. In the 2-step putty/light body technique a stock tray is painted with adhesive and the putty material produces a tray similar to that of acrylic resin, in the second step selectively relieve the putty and details are recorded by the light body. One precaution is to select a tray closely fitting the arch form thus reducing the amount of impression material and facilitate seating of the loaded tray intraorally. [2]

There is a potential difficulty with this technique as it is practically impossible to control the bulk and even amount of wash material. Moreover, further modifications to this technique include the use of polyethylene spacer.

Some authors claim that the extent of accuracy of dies is determined more with the technique than by the material itself and others reporting that the impression accuracy is governed more with the material employed.[3,4]

However with the proven accuracy of the material, the technique also has to be considered, especially in cases of fixed partial denture. The purpose of this study was to access the accuracy of different impression techniques in a laboratory model that simulated the clinical practice.

The null hypothesis of this study was that no differences would exist in dimensional accuracy of casts fabricated using with the experimental group and the control group.

MATERIAL & METHODS:

METHODS OF COLLECTION OF DATA:

Preparation of master model:

The typhodont teeth were embedded in the maxillary Nissan model base. A master model was selected from The Crown Preparation Step Model. Central incisor 11 prepared for full ceramic was selected. In order to prevent possible wear or fracture of master model from repetitive impression taking procedure, dentiform models (Nissan Dental Prod. Inc., Japan) & 11 was duplicated with Pattern resin (GC Dental, Japan) and casted with NiCr and then it was electroplated (fig.III). The measurement of metal die was kept as control group.

The impressions were categorized into 3 groups. For all the groups before making the impressions, the master model was immersed in the water bath maintained at 370C ⍰ 20C to simulate the oral temperature. After that the master model was taken out of the water bath

and dried with air. The impressions were made according to the individual technique.

Group I impressions:

The Matrix Impression System (MIS)19 requires a series of three impression procedures, using three different types of viscosity of elastomeric impression materials.

Firstly, an elastomeric semi-rigid material, polyvinyl siloxane-putty, (3M ESPE, Express XT STD) base and catalyst was hand mixed and placed in a modelling wax and an impression of the prepared tooth was made to obtain a matrix. This was allowed to set for 8 minutes.

The thickness of the matrix was kept between 1 to 3 mm using wax caliper. The outer portion of the matrix was trimmed to the gingival crest with a scalpel (No.15). The axial walls of the prepared tooth in the matrix were trimmed to provide space for the impression material.[19] The internal, incisal or occlusal aspect of the matrix was not trimmed, as these serve as vertical stops. The portion of the matrix contacting the proximal surfaces of adjacent unprepared teeth were relieved.[19]

Secondly a definitive impression was made using the matrix of the prepared tooth with a high viscosity (3M ESPE, express) elastomeric impression material, which was injected over the abutments with an automatic mixing system.[9] Simultaneously, the stock tray was loaded with medium viscosity (3M ESPE, express) elastomeric impression material available with an automatic mixing system which was seated over the master model to make an impression of the remaining arch. The tray was held in place for 8 minutes for the material to set. After the setting time, the air seal was broken with light pressure and then the impression was recovered with a snap. Fifteen such impressions were made following the same procedure were considered as Group I impressions, and casts correspondingly.

Group II impressions :

A two-step technique Putty Reline Technique (PRT)[1] was used.

In the first step, equal amounts of putty base and catalyst (3M ESPE, express STD) were hand mixed and loaded into the perforated metal stock tray, and the impression of the master model was made using cellophane sheet as spacer for light body. The impression was allowed to set for 5 minutes. Once the impression was set, it was removed from the master model.[1] Then a mix of light body (3M ESPE, express) was injected over the prepared tooth with an automatic mixing system, and the tray was reseated over the master model accurately. The tray was held in place for 8 minutes for the material to set. After the setting time, the impression was recovered with a snap. Fifteen such impressions were made following the same procedure. The impressions made using PRT was considered as group II

impressions, and the casts acquired were considered as Group II casts.

Group III impressions :

The group impressions were made using multiple mix technique (MMT). [21]

The irreversible hydrocolloid impression material (Imprint - DPI) was used to make the impression and cast was made with, the dental plaster (Katdent, Kalahari, and Karson-Mumbai).

Fabrication of the custom trays:

Three tissue stops of approximate area 3 x 2mm were marked on incisal edge of tooth No. 13, 21 & 23. The modelling wax (Y-Dents, MDM Corp, Delhi) was softened in hot water and two layer thickness was adapted on to the cast uniformly and was extended 3-5mm beyond the marginal gingiva of the model. The tissue stops were cut at the marked tissue stop areas. A thin aluminum foil was adapted onto the wax spacer to prevent the wax contamination of the custom tray. [22]

The custom trays were made with acrylic resin material (DPI) and were left on the casts for further 24 hrs. to allow complete polymerization and to avoid dimensional changes after the impression procedures.[23] Fifteen custom trays were fabricated by using the same procedure.

The wax spacer of the custom tray was removed along with the aluminum foil. The custom tray was cleaned and dried. The tray adhesive (3M ESPE, VPS tray adhesive) was applied uniformly on the tissue side of the custom tray and also on the border as well as 2-3 mm beyond the border of the custom tray. The tray adhesive was air dried for 5 minutes.

Then a mix of regular bodied consistency (3M ESPE, express) was injected into the custom tray and simultaneously a mix of light body (3M ESPE, express) was injected over the prepared tooth [(11)]. The loaded custom tray was seated completely, to make an impression of the entire arch. The tray was retained in position for 8 minutes from the beginning of the mix.

After the complete setting of the impression material, the seal was broken by slowly pulling the tray and then the impression was snapped out rapidly. Fifteen such impression were made following the same procedure and the casts poured in these impressions were considered as Group III casts

Preparation of the master cast:

Once the impressions were made, all the impressions were stored at room temperature for 30 minutes before being poured (for complete polymerization). Then 29 ml of distilled water was dispensed in the bowl and 50gm of improved dental stone (type IV) (Ultrarock, Kalabhai, Karson-Mumbai) weighed in an electronic measuring balance was sifted gradually into the water and allowed to soak for 30 seconds. Later the stone was hand mixed for 30 seconds. The bowl was placed on the mechanical vibrator to remove all

the air bubbles. The small increments of the stone mix were placed in the impression, which was placed on the vibrator by using the camel hair brush from one end of the impression to avoid entrapment of the air voids. After pouring the casts, the improved stone were allowed to set for 1 hr. before separating the casts from the impression. [22] A total of forty five impressions of all groups were made and the casts were poured in the same manner to obtain the master casts.

Measurements:

The measurements of the master model as well as group I, II and III casts were done in Physics Department of Teerthanker Mahaveer Engineering College, Moradabad using Traveling Microscope (fig.II & fig.IV).

Measurement of the master model:

In the master model, the tooth No.11 mesio-distal was considered as MD, bucco-palatal as BP.

On the prepared tooth the distance between the mesio-distal margins was considered as measurement No.1.

The distance between the bucco-palatal margins was considered as measurement No.2.

All the measurements were recorded 3 times for the model by the same operator and the mean was calculated and noted.

RESULT:

The mesio-distal and bucco-lingual measurements of the group I, group II and group III casts and metal die were done by using the Travelling Microscope (Mars Communication, Lakshmi Nagar, Delhi, serial no- 0812653). Mesio-distal & bucco-palatal side of every model was measured 3 times each for all the forty five casts by the same operator. The measurements were tabulated and mean was calculated and statistically analyzed. Descriptive statistics like mean, standard deviation were calculated for each group and also for the differences between the groups.

Paired t-test was used to compare the discrepancy between matrix impression system, putty reline technique and multiple mix technique. Multiple group comparisons were made by one-way analysis of variance (ANOVA). Unpaired t-test was used for group-wise comparisons. P-value of 0.05 or less was considered for statistical significance.

The mean and SD for all distance measurements were calculated and used as the control to compare among the 3 impression techniques. The intra-observer variability for all distance measurements ranged between 2.639 and 1.713µm, which was 0.04% to 0.02% of measurement errors. The percentage of deviations from the master model for each impression technique was calculated of each measurement location.

Table I :

Shows the mean differences of measurements of central incisor 11 between the master model and group I, II and III working casts.Statistical comparison between the master model and group I, II, III casts measurements by paired t-test showed significant statistical difference (P<0.05) for all the groups.

Table II :

Shows the percentage of deviation and absolute change (µm) between the metal die and master cast prepared respectively for each impression technique. It was found that there was expansion in group I cast (matrix impression technique) whereas the Group II and Group III showed contraction.

Table III :

Shows the difference between groups I-II, I-III and II-III.

Statistical comparison between group I, II and III casts measurements by one way ANOVA (F-test) and unpaired-t-test showed highly significant statistical difference between the three groups from each other. T test was used for pair-wise comparison between the means when ANOVA test is significant. The significance level was set at $P \leq 0.01$. Here the *p*-value is ≤ 0.01, it suggests that the observed data is inconsistent with the assumption that the null hypothesis is true, and hence we reject the null hypothesis and accept the alternative hypothesis and finally conclude that there is significant differences among the three impression techniques (Table 3) for all mesio-distally (MD) and bucco-palataly (BP) locations (P<0.01). These analyses revealed a significant difference between the three techniques. Overall discrepancies of the matrix impression technique was significantly smaller than those in the putty reline and multiple mix impression techniques. Further investigation is needed to determine the exact amount of differences between the mentioned impression techniques.

Graph I shows the mean mesio-distal measurements of central incisor on master model, Gr I, II and III casts while Graph II shows the mean labio-palatal measurements of central incisor on master model, Gr I, II and III casts.

DISCUSSION:

Making an accurate impression of single tooth or whole dentition is very vital in obtaining accurate working casts, and for the fabrication of the prosthesis or restorations.

For obtaining an acceptable impression and the working casts, various factors have to be considered, like the proper selection of the impression technique, the impression material and the type of trays. Over the past four decades, tremendous progress has been made in procedures for making fixed prosthodontic impressions. These impression procedures involve a wide range of procedures and an even wider range of materials. Many studies

reported that the elastomeric impression materials provide accurate and dimensionally stable impressions.

Polyvinyl siloxane (PVS) impression materials are extremely popular because of their combination of excellent physical properties, handling characteristics and dimensional stability.[6,24,25] In polyvinyl siloxane impression materials, the strength of the bond between the putty and wash is sufficient to overcome stress that might tend to separate the materials at their interface and result in potential errors in the impression.[8] The bond between the putty material and light body is chemical in nature and any bond failure which occurs is a cohesive failure in the weaker material.[26] Several factors affect the accuracy of reproduction of an impression material which includes the tray,[27] tray adhesive [28] and the impression technique.

Various impression techniques like matrix impression system [18,19], putty reline technique [3,17], multiple mix technique [21] became popular for making fixed prosthodontic impressions. Various authors have reported conflicting results as regard to superiority of one technique over the other. Livaditis GJ [18, 19] reported that matrix impression system is more accurate than the conventional impression techniques.

The matrix impression system incorporates the attributes of traditional methods and overcomes important deficiencies in registration of subgingival margins, gingival retraction and relapse, hemostasis and sulcular cleansing, delivery of impression material subgingivally, strengthening the sulcular flange of the impression and simplification for making complex impressions [18].

The matrix forming material should register details equal to the best impression materials. The matrix-forming material should be rapid setting and compatible with the matrix impression and tray impression materials. Ideally, it should bond with the other two materials without the use of an intermediate adhesive layer.[18]

Livadatis GJ.[18] reported that the matrix should encompass the portions of the arch that are critical for a fixed prosthodontic impression, which include the prepared abutments, free gingival margin, marginal ridges and proximal surfaces of adjacent unprepared teeth, and soft tissue portions under planned pontics and precision attachments.

For putty reline technique Fusayama T et al6 and Wassel RM et al [14] reported that one step putty reline technique produced more accurate casts, whereas Dhiman RK et al, [28] Johnson GH et al [29] and Nissan J et al [1] reported that dimensional accuracy was better with 2-step technique. Hung SH et al, [3] Idris B et al, [16] Lacy AM et al [7] and Stack House J [5] did not find any difference between the two techniques.

Additional parameter that has to be considered for accurate impression is the uniformity of the wash space. [12,39] Eames WB et al [5] reported that 2 mm thickness of rubber base material provided accurate impression than 4 and 6 mm thickness, because of lesser polymerization shrinkage. Increasing the thickness of the impression material, produces more distortion because of greater polymerization shrinkage. [30]

The objective of this in vitro study was to compare the accuracy of matrix impression system with conventional putty reline technique and multiple mix technique for individual die in master model using the three impression techniques.

A perforated metallic stock tray was used for making the impression and before making the impressions, tray adhesive was applied on the tray and air dried for 5 minutes, because the results are enhanced both in accuracy and consistency, when the tray adhesive is used in a perforated stock tray. [6, 27]

After the master model was removed from the water bath, it was dried before making the impression because presence of moisture affect the detail reproduction of elastomeric impression.[20] Equal amounts of putty base and catalyst were hand mixed without gloves because some brands of latex gloves cause the setting inhibition of elastomers. [10]

An automatic mixing system was used for adding heavy body, medium body and light body on the abutments in all the three impression techniques. The automatic mixing system is simple to use, reduces bubbles in the mix resulting in more precise impressions, no spatulation required and being economical. [11, 31]

The results showed the mesio-distal dimensions of central incisor in Group I was 0.660444 cm against the master model which was 0.643511 cm. (Table 1).The percentage deviation from master model in Gr I was 2.6, in Gr II was 2.6 and Gr III was 1.6 respectively (Table 6).

The contraction was observed in Gr II and Gr III whereas the measurements of Gr I was expanded as compared to that of the master model.

The contraction in Gr II may be because the wash material may have hydraulically displaced the preliminary putty impression during impression seating and the putty may then have exhibited some elastic recovery upon removal of the impression and resulted in tendency towards smaller dies. [16]

The results observed in this study are in correlation to that of Nissan J et al, [1] Idris B et al [15] and Gautam N et al. [4] They stated that contraction may be due to uncontrolled wash bulk, which allows for differential contraction and results in uneven dimensional change. This may result in dies which are short mesio-distally.

The labio-palatal dimensions of central incisor was 0.659311 cm, against the

master model which was 0.658711 cm (Table 1).

The percentage deviation from master model in Gr I was 0.09, Gr II was 2.4 and Gr III was 2.8 respectively (Table 6). It showed a considerable amount of contraction. The contraction occurred was more in Gr II and Gr III where as in Gr I, the expansion was not significant because the small bulk of the impression material with in the matrix minimizes the polymerization shrinkage and improves the accuracy of the individual abutment.[32]

The contraction in Gr II may be due to more polymerization shrinkage or elastic recovery of the putty. The contraction in Gr III may be due to the uncontrolled wash bulk, which results in uneven dimensional change. This may lead from narrow die in a bucco-lingual direction.

The results found in this study were similar to those found by Gordon GE et al [33] and Gautam N et al [4], which revealed a slight increase in the vertical dimension of the dies when PVS impression material was used with stock trays.

The putty material will get compressed if the tray is not seated passively and the putty material will show through after the wash impression is made. It may rebound to cause deformation. The wash impression material may hydraulically compress the putty during the seating of the impression. The putty could then exhibit some elastic recovery upon removal of the impression. This may result in an elongated die in cervico-incisal direction. [4, 34]

The results found in this study are in correlation with that of the findings of Nissan J et al [1], Idris B et al [32] and Petersen GF et al. [13]

From the above mentioned results and discussion it can be concluded that group I impressions (matrix impression system) produced the most accurate casts. Group II impressions (putty reline technique) produced more accurate casts than group III impressions which were in agreement with the findings of Gordon GE et al. [33] Most dimensional differences were shown in group III impressions (multiple mix technique) which were in agreement with the findings of Nissan J et al [1] and Idris B et al. [32] The matrix impression system is more acceptable to obtain accurate dies with polyvinyl siloxane impressions.

CONCLUSION:

The purpose of this study was to compare the marginal accuracy of dies obtained from different impression techniques, to evaluate the marginal width of dies made by using different impression techniques, to compare the accuracy of marginal width using different impression techniques & to evaluate the most accurate impression technique among the three techniques used.

Within the limitations of this study when the working casts of the three groups were compared with the master model,

the conclusion was drawn that the overall discrepancies of the matrix impression technique was significantly smaller than those in the putty reline and multiple mix impression techniques. Further investigation is needed to determine the exact amount of differences between the mentioned impression techniques.

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TABLES:

Table I: Mean differences of measurements of abutment 'Central Incisor 11' between master model and groupI, II and III working casts.

Measurements of 11	Master model		Group I			Group II			Group III		
	Mean	SD	Mean	SD	Diff. From master model	Mean	SD	Diff. From master model	Mean	SD	Diff. From master model
MD	0.643511	0.002639	0.660444	0.010383		0.637311	0.003924	0.017111	0.633011	0.004586	0.0105
BP	0.658711	0.001713	0.659311	0.005076	0.0006	0.642611	0.008872	0.0161	0.639811	0.005264	0.0189

Table II : Absolute change (μm) and percentage deviation (%) from master model of each impression technique

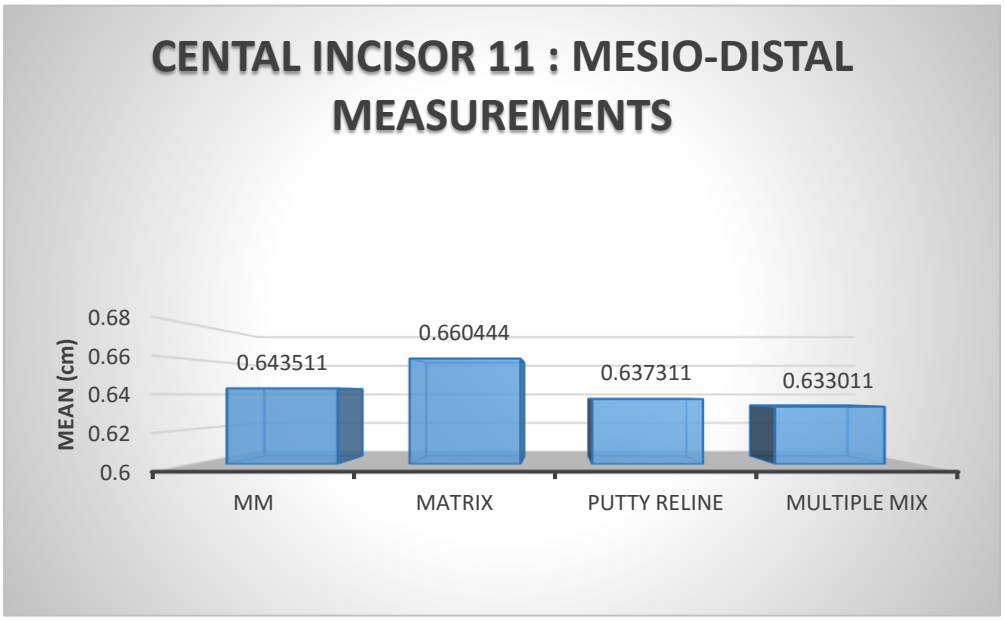
Teeth	Measurement	Group I		Group II		Group III	
		μm	% dev	μm	% dev	μm	% dev
Central Incisor 11	Mesio distal	169.33	2.6	-171.11	2.6	-105	1.6
	Labio palatal	6	0.09	-161	2.4	-189	2.8

Table III : Difference between groups I-II, I-III and II-III

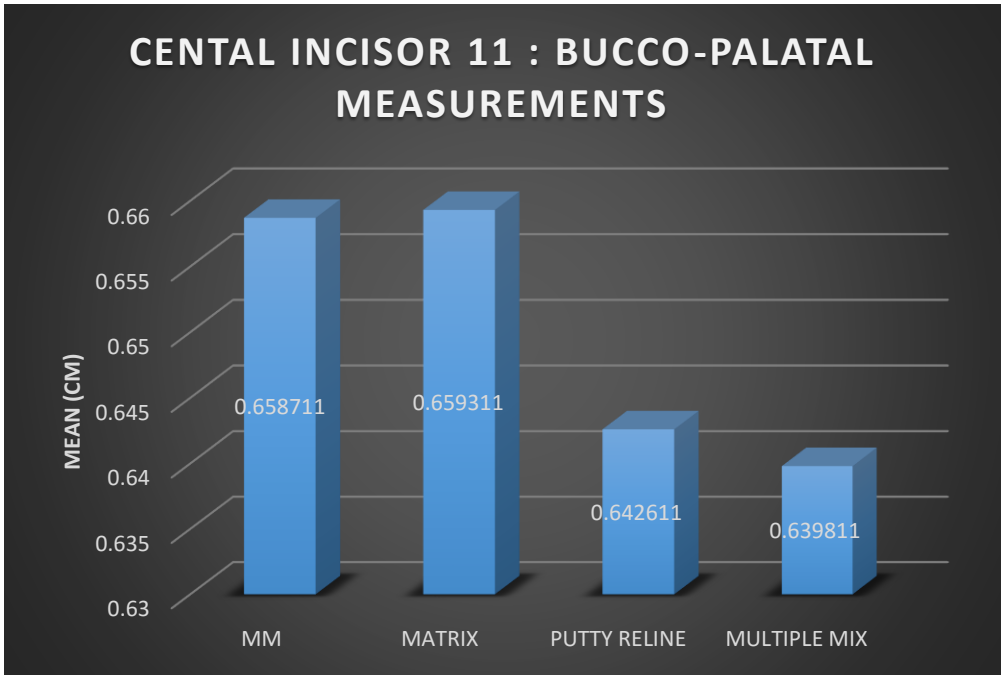
Difference between groups				
Anova		I-II	I-III	II-III
F	P			
42.58954	<.001	p<0.001	p<.001	p<0.3
42.58954	<.001	p<0.02	p<.001	p<0.1

GRAPHS:

Graph I: The mean mesio-distal measurements of central incisor on master model, Group I, II and III casts.



Graph II: The mean labio-palatal measurements of central incisor on master model, Group I, II and III casts.



FIGURES:

FIGURE I : Materials Used In The Study

FIGURE II :Travelling Microscope & Cast

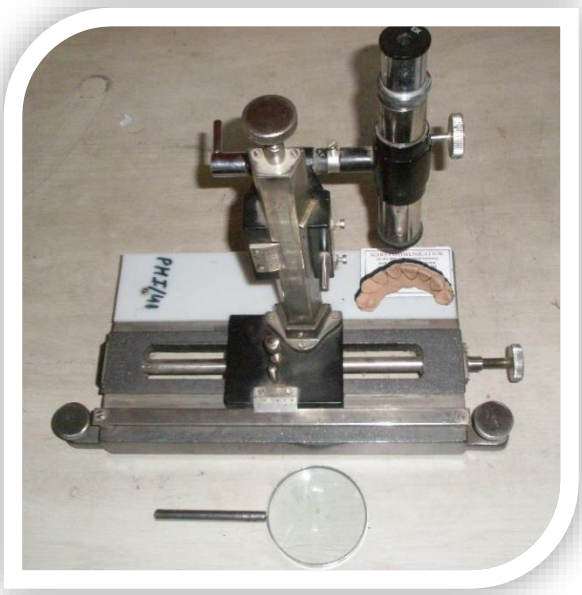


FIGURE III : Master Model with Metal Die Central Incisor 11

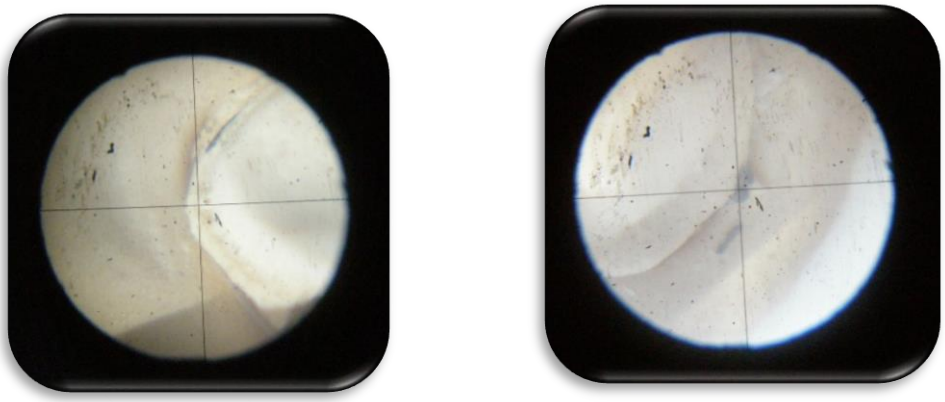


FIGURE IV: Casts Seen Under Magnification Travelling Microscope