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AN IN - VITRO ANALYSIS OF THE DIMENSIONAL ACCURACY OF DIES OBTAINED BY USING DIFFERENT IMPRESSION TRAYS

Dissertation submitted to

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In partial fulfillment for the degree of

MASTER OF DENTAL SURGERY

BRANCH VI – PROSTHODONTICS

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CERTIFICATE

This is to certify that this dissertation titled **"AN IN - VITRO ANALYSIS OF THE DIMENSIONAL ACCURACY OF DIES OBTAINED BY USING DIFFERENT IMPRESSION TRAYS"** is a bonafide record of work done by **Dr. SREE VIDYA LAGISETTY,** postgraduate student of M.D.S branch VI Prosthodontics of Ragas Dental College and Hospital**,** under our guidance and supervision during her post graduate study period between 2003 – 2006.

This dissertation is submitted to The Tamilnadu Dr. M.G.R. Medical University in partial fulfillment for the award of the degree of Master of Dental Surgery in Branch VI – Prosthodontics.

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TABLE OF CONTENTS

ANNEXURE A

LIST OF TABLES

Table No.

11. Comparison of mean values of coordinates measured from samples of different groups (Group I, Group IIA,Group IIB,Group IIC & Group IID).

12. **A** Mean and Standard deviation of different groups at Coordinate 1 (18-22)
B ANOVA test for Coordinate 1 (18-22)

13. **A** Mean and Standard deviation of different groups at Coordinate 2 (20-24)
B ANOVA test for Coordinate 2 (20-24)

14. **A** Mean and Standard deviation of different groups at Coordinate 3 (15-17)
B ANOVA test for Coordinate 3 (15-17)

15. **A** Mean and Standard deviation of different groups at Coordinate 4 (14-15)
B ANOVA test for Coordinate 4 (14-15)

16. **A** Mean and Standard deviation of different groups at Coordinate 5 (15-12)
B ANOVA test for Coordinate 5 (15-12)

17. **A** Mean and Standard deviation of different groups at Coordinate 6 (10-7)
B ANOVA test for Coordinate 6 (10-7)

18. A Mean and Standard deviation of different groups at Coordinate 7 (4-3)
B ANOVA test for Coordinate 7 (4-3)

19. **A** Mean and Standard deviation of different groups at Coordinate 8 (4-2)
B ANOVA test for Coordinate 8 (4-2)

20. **A** Mean and Standard deviation of different groups at Coordinate 9 (4-1)

B ANOVA test for Coordinate 9 (4-1)

21. **A** Mean and Standard deviation of different groups at Coordinate 10 (15-3)

B ANOVA test for Coordinate 10 (15-3)

22. **A** Mean and Standard deviation of different groups at Coordinate 11 (22-10)

B ANOVA test for Coordinate 11 (22-10)

23. POST HOC TESTS for coordinates 1 to 11

LIST OF FIGURES

Figure No.

GRAPHS

24.	Dimensional variation comparision at Coordinate 9 with different impression trays
25.	Dimensional variation comparision at Coordinate 10 with different impression trays
26.	Dimensional variation comparision at Coordinate 11 with different impression trays

INTRODUCTION

The traditional goal of successful prosthodontic restorations depends upon the accuracy of reproduction of casts and dies. A cast or die is a positive replica made from a negative replica which is traditionally named as impression. There are various techniques, concepts and theories advocated by research methodologists to obtain an accurate impression. Accordingly, the impression trays have been designed to suit the requirements of the restoration to be prepared and the consistencies of the tissues in the area where the impression has to be made.

These impression materials vary in consistencies from rigid to elastic after they set. However, for obtaining accurate details and to maintain dimensional stability the impression material should possess adequate flow and highly elastic properties. The property of flow enables the material to obtain all details and elastic properties enable their use in undercut areas. Hence, elastic impression materials are "the" choice for making the impression of dentulous dental arches.

The device which holds the impression material to make impressions is known as impression tray. There are various dentulous impression trays available for making impressions such as complete stock trays made up of either metal or plastic. These trays are also available as perforated and nonperforated. To limit the usage of material onto the area of restoration, these trays are also available as partial trays.

There are viewers who felt that complete impression trays are preferred over partial trays for fabricating accurate cast restorations. Some advocates feel that the rigidity and close adaptability of the impression trays may limit the thickness and permit the correct flow of the material to the required areas, for obtaining surface details and to maintain dimensional stability. Recent advances focused on gnathological concepts stress that the impression should be made when the teeth are at the maximum intercuspation. It is also suggested that the impression should be well adherent to the impression trays. To achieve this the manufacturers have designed perforated impression trays. Adhesives are also supplied for bonding of impression material to the trays. Some trays have mesh work with either natural or synthetic materials incorporated to improve retention of the impression material to the tray.

To prevent cross-infection, use of disposable or plastic trays has been advocated. Also, impression materials which do not show any exothermic reaction or warmth, either at the time of manipulation or during setting resulted in the introduction of tray designs with polymeric materials. The material and design framework of the impression tray are also to be considered, as elastomers are available in different consistencies to make impressions. Tray design may form a factor for the accuracy and for the dimensional stability of the impressions to produce accurate casts in the crown and bridge prosthodontics.

Hence viewing all the above facts, the impression tray designs are being modified from time to time to suit the particular material, its consistency and the technique followed. Irrespective of the above criteria, the ultimate aim is to produce a precise cast or die which is an analogue of the prepared dental structure.

Keeping the above views in mind the study has been undertaken with the following objectives:

1. To measure and compare the dimensions of the stone dies obtained from polyvinyl siloxane impression using different types of impression trays.

2. To evaluate variations of dimensions of stone dies obtained from polyvinyl siloxane impression made from one type of impression tray to the other.

3. To evaluate least dimensional variation of stone dies made from polyvinyl siloxane with any one of the trays selected.

REVIEW OF LITERATURE

In the construction of fixed prostheses, the impression stage plays a vital role in preparing a precise analogue of the natural tissues.

Impression making for Fixed Prosthodontics has matured from carving wooden or ivory blocks that accommodated the intraoral contours to the more scientific methods that are used in the modern day practice.

Rush Bailey (1955)[59] explained the advantages of rubber base impression materials as being very elastic and dimensionally stable. More than one cast can be made successfully from the same impression if care is exercised. Exceptionally smooth and accurate dies could be obtained. He recommended that impressions pouring could be delayed.

Fairhurst CW *et al* (1956)[21] explained that for most rubber base impression materials, the elastic properties improved considerably when they were allowed to set longer than recommended by the manufacturer. He also stressed that large deviations from the manufacturer's recommended ratio of the components is not advisable since inferior elastic properties will result. He recommended use of an individual tray allowing 2 to 3 mm thickness of the impression material, avoiding extension of the material into larger adjacent undercuts.

Myers GE *et al* (1958)[51] reviewed and investigated the physical properties of Thiokol rubber base impression materials at room temperature and at 37 ^{0} C. The effect of variations in proportioning of base and the catalyst were determined and a comparative evaluation of the consistencies of the products conducted. They recommended suitable manipulation techniques to get optimum working time. They concluded that outstanding inlays could be prepared by using the rubber base products for impression making.

William H Gilmore *et al* (1959)[71] investigated seven popular silicone impression materials to determine various factors which influence their accuracy. Their study involved the use of master castings on hydrocal dies poured in impressions treated in varying ways. They concluded that, the use of a double mix procedure, will produce more accurate impressions than a single mix technique. A uniformly thin (2mm or less) layer of silicone produces more accurate results than thicker or unevenly distributed masses of material. Accuracy could be improved by allowing the impression material to become slightly elastic before seating.

Myers and Stockman (1960)[50] discussed the factors that affect the accuracy and dimensional stability of the poly sulfide impression materials. The mixing time of the material is critical and the recommended time should be used. Under mixing resulted in inaccurate casts. Also they recommended use of a custom tray as compared to a stock tray. The number of accurate casts from a second pour in the same impression was higher when a contoured tray was used than when a stock tray was used.

Frederic Custer *et al* (1964)[22] investigated the accuracy and dimensional stability of a silicone rubber base impression material. When a silicone impression material was used, greater accuracy was obtained in custom trays or with wash techniques than with impressions made with stock trays. Second casts made in the same impression were only one half as accurate as the first casts.

Carl P Regli and Ellsworth K Kelly (1967)[9] stressed the importance of the closed mouth impression technique. They described that mandibular flexure occurs in mouth opening. They were of the opinion that this amount of mandibular distortion is sufficient to affect the fit of the partial denture. The phenomenon of decreased mandibular arch width in opening movements creates enough stress on abutment teeth with a fixed partial denture to bring about its early failure.

James A Stackhouse (1970)[35] investigated the accuracy of stone dies as affected by the three dimensional changes in rubber impression during setting and following removal from the mouth. He used Thiokol and silicone rubber impression material in custom tray for the study. Uniform dies were produced from silicone than from mercaptan rubber. The use of custom tray produced undersized dies.

Joseph V Mitchell and Joseph A Damele (1970)[40] conducted a study to investigate the effects of the restrictive influence of the impression trays on distortion of 4 types of elastic impression materials. They tested reversible and irreversible hydrocolloids and two elastomeric materials (polysulfides and silicone base). They utilized perforated, rim lock and undercut brass trays of equal volume. Their findings indicated that tray form had a significant bearing upon the amount of impression distortion displayed. Shrinkage of the impression material toward the attachment of the tray was a major contributor to distortion.

James A Stackhouse (1971)[36] gave different advantages of the custom tray he fabricated. The exothermic reaction of the polymerizing resin enhances rapid drying of the adhesive which bonds the elastomer to the tray. Minimal impression material is needed. It ensures an even and optimal thickness of impression material with minimum danger of over compression. The tray is rigid, has little dimensional change, and maintains the elastomer in good contact with the preparation.

Wilson (1971)[73] studied statistical principles in experiential design of the trays, showed that the impression trays with addition silicone produced casts indisguinshable from standard dimensions than that of polyether and polysulphide.

Fusayama *et al* (1974)[22] developed a new technique called the laminate single impression technique. The author conducted a study to check the accuracy of the stone dies made by four techniques namely the single mix impression technique using the regular type material, the double impression technique without spacing using the heavy type followed by the wash type and the laminated single impression technique. He concluded that double impression technique without spacing produced the greatest distortion. Laminated single impression technique produced the least distortion.

Thomas J De Marco (1974)[68] described that the shape of the mandible is designed so that it can withstand any bending or shearing stress and also prevent any dimensional changes or fracture during function. Depressor muscles insert into the mandible that change the shape of the mandible during depression. He conducted a study to determine bending movement at various degrees of opening. No change in the width of the mandible occurs upto 28% of opening of the mouth and thereafter the change in the width is related to the percentage of opening which is due to the stresses exerted by muscles that depress the mandible.

Clinically this study indicated that full mouth impression techniques would best be conducted at a closed position as possible since wider the patient opens the mouth, the greater the mandibular distortion.

Reisbick and Matyas (1975)[56] conducted an invitro study to evaluate the accuracy of the casts made from impressions that utilized new silicone system type I and type II elastomers. The measurements were made initially on the die and template to provide a reference standard and then on duplicated casts.

Ten impressions were made with each elastomer system. These silicone systems proved to be as accurate as other standard impression materials and could also be used for dental duplication procedures.

Stackhouse (1975)[64] investigated various brands of elastic impression materials. He concluded that all but two of the silicone and mercaptan elastomers studied conformed to ADA Specification No. 19 for mixing time, working time, and consistency. When the die material was poured in 30 minutes, there were no significant differences in accuracy among all of the elastomers tested.

Davis *et al* (1976)[17]conducted a study to determine the most retentive surface preparation for the self curing acrylic resin tray and to compare the bond strengths of selected commercial polysulfide, silicone and polyether impression materials to acrylic resin tray material. Results showed that the surface yielded by the acrylic resin formed against tinfoil provided better retention for the rubber base than any other surface tested. The use of wax or asbestos spacers would not degrade the resin surface if tin foil or aluminum foil were used as a separating medium.

Stanffer JP (1976)[65] investigated the general accuracy of four groups of elastic impression materials for a complete-arch fixed prosthesis. He tested the accuracy of hydrocolloids, silicones, polysulphide rubbers and polyether by visual comparison and indirect measurement methods. He concluded that accurate prosthesis resulted from casts poured in polyether and silicone impression; whereas hydrocolloids and polysulphide rubbers gave less satisfactory results.

Eames WB (1979)[19] conducted a study to examine the accuracy and dimensional stability of 34 elastomeric impression materials of 13 manufacturers. The amount of contraction exhibited by all materials at 30 minutes after making impression ranged from 0.11% to 0.45%. At 24 hrs, stability ranged from 0.15% to 0.84%. Addition reaction silicones exhibited least change.

Eames *et al* (1979)[18] studied the effect of the bulk of the material on the accuracy of the impression and die. Omnivac trays were constructed using 2 mm plastic to provide 2, 4 and 6 mm spaces for the impression materials. The impressions were measured and the results showed that 2 mm spacing gave overall better accuracy than either the 4 or 6 mm tray spaces.

James N Ciesco *et al* (1981)[37] conducted a research to compare the dimensional stability and accuracy of selected elastomeric impression materials at various time intervals and also to determine the effect of using a custom tray with these materials. They evaluated: two polysulphides, two silicones and one polyether. These materials were subjected to simulated clinical conditions. Polyether material consistency yielded superior results followed by addition reaction silicone, lead-cure polysulphide and condensation polymerization silicone respectively.

Lacy AM *et al* (1981)[45] conducted a study to compare the accuracy and dimensional stability of polysulfides, poly ether and poly vinyl siloxanes by comparing the rate and magnitude of change of die size obtained from sequential pours of dental die stone in a given impression over a four day period. The modes of impression involved putty-wash systems and wash - adhesive custom tray systems. They concluded that addition silicones are the most stable of elastomers currently available and best results could be achieved by use of custom trays and adhesives.

Roland P Pagniano *et al* (1982)[58] conducted a study to ascertain the linear dimensional change of four commercial cold curing acrylic resin custom tray materials and to measure the dimensional changes of the acrylic resin materials. The results showed that most rapid linear shrinkage of all materials occurred in the first hour after mixing and that the greater the period of time a cold curing acrylic resin custom tray is stored prior to use, the more stable it becomes. Ideally, waiting at least 9 hours after fabrication of a custom tray allows the materials tested to become comparatively stable.

Edmund G Wilson *et al* (1983)[20] described double arch impression technique in which double arch impression trays were used. While describing the technique he felt that double arch impression trays can be used with any type of elastomeric impression material. He was also of the opinion that double arch impression technique requires fewer steps, reduces gagging reflex of the patient, eliminates the possibility of disease transmission from one patient to another. Further the centric relation record is also made at time of making the impression. Physical deformation of the mandible during opening is eliminated and natural shifting of the teeth to assume a maximum intercuspation can be registered. The counter impressions are poured first.

Peter T Williams *et al* (1984)[53] conducted an invitro study to compare the dimensional stability of six polysiloxane materialswith one condensation silicone, three polysulfides and one polyether. Results showed that all the addition silicone materials had exceptionally good dimensional stability and when poured immediately their dimensional change was negligible.

Sandric (1984)[60] reviewed various impression materials for precision negative mold and stated that “irreversible hydrocolloid is not sufficiently accurate for cast restoration.” He further mentioned that polyether and poly vinyl siloxanes are preferable because they exhibit sufficient long term dimensional stability.

Valderhaug J *et al* (1984)[69] described rubber base impression materials as highly accurate and stable when they have an even thickness of 2-4 mm achieved within an acrylic custom tray. He compared the stability of impressions made in custom trays and chromium plated brass tray with polyether and silicone. He concluded that the dimensional stability was the result of the dimensional stability of the impression materials and also due to bonding adhesives on non perforated trays with limited elastic properties. Linear dimensional stability of the impression made in stock trays was not inferior to the stability of impressions made in custom trays.

Glen H Johnson *et al* (1985)[27] conducted a study to describe accuracy of addition silicone, condensation silicone, polysulphide and polyether to evaluate accuracy as a function of time and pouring and repeated pour of die material independently. The silicones demonstrated best recovery from undercuts and least change in dimensions between initial and second pour of an impression.

Goldfogel M *et al* (1985)[30] examined newer improved auto polymerizing acrylic resin tray materials. Twelve auto polymerizing acrylic resin tray materials were studied for linear curing shrinkage with a measuring microscope. All trays exhibited shrinkage during the 24 hour test period. He concluded that auto polymerizing acrylic resin tray materials should not be used for an impression the same day they are made, unless the tray is boiled.

Alfred W Fehling *et al* (1986)[1] conducted a study to establish an optional interval between making an auto polymerizing acrylic resin custom tray and using it. Linear dimensional changes occurred through out 6 hours, which suggested that any impression made in a methyl metha acrylate resin custom impression tray should be poured as soon as it is conveniently possible. He concluded that while an aged tray is preferred, it is acceptable to make an impression in an auto polymerizing resin custom impression tray after 40 minutes.

Glen H Johnson *et al* (1986)[28] describes addition silicones to be more accurate and dimensionally stable. He described the effect of tray design on dimensional accuracy of the impressions. Addition silicone material used along with putty wash technique produced more accurate dies than condensation silicone. He stated that the custom tray is impression tray of choice even for addition silicones which produced relatively little polymerization shrinkage and are dimensionally stable.

Bomberg TJ *et al* (1988)[7] conducted a study to determine the effect of the some of the adhesion factors of various combinations of trays and adhesive usage. These included the lack of the usage of liquid adhesive cement bonding in perforated and non perforated custom acrylic resin and stock impression trays. Perforated, non perforated custom acrylic resin trays and perforated, non perforated stock trays were used along with two impression techniques (Single mix impression technique and putty-wash system). The results showed that use of full application of adhesive and the perforated trays were associated with the minimization of marginal opening. The use of stock or custom trays and use of the putty wash or single mix technique had no significant effects on the marginal opening.

Chang chi Lin *et al* (1988)[11] conducted an experimental design to compare the accuracy of complete arch impressions of six different impression materials using complete crown preparations. A maxillary partially edentulous model was modified as the master model and four orientation marks were made to standardize the measuring position of each stone cast in front of the travelling microscope.

The results showed that polyethers produced the most accurate complete arch replicas followed by vinyl polysiloxanes, followed by the poly sulfides and the irreversible – reversible hydrocolloids.

Reitz CD and Clark NP (1988)[57] found that the disadvantage of addition silicone impression material is the setting inhibition caused by some brands of latex gloves. He is of opinion that if putty system is used, gloves that do not interfere with setting reaction should be selected.

Gary A Schoenrock(1989)[31] described laminar impression technique as a precise rapid and predictable alternative to traditional method of impression making in fixed prosthodontics. This technique used double arch plastic trays where he advocated making of putty impressions before the preparation of tooth and later making the wash impression after the preparation of tooth. Precise injection of wash material avoided wastage and the flushing action of injecting ensures a continuous flow of material and aids in removal of sulcular contaminants to produce a clear detailed impression of the critical region.

Naofumi Shigeto *et al* (1989)[52] evaluated the dimensional accuracy of dies in complete dental arch casts made by three different methods of dislodging the impression tray. The dimensional changes of the molar die were significantly affected by the dislodging method in the inclined way but not of those of the incisor die. The anteriorly inclined method showed fewer dimensional changes than the posteriorly inclined method. On the other hand, the dimensional changes of the incisor die were not significant by any dislodging method. If the impression tray is removed by the inclined way, the fulcrum should be chosen at a region remote from the abutment instead of at the proximal region.

Prattern and Craig (1989)[54] conducted a study to compare the wettability of hydrophilic addition silicone to that of other elastomeric impression materials.The impression materials were evaluated for their ability to produce gypsum casts without air bubbles and voids.The results showed that hydrophilic addition silicone impression material has been found to have wettability not significantly different from that of a polyether impression material.

Setz J (1989)[61] mentioned that addition silicone was introduced as a dental impression material in 1970. This material was also known as polyvinyl siloxane (PVS). It has much greater dimensional stability and its working time is much affected by temperature.

Barry Marshak *et al* (1990)[4] explained a technique to achieve an accurate seating of putty impression tray by use of unprepared teeth and provisional restorations in the arch as landmarks, stops and guiding planes. The putty impression was made with resin provisional restorations in place on the prepared teeth and allowed to set. The provisional restorations provided space for wash material. They recommended that to ensure accurate reseating of the putty impression and venting away excess wash material, all undercuts, projections into the embrasures or tooth material were to be cut away from the putty before loading of the wash material.

Claudio P Fernandes *et al* (1990)[13] reviewed several silicone impression materials and found that accurate replication of intraoral structures was due to their favorable physical properties. In several studies, addition reaction silicones have been found to be the most stable impression material, followed by polyethers, polysulfides, and, last by condensation reaction silicones. However disadvantage of addition polymerization silicones is their poor wettability properties. Plasma treatment has been reported to improve the wettability of silicone impression materials.

Their study investigated plasma treatment of silicone impressions and found that the detail reproduction was superior in casts produced from plasma-treated impressions.

Glenn E Gordon, Johnson and David Drennon (1990)[26] evaluated the accuracy of reproduction of stone casts made from impressions using acrylic resin, a thermoplastic and plastic trays and addition silicone, polyether and a polysulphide impression materials. Impressions of the fixed partial denture simulation were made with all three impression materials and all the three tray types. Impressions with cross arch and anteroposterior land marks were made with all three types using addition silicone impression material. Results indicated that custom made trays of acrylic resin and the thermoplastic material performed similarly regarding die accuracy and produced clinically acceptable casts. The stock plastic tray consistently produced casts with greater dimensional change than the two custom trays.

Ray A Walters and Steven Spurrier (1990)[55] conducted a study on the effect of tray design and tray modification on linear dimensional changes in impression made with polysulphide material. According to them custom tray provides less bulk and reduces the distortion. Tray design, the use and the placement of adhesive or the perforations present in the tray and also the bulk of the impression material in the tray have definite effects on the accuracy of the resulting impression of the abutment teeth prepared. They suggested a modified custom tray with 3 mm spacer and adhesive for optimal results.

Chai JY *et al* (1991)[10] studied the tensile strength of five impression adhesive systems: polysulphide, polyether, polyvinylsiloxane, condensation silicone, and polyvinylsiloxane putty adhesive systems. Results showed no significant difference in adhesive bond strength to auto polymerizing resin between the former four impression materials studied. The polyvinylsiloxane putty did not adhere to its impression adhesive.

Wassell and Ibbetson (1991)[70] did an invitro investigation to assess the influence of stock trays on the accuracy of impressions recorded with heavy light body and putty light body wash impression techniques. Two brands of trays were tested and the same trays were reinforced with acrylic resin. Significant inaccuracy at the second molar area was found for all trays when putty- light body impressions were made. Heavy light body impressions regardless of the type of the tray produced highly accurate dies at the critical site. Resultant overall cast distortion was reduced.

Chee WWL and Donovan TE (1992)[12] reviewed the composition, physical properties and manipulative variables of polyvinyl siloxane and also discussed guidelines for techniques that will result in optimum performance. Several methods of using very high viscosity (putty) materials to form "trays" to obtain uniform bulk of the wash impressions were described and the disadvantages of each of these techniques were pointed out. They recommended that for best results resin custom trays should be used routinely.

Shirley H Hung *et al* (1992)[63] recommended putty wash impression technique to overcome problems associated with polymerization shrinkage of condensation silicone impression materials. However he has suggested putty wash impression technique for addition silicone impression materials for obtaining better results of dimensional stability of the impression because of stable polymerization reaction of addition silicone.

They evaluated the accuracy of one-step putty wash impression with two-step putty wash impression techniques using five different addition silicone materials. They concluded that the accuracy of addition silicone impression material is affected more by material than technique. Accuracy of putty-wash one step impression technique was not different from the putty wash two-step impression technique.

Idris B et al (1995)[34] conducted a study to compare the accuracy of the putty/wash one step and two-step technique with an addition-type silicone impression material and evaluated the effect of undercuts of two different configurations on the accuracy of an addition-type silicone by the use of these techniques. The results indicated that the inter abutment distances increased slightly compared with the stainless steel model for both techniques, but the differences between techniques were not considered to be clinically important.

Justin I Boulton *et al* (1996)[42] investigated horizontal and vertical accuracy of gypsum dies produced from addition silicone, polyether and polysulphide impressions using both custom and stock trays. They found that the impressions taken in well made custom tray with elastomeric materials other than polysulphide produce stone dies with minimal dimensional changes. Stock trays produced significant decrease in abutment height with polysulphide when compared with putty wash impression technique. Custom trays produced decreased vertical dimension with polysulphide when compared too the putty wash impression technique.

Joseph Nissan *et al* (2000)[41] conducted a study to assess the accuracy of 3 putty-wash impression techniques using the same impression material (polyvinyl siloxane) in a laboratory model.

The 3 putty-wash impression techniques used were (1) 1-step (putty and wash impression materials used simultaneously); (2) 2-step with 2 mm relief (putty first as a preliminary impression to create 2 mm wash space with prefabricated copings. In the second step, the wash stage was carried out); and (3) 2-step technique with a polyethylene spacer (plastic spacer used with the putty impression first and then the wash stage).They concluded that the polyvinyl siloxane 2-step, 2 mm, relief putty-wash impression technique was the most accurate for fabricating stone dies.

Luca Ortensi (2000)[46] explained the fabrication method of a modified custom tray using auto polymerizing acrylic resin. The tray was fabricated by intraoral relining with auto polymerizing resin that is polymerized extra orally. The final impression was obtained during the same session after tray polymerization at 100^{0}C for 5 minutes. Relined areas were refined by trimming excess resin with burs of a known diameter to create a 2 mm clearance for the elastomer. According to Luca Ortensi, this procedure was time saving as it reduces the need for a retraction cord and minimizes inaccuracies that would necessitate another impression.

Andrew Lane *et al* (2003)[2] conducted a study to establish whether a double arch impression technique could produce restorations comparable with those produced by use of the complete arch technique and to investigate reported time and material savings. Two sets of impressions, one complete arch in a stock metal tray and one double arch in a plastic double arch tray were made in addition polymerized silicones. Equal numbers of crowns were made from complete and double arch impressions. At the time of crown placement, the accuracy of fit, occlusal harmony and time taken for try in, weight of impression material were also recorded. Results showed that double arch impressions were found to take less time, use less material and preferred by patients and resulting restorations were no less accurate than those made from complete arch impressions.

Cynthia S Petrie *et al* (2003)[15] investigated by comparing dimensional accuracy and surface detail reproduction of 2 hydrophilic VPS impression materials when used under dry, moist and wet conditions. Dimensional accuracy was measured by comparing the average length of the middle horizontal line in each impression to the same line on the metal die by using a measuring microscope with an accuracy of 0.001mm.results showed that conditions (i.e.) dry, moist and wet did not cause significant adverse effects on the dimensional accuracy of either material. Best surface detail results were obtained only under dry conditions for both the materials.

Jeffery A Ceyhan *et al* (2003)[38] described the use of metal and plastic dual arch trays. He compared the accuracy of gypsum working dies made from the impressions with metal and plastic dual arch trays and complete arch custom tray. He found no significant differences in die accuracy among three trays for mesiodistal and occlusogingival dimensions. Plastic dual arch trays produced more accurate working dies in the buccolingual dimension than the metal dual arch tray. Custom tray was not shown to differ from dual arch trays in accuracy.

Monica J Cayouette *et al* (2003)[49] described dual arch impression tray techniques as an alternative method for making the impressions for fixed prosthodontics. They measured and compared the three dimensional differences in gypsum casts poured from impressions using plastic full arch stock tray, triple tray-metal reinforced rigid dual arch tray and a triad custom tray, with vinyl poly siloxane and polyether materials to the dimensions of original master model. A three dimensional system was used to determine coordinates of 32 points on the master model and resulting casts. Intra and inter tooth dimensions were calculated from the measuring coordinates. They found that casts made using a custom tray with both polyether and vinyl siloxane impression material and triple tray with polyether showed no detectable inaccuracies and were reproducible as the master model. The custom tray technique was more accurate than other impression techniques. Changing in the sequence of pouring of the casts in the dual arch impression tray produced statistically no difference. The accuracy of the dual arch impression technique does not depend upon the reduction of the teeth and the thickness of the two impression materials which were used for the study.

George Cho *et al* (2004)[25] evaluated the rigidity and ability to resist deformation of disposable plastic stock trays and metal stock tray when used in conjunction with a high viscosity polyvinylsiloxane impression material. The dimensions of the tray in cross section at the mandibular right first molar area were measured before, during and after the impression procedure with electronic digital calipers.

The results indicated that the disposable plastic trays were not sufficiently rigid to resist deformation when used with very high viscosity putty material. There was distortion of the trays both across the arch and in cross section.

MATERIALS AND METHOD

The objectives of the study were to ***apply the usage of different types of trays for evaluating the dimensions of the dies*** fabricated from selected impression techniques using the polyvinyl siloxane impression material.

IMPRESSION TRAYS

The following four types of impression trays were used to carry out this study (Fig 1).

Stock metal tray (Fig 1-M)

A stock metal tray of complete dentulous perforated type made up of stainless steel was selected as one of the trays for loading the impression material and making the impressions. The tray is manufactured by Sun German Dental Company. Size L4 was selected.

Stock plastic tray (Fig 1-P)

A complete dentulous perforated plastic stock tray made from Dentaurum Dental Company of suitable size, L4, was selected. The tray is not as rigid as metal stock tray.

Custom tray (Fig 1-C)

A custom made perforated complete dentulous tray fabricated from autopolymerising acrylic tray material was considered for the study.

Fabrication of custom tray

A sheet of base plate wax with thickness of 2mm is softened, folded and placed on the mandibular member of the typhodont dentulous teeth attached to the frame of the mandibular arch fitted to the rubber mold simulating the mandibular dental arch. The softened wax was adapted to the cast and the excess wax extending more than 2-3 mm beyond the neck of the teeth was trimmed. The wax thus adapted was formed as a spacer for the impression material and also for covering the undercut areas in the given teeth.

3x3 mm windows were punched in the wax to provide for occlusal stop. The stop space was created distal to the required tooth for tooth preparation which was utilized for evaluating tooth dimensions.

An aluminum foil was adapted over the spacer wax. The aluminum foil prevents the wax from impregnating the surface of the tray during the exothermic polymerization of acrylic resin and also presence of wax layer on the inner surface will diminish bonding of the tray adhesive applied before placement of the impression.

Auto polymerizing resin was mixed according to manufacturer's instructions. When it reached a dough-like stage, it was molded into a shape of the mandibular arch and then adapted onto the spacer and aluminum foil formed over the typhodont dental arch framework. The acrylic resin was allowed to polymerize completely. Some amount of resin was mixed and a handle was attached to the tray. After the completion of polymerization, the tray was removed smoothened and polished. Bur holes were made to perforate the tray after removal of the spacer. The finished tray was used to make the impressions. The tray was standardized to provide for uniform thickness of impression material.

Triple tray (Fig 1-T)

It is also called ***dual arch impression tray***. It has a plastic framework with a U shaped frame and a piece of fabric mesh. The mesh connects the sides of the tray in the superior –inferior dimensions. This mesh is fixed with in the triple tray. Posterior and anterior design trays are available. The posterior design tray was used for the study.

TABLE 1

CODE DESIGNATION FOR IMPRESSION TRAYS USED IN THE STUDY

NAME OF THE TRAY	MATERIAL	COMPANY	CODE
Stock metal tray	Stainless steel	Sun Germany	***M***
Stock Plastic tray	Plastic	Dentaurum	***P***
Custom tray	Autopolymerising Resin	Custom made	***C***
Triple tray	Plastic frame with a fabric mesh	Bego	***T***

IMPRESSION MATERIAL (Fig 2A &2B)

The impression was of dentulous type. Hence addition silicone (polyvinylsiloxane) elastomeric impression material was used in the study. Three different viscosities such as, putty, light-body and monophase were used.

TABLE 2

CODE DESIGNATION FOR IMPRESSION MATERIALS USED IN THE STUDY

TYPE	CONSISTENCY	COMPANY	CODE
Addition silicone	Putty	Flexitime (Heraeus Kulzer)	***P***
Addition silicone	Light – body	Flexitime (Heraeus Kulzer)	***L***
Addition silicone	Monophase	Provil novo (Heraeus Kulzer)	***M***

DIE STONE (Fig 3)

Type IV, Die stone (Ultra Rock, Kalabhai Karson pvt Ltd) was selected to pour the impressions. The specifications according to manufacturer's instructions are as follows:

Color- Beige.

Mixing time-30 seconds (mechanical).

Setting time-approximately 6 minutes.

Hardening time-approximately 30 minutes.

Setting expansion-0.08%.

Water powder ratio-20cc/100 gms.

TYPHODONT ARTICULATOR WITH TEETH SET (Fig 4)

Typhodont teeth attached to the hinge articulator (Kavo) have been used for the study. Tooth number 46 was removed to create a pontic space to simulate a 3–unit Fixed Partial Denture situation, in which teeth number 45 and 47 were considered as abutments **(Fig 5).**

PREPARATION OF TYPHODONT TEETH FOR GROUP I SAMPLES (Standard Group/Control Group) (Fig 5)

Among the entire dental arch, two teeth were selected for the study. The typhodont teeth, 45 – right mandibular second premolar and 47 - right mandibular second molar, were prepared for full veneer crowns by following the principles of tooth preparation.

Preparation of Notches (Fig 6 &7)

In addition, on the premolar (45), index notches were placed at the junction of the occlusolabial surfaces on either side of the preparation of the labial surface, one facing towards mesial and the other one facing towards distal. In the same way, index notches were placed on the lingual surface of point angles at the junction of occlusolingual surfaces, one facing towards mesial and one facing towards distal.

Regarding the molar tooth, six index notches were made as follows at mesiobuccoocclusal, distobuccoocclusal point angles, occlusolabial line angle at the center of the tooth and mesiolinguoocclusal, distolinguoocclusal point angles and occlusolingual line angle, at the center of the tooth. These indexes were made for measuring the dimensions of the dies for the study.

In the same way, on the premolar a total number of seven index notches were made on the cervical finish line step facing the occlusal area. These notches were placed, two on the labial side, three on the lingual side and one each on the proximal side.

Similarly, on the molar a total number of eight index notches were made on the cervical finish line step facing the occlusal area. These notches were placed, three on the labial side, three on the lingual side and one each on the proximal side. Numbers were assigned to all the notches to aid in the measurement.

Thus all precautions were followed not only for tooth preparation, but also for the accurate measurement of the dies. The prepared teeth with notches which were attached to the rubber mold of the dental arch along with the unprepared teeth were considered for the control group study. The dimensions between specific notches were represented as coordinates and were measured on the prepared teeth itself (Tables 3, 4, &5). Ten readings were taken for each coordinate. Each reading was designated from S1 to S10 and the basic data was obtained for calculating the results.

PREPARATION OF STUDY GROUP (GROUP II) SAMPLES

In order to obtain dies for the study group, impression procedures were carried out using addition silicone impression material (**Fig 2A & 2B)** with the study group of trays**(Fig 1).**

Specimens for Group II A and B

(IIA – Dies made from metal stock tray with two-step putty wash impression technique)

(IIB- Dies made from plastic stock tray with two-step putty wash impression technique)

To prepare Group IIA and IIB specimens, metal and plastic stock trays coded as 'M' and 'P' were selected (Figs 1-M & 1-P). The tray selection was based on the close adaptation of the trays to the prepared typhodont teeth. The tray was checked for its extension and spacing for the material and tried on the typhodont. The two-step putty wash impression technique was followed for both metal and plastic trays.

Impression technique (Two –step putty wash impression technique) (Figs 8A, 8B, 9A & 9B)

Adhesive was applied on the inside of the tray. High viscosity putty was mixed according to the manufacturer's instructions. Equal amount of base and catalyst were taken and kneaded. As it is common with all addition silicone impression materials, inhibiting reactions of the material can occur when in contact with latex gloves, therefore, the kneading was done with bare hands. A total mixing time was 45 seconds and working time of 2min 30 seconds as instructed by the manufacturer was employed. The putty was rolled into an elongated cylinder and inserted into the stock tray. Putty was covered with spacer (polyethylene sheet) provided by the manufacturer. The tray was placed on the model in a rocking motion. The tray was held in the same position till the material was set. (2minutes 30 seconds). The tray was removed, spacer was peeled off and the excess material removed with sharp knife.

The light-body material was syringed starting from one proximal side to the other all over the prepared teeth with an automixing gun. The light-body impression material was injected on the putty impression in the tray which was made earlier. The tray was repositioned over the arch (seating from posterior to anterior). Final set was awaited for 2min30 seconds and then the impression was removed.

Ten impressions with metal stock tray (Group IIA) and ten impressions with the plastic stock tray (Group IIB) were made by this technique.

Evaluation of set impression:

- Elastomeric material was present 0.5mm beyond visible finish line.
- No tray show through in any of the areas of impression.
- No voids present.
- No thin areas leaving finish line unsupported.

Specimens for Group II C

(IIC – Dies made from custom tray with monophase addition silicone).

To prepare Group IIC specimens, custom tray coded as ‘C’ **(Fig 1-C)** was selected. Impression was made from monophase addition silicone impression material using custom tray. The procedure of making custom tray for this study group has already been mentioned.

Impression technique (Fig 10)

Adhesive was applied to the inner surface of the custom tray and the borders of the tray. The monophase material was mixed according to manufacturer’s instructions. Equal amount of base paste and catalyst paste was mixed on a glass slab with a mixing time of 30 sec.

The same material was loaded in the tray and syringed over the preparation. (Total working time-2.5 minutes). The tray was placed on the arch and final set of the material awaited (4.5minutes) and the impressions were removed.

A total of ten impressions of the arch were made using this technique.

Specimens for Group II D

(IID- Dies made from triple tray using one-step putty wash impression technique)

To prepare Group II D specimens, triple tray coded as ‘T’ (**Fig 1-T)** was selected. Impressions were made with addition silicone using putty and light body viscosities. Single stage impression technique was used. Precautions were taken to check the impression tray so that the framework did not interfere with the teeth in the articulated typhodont.

Impression technique (Fig 11)

High viscosity putty was mixed according to manufacturer’s instructions. Equal amount of base and catalyst were taken and kneaded. The putty was rolled and placed on either side of the triple tray and low viscosity material is dispensed onto putty using a dispensing gun and some amount on the prepared teeth to avoid any air entrapment.

First the tray was placed on the mandibular member and the maxillary member of the master model was closed until both arches were touching and a 2.5lb weight was placed on the top of the maxillary member simulating the biting force[49]. The tray was held in same position till the material was set (2min 30 sec).

Impressions were removed from the master model by first breaking the seal at the buccal flange of each member of the tray. Then the maxillary arch of the master model was lifted while holding the tray in place against the mandibular arch. Finally, the tray was separated from the mandibular arch by grasping the handle only. Impressions were stored at room temperature.

A total of 10 impressions were made using this technique.

Thus a total of 40 impressions were made using four different impression trays used for the study.

FABRICATION OF STONE DIES FOR ALL SPECIMENS OF GROUPII A, B, C AND D

The die stone (Ultra Rock Class IV) was supplied in bulk packaging from the manufacturer. The impressions were poured in die stone 15 minutes after the impressions were made as per the manufacturer's instructions. At the time each impression was poured, 100gm of powder was weighed using a balance, and 20 ml of room temperature distilled water was measured and placed in a vacuum mixing bowl to which powder was added and mixed by hand until the powder was wet. The mixture was then mechanically spatulated **(Fig 12)** under vacuum for 60 sec according to manufacturer's directions. Then the stone was poured in all impressions. At the time of pouring, the impressions were placed on the vibrator **(Fig 13)** to prevent entrapment of air in the poured stone.

The dual arch impressions were poured on the preparation side first. The dental stone was allowed to set for 40 min and then the opposing side was poured. The casts were separated after 40- 45 min after both sides were poured. Care was taken to see that the stone was dry at the time of separating the casts from the impressions.

Once the casts were separated, they were trimmed on a model trimmer to remove excess stone on either side. The models were trimmed so that one tooth is left on either side of the prepared teeth.

Base was poured for the prepared dies using dental stone in a base former. Care was taken to keep the preparation parallel to the base. Then the dies were stored at room temperature.

Thus a total of forty samples were fabricated from the impressions made using four types of impression trays **(Fig 14).**

The samples obtained from the metal tray were designated as **Group IIA**: M1 to M10 =10 samples.

The samples obtained from the plastic tray were designated as **Group IIB**: P1 to P10 =10 samples.

The samples obtained from custom tray were designated as **Group IIC**: C1 to C10 =10 samples.

The samples of obtained from triple tray were designated as **Group IID**: T1 to T10 =10 samples.

MEASUREMENT OF GROUP I (CONTROL GROUP) & GROUP II (STUDY GROUP)

Eleven coordinates were formulated for the measurement of dimensions (calculated between the grooves present) of individual premolar, molar typhodont teeth and the inter-abutment distance between them and also of individual dies of premolar, molar and the interabutment distance between them. The measurements were done with travelling microscope. **(Fig 15)** and the data obtained were tabulated for calculating the results.

TABLE 3

MEASUREMENT OF DIMENSIONS OF INDIVIDUAL MOLAR (47)

COORDINATE	DIMENSION (Measured between index notches as under)
1	18-22
2	20-24
3	15-17
4	14-15
5	15-12

TABLE 4

MEASUREMENT OF DIMENSIONSOF INDIVIDUAL PREMOLAR (45)

COORDINATE	DIMENSION (Measured between notches points as under)
6	10-7
7	4-3
8	4-2
9	4-1

TABLE 5

MEASUREMENT OF INTER-ABUTMENT DISTANCE BETWEEN PREPARED PRE MOLAR (45) AND MOLAR (47)

COORDINATE	DIMENSION (Measured between notches points as under)
10	15-3
11	22-10

FIGURE 1

IMPRESSION TRAYS

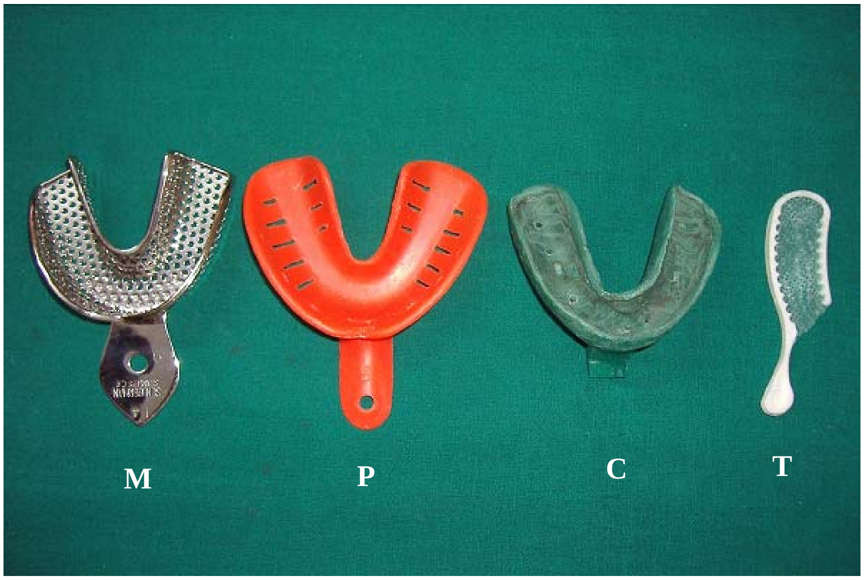


FIGURE 2A

MONOPHASE ADDITION SILICONE IMPRESSION MATERIAL

FIGURE 2B

PUTTY AND LIGHT BODY ADDITION SILICONE IMPRESSION MATERIAL

FIGURE 3

DIE STONE (ULTRA ROCK TYPE IV)

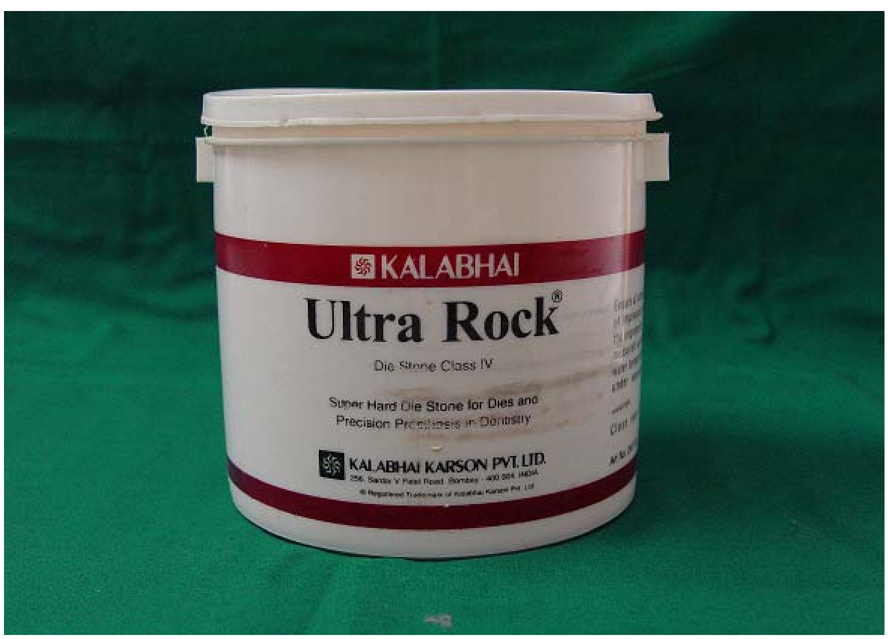


FIGURE 4

ARTICULATED TYPHODONT

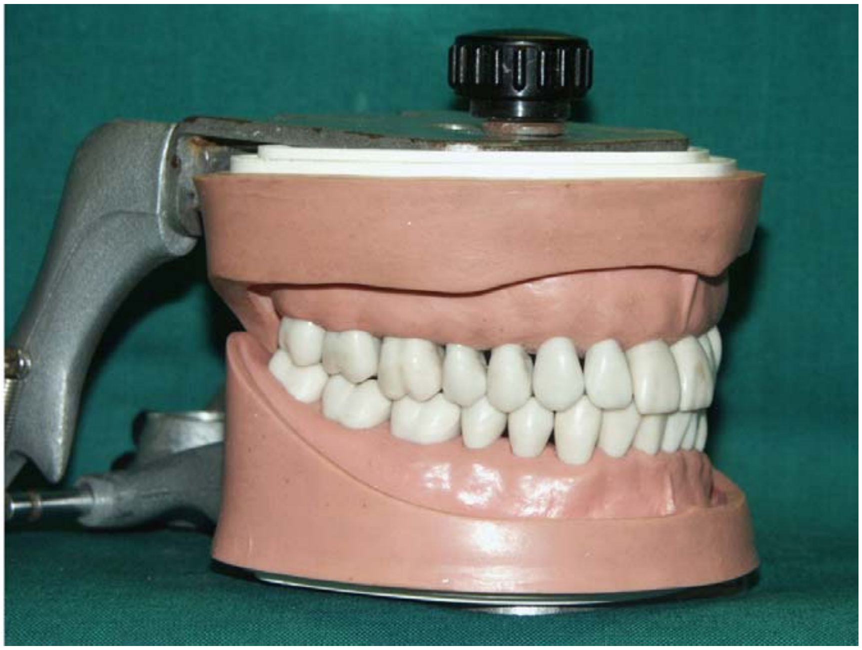


FIGURE 5

ARTICULATED TYPHODONT AFTER TEETH PREPARATION OF 45, 47

FIGURE 6

OCCLUSAL VIEW OF PREPARED TEETH 45 & 47 SHOWING THE PREPARED NOTCHES

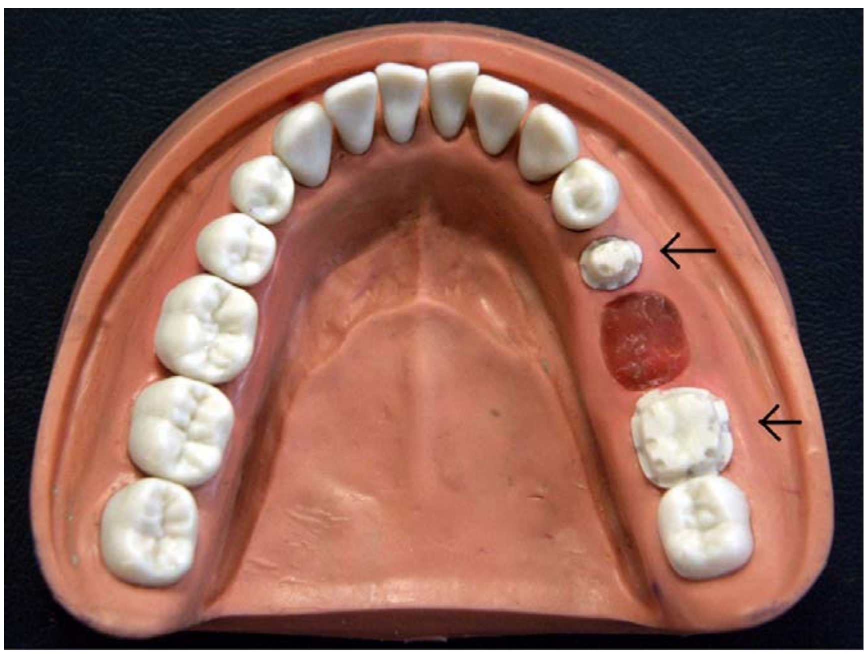
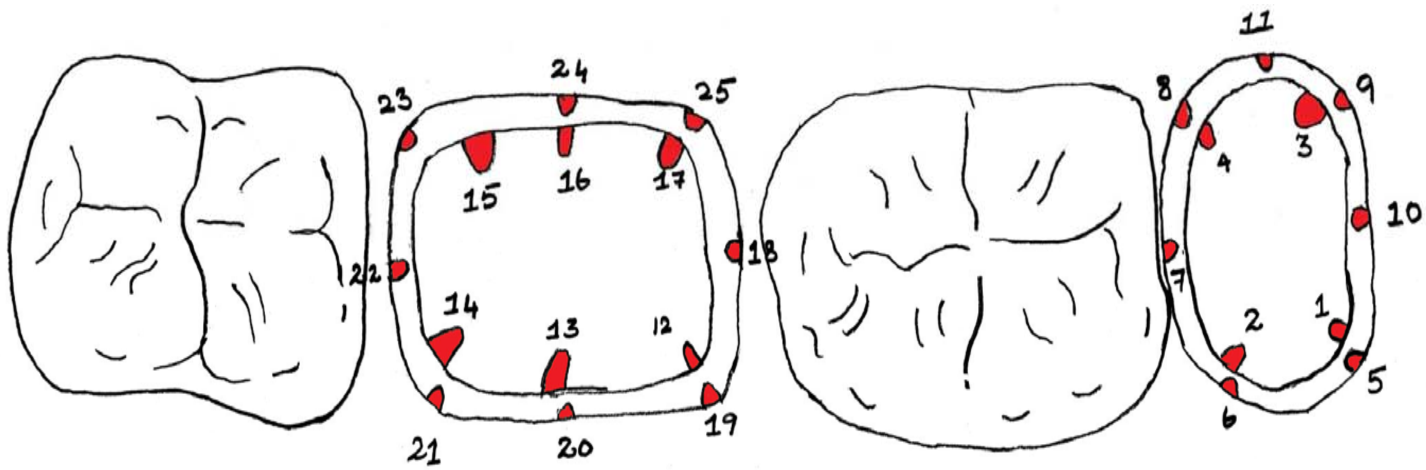


FIGURE 7

NUMERICAL POSITION AND DESIGNATION OF THE NOTCHES PREPARED ON THE TYPHODONT PREMOLAR (45) AND MOLAR (47)



48 **47** **46** **45**

LEGEND ON NEXT PAGE

LEGEND
FOR PREMOLAR (45)

NUMBER ASSIGNED	POSITION OF THE NOTCH
1	MESIO BUCCO OCCLUSAL POINT ANGLE
2	DISTO BUCCO OCCLUSAL POINT ANGLE
3	MESIO LINGUO OCCLUSAL POINT ANGLE
4	DISTO LINGUO OCCLUSAL POINT ANGLE
5	MESIO BUCCO CERVICAL POINT ANGLE
6	DISTO BUCCO CERVICAL POINT ANGLE
7	DISTO CERVICAL LINE ANGLE
8	MESIO LINGUO CERVICAL POINT ANGLE
9	DISTO LINGUO CERVICAL POINT ANGLE
10	MESIO CERVICAL LINE ANGLE
11	LINGUO CERVICAL LINE ANGLE

LEGEND
FOR MOLAR(47)

NUMBER ASSIGNED	POSITION OF THE NOTCH
12	MESIO BUCCO OCCLUSAL POINT ANGLE
13	MESIO OCCLUSAL LINE ANGLE
14	DISTO BUCCO OCCLUSAL POINT ANGLE
15	DISTO LINGUO OCCLUSAL POINT ANGLE
16	LINGUO OCCLUSAL LINE ANGLE
17	MESIO LINGUO OCCLUSAL POINT ANGLE
18	MESIO CERVICAL LINE ANGLE
19	MESIO BUCCO CERVICAL POINT ANGLE
20	BUCCO CERVICAL LINE ANGLE
21	DISTO BUCCO CERVICAL POINT ANGLE
22	DISTO CERVICAL LINE ANGLE
23	DISTO LINGUO CERVICAL POINT ANGLE
24	LINGUO CERVICAL LINE ANGLE
25	MESIO LINGUO CERVICAL POINT ANGLE

FIGURE 8A & 8B

IMPRESSION MADE WITH STOCK METAL PERFORATED TRAY - TWO-STEP PUTTY WASH IMPRESSION TECHNIQUE

FIGURE 8A

FIGURE 8B

FIGURE 9A&9B

IMPRESSION MADE WITH STOCK PLASTIC PERFORATED TRAY -TWO-STEP PUTTY WASH IMPRESSION TECHNIQUE

FIGURE 9A

FIGURE 9B

FIGURE 10

IMPRESSION MADE WITH CUSTOM TRAY- MONOPHASE SINGLE MIX IMPRESSION TECHNIQUE

FIGURE 11

IMPRESSION MADE WITH TRIPLE TRAY-ONE STEP PUTTY WASH IMPRESSION TECHNIQUE

FIGURE 12

VACUUM MIXER

FIGURE 13

VIBRATOR

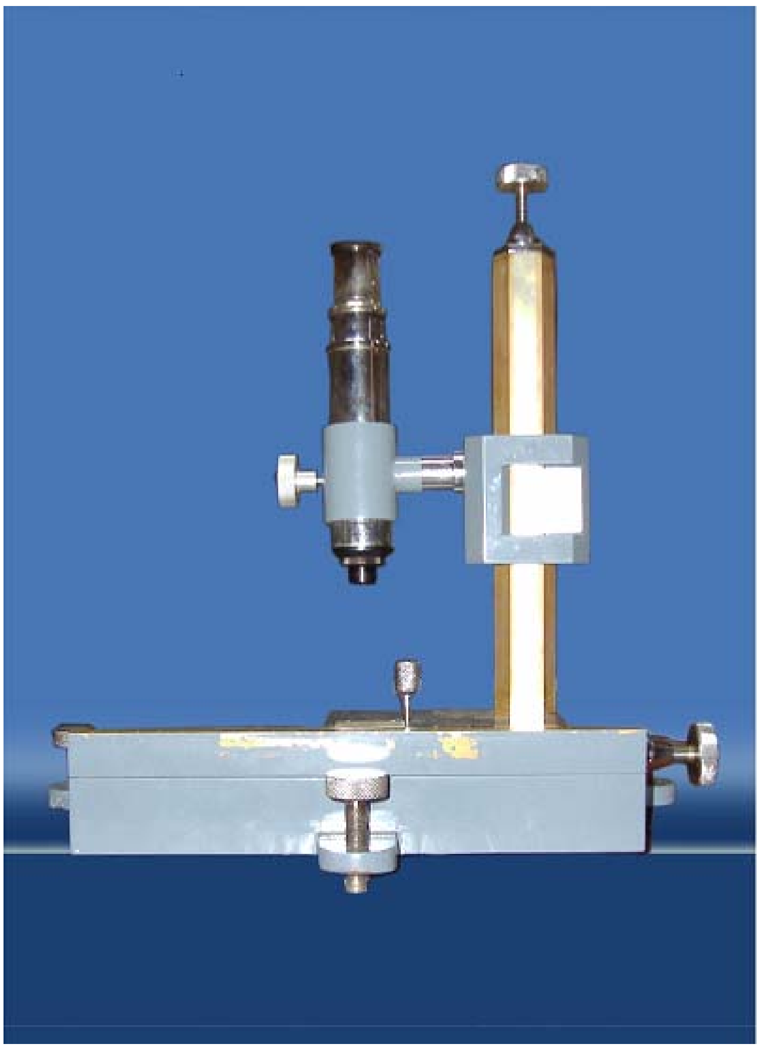
FIGURE 14

DIES OBTAINED FROM DIFFERENT IMPRESSION TRAYS

GROUP IIA (M1-M10)	GROUP IIB (P1-P10)	GROUP IIC (C1-C10)	GROUP IID (T1-T10)

FIGURE 15

TRAVELLING MICROSCOPE



RESULTS

The following results were drawn from the study which compared the dimensional accuracy of the dies generated from four different impression trays.

Ten samples were made in each group and in each sample eleven measurements were made for eleven coordinates. Each coordinate represents a dimension measured between two specific grooves made on the prepared typhodont teeth and dies. Hence 110 readings were taken for each of the five groups, in which one group (Group I) was the prepared teeth mounted on a typhodont which was taken as a Standard and the other four groups (Group IIA, IIB, IIC and IID) were the samples prepared from the impressions made by using different impression trays. 10 readings were taken for each of the eleven coordinates for the standard group (Group I).

Table 6 shows the basic data obtained by measuring the distance for eleven different coordinates in standard typhodont model (Group I-S1-S10). Ten readings were taken for each coordinate. The last column shows the average of 10 readings at a particular coordinate. The readings are shown in millimeters obtained on viewing the samples under the travelling microscope.

Table 7 shows the basic data obtained by measuring the distance for eleven different coordinates from the specimens of Group IIA (samples obtained from impressions of metal stock tray, M1-M10). In each of the ten samples, eleven measurements were made for eleven coordinates. The last column shows the average of 10 readings at a particular coordinate. The readings are shown in millimeters obtained on viewing the samples under the travelling microscope. The values are recorded at the same coordinates as for Group I.

Table 8 shows the basic data obtained by measuring the distance for eleven different coordinates from the specimens of Group IIB (samples obtained from impressions of plastic stock tray, P1-P10). In each of the ten samples, eleven measurements were made for eleven coordinates. The last column shows the average of 10 readings at a particular coordinate. The readings are shown in millimeters obtained on viewing the samples under the travelling microscope. The values are recorded at the same coordinates as for Group I.

Table 9 shows the basic data obtained by measuring the distance for eleven different coordinates from the specimens of Group IIC (samples obtained from impressions of custom tray, C1-C10). In each of the ten samples, eleven measurements were made for eleven coordinates. The last column shows the average of 10 readings at a particular coordinate. The readings are shown in millimeters obtained on viewing the samples under the travelling microscope. The values are recorded at the same coordinates as for Group I.

Table 10 shows the basic data obtained by measuring the distance for eleven different coordinates from the specimens of Group IID (samples obtained from impressions of triple tray, T1-T10). In each of the ten samples, eleven measurements were made for eleven coordinates. The last column shows the average of 10 readings at a particular coordinate. The readings are shown in millimeters obtained on viewing the samples under the travelling microscope. The values are recorded at the same coordinates as for Group I.

Table 11 shows the comparison of mean values of coordinates measured from samples of different groups (Group I, Group IIA, Group IIB, Group IIC and Group IID).

Table 12A shows the mean and standard deviation of Group I, Group IIA, Group IIB, Group IIC, and Group IID at coordinate 1(18-22). The dimensions were measured between index notches 18 and 22 (18-22). The standard deviation was calculated keeping N=10 in each group. Table 12A also shows 95% confidence interval for mean gap. Lower boundary shows the minimum mean gap in all the groups and the upper boundary shows the maximum mean gap in all groups at coordinate 1.

Confidence interval – gives the upper and lower boundary of the estimate.

Table 12B shows ANOVA test at coordinate 1(18-22). P value of 0.002 indicates that there is a significant amount of change of dimensions at coordinate 1.

Table 13A shows the mean and standard deviation of Group I, Group IIA, Group IIB, Group IIC and Group IID at coordinate 2(20-24). The dimensions were measured between index notches 20 and 24 (20-24). The standard deviation was calculated keeping N=10 in each group. Table 13A also shows 95% confidence interval for mean gap. Lower boundary shows the minimum mean gap in all the groups and the upper boundary shows the maximum mean gap in all groups at coordinate 2.

Confidence interval – gives the upper and lower boundary of the estimate.

Table 13B shows ANOVA test at coordinate 2(20-24). P value of 0.002 indicates that there is a significant amount of change of dimensions at coordinate 2.

Table 14A shows the mean and standard deviation of Group I, Group IIA, Group IIB, Group IIC and Group IID at coordinate 3(15-17). The dimensions were measured between index notches 15 and 17 (15-17). The standard deviation was calculated keeping N=10 in each group. Table 14A also shows 95% confidence interval for mean gap. Lower boundary shows the minimum mean gap in all the groups and the upper boundary shows the maximum mean gap in all groups at coordinate 3.

Confidence interval – gives the upper and lower boundary of the estimate.

Table 14B shows ANOVA test at coordinate 3(15-17). P value of 0.001 indicates that there is a significant amount of change of dimensions at coordinate 3.

Table 15A shows the mean and standard deviation of Group I, Group IIA, Group IIB, Group IIC and Group IID at coordinate 4(14-15). The dimensions were measured between index notches 14 and 15 (14-15). The standard deviation was calculated keeping N=10 in each group. Table 15A also shows 95% confidence interval for mean gap. Lower boundary shows the minimum mean gap in all the groups and the upper boundary shows the maximum mean gap in all groups at coordinate 4.

Confidence interval – gives the upper and lower boundary of the estimate.

Table 15B shows ANOVA test at coordinate 4(14-15). P value of 0.315 indicates that there is no significant amount of change of dimensions at coordinate 4.

Table 16A shows the mean and standard deviation of Group I, Group IIA, Group IIB, Group IIC and Group IID at coordinate 5(15-12). The dimensions were measured between index notches 15 and 12 (15-12). The standard deviation was calculated keeping N=10 in each group. Table 16A also shows 95% confidence interval for mean gap. Lower boundary shows the minimum mean gap in all the groups and the upper boundary shows the maximum mean gap in all groups at coordinate 5.

Confidence interval – gives the upper and lower boundary of the estimate.

Table16 B shows ANOVA test at coordinate 5(15-12). P value of 0.014 indicates that there is a significant amount of change of dimensions at coordinate 5.

Table 17A shows the mean and standard deviation of Group I, Group IIA, Group IIB, Group IIC and Group IID at coordinate 6(10-7). The dimensions were measured between index notches 10 and 7 (10-7). The standard deviation was calculated keeping N=10 in each group. Table 17A also shows 95% confidence interval for mean gap. Lower boundary shows the minimum mean gap in all the groups and the upper boundary shows the maximum mean gap in all groups at coordinate 6.

Confidence interval – gives the upper and lower boundary of the estimate.

Table 17B shows ANOVA test at coordinate 6(10-7). P value of 0.168 indicates that there is a significant amount of change of dimensions at coordinate 6.

Table 18A shows the mean and standard deviation of Group I, Group IIA, Group IIB, Group IIC and Group IID at coordinate 7(4-3). The dimensions were measured between index notches 4 and 3 (4-3). The standard deviation was calculated keeping N=10 in each group. Table18A also shows 95% confidence interval for mean gap. Lower boundary shows the minimum mean gap in all the groups and the upper boundary shows the maximum mean gap in all groups at coordinate 7.

Confidence interval – gives the upper and lower boundary of the estimate.

Table 18B shows ANOVA test at coordinate 7(4-3). P value of 0.006 indicates that there is a significant amount of change of dimensions at coordinate 7.

Table19A shows the mean and standard deviation of Group I, Group IIA, Group IIB, Group IIC and Group IID at coordinate 8(4-2). The dimensions were measured between index notches 4 and 2 (4-2). The standard deviation was calculated keeping N=10 in each group. Table19A also shows 95% confidence interval for mean gap. Lower boundary shows the minimum mean gap in all the groups and the upper boundary shows the maximum mean gap in all groups at coordinate 8.

Confidence interval – gives the upper and lower boundary of the estimate.

Table 19B shows ANOVA test at coordinate 8(4-2). P value of 0.788 indicates that there is no significant amount of change of dimensions at coordinate 8.

Table 20A shows the mean and standard deviation of Group I, Group IIA, Group IIB, Group IIC and Group IID at coordinate 9(4-1). The dimensions were measured between index notches 4 and 1 (4-1). The standard deviation was calculated keeping N=10 in each group. Table 20A also shows 95% confidence interval for mean gap. Lower boundary shows the minimum mean gap in all the groups and the upper boundary shows the maximum mean gap in all groups at coordinate 9.

Confidence interval – gives the upper and lower boundary of the estimate.

Table 20B shows ANOVA test at coordinate 9(4-1). P value of 0.020 indicates that there is a significant amount of change of dimensions at coordinate 9.

Table 21A shows the mean and standard deviation of Group I, Group IIA, Group IIB, Group IIC and Group IID at coordinate 10(15-3). The dimensions were measured from index notches 15 and 3 (15-3). The standard deviation was calculated keeping N=10 in each group. Table 21A also shows 95% confidence interval for mean gap. Lower boundary shows the minimum mean gap in all the groups and the upper boundary shows the maximum mean gap in all groups at coordinate 10.

Confidence interval – gives the upper and lower boundary of the estimate.

Table 21B shows ANOVA test at coordinate10 (15-3). P value of 0.000 indicates that there is no significant amount of change of dimensions at coordinate 10.

Table22A shows the mean and standard deviation of Group I, Group IIA, Group IIB, Group IIC and Group IID at coordinate 11(22-10).

The dimensions were measured between index notches 22 and 10 (22-10). The standard deviation was calculated keeping N=10 in each group. Table22A also shows 95% confidence interval for mean gap. Lower boundary shows the minimum mean gap in all the groups and the upper boundary shows the maximum mean gap in all groups at coordinate 11.

Confidence interval – gives the upper and lower boundary of the estimate.

Table 22B shows ANOVA test at coordinate11 (10-22). P value of 0.095 indicates that there is no significant amount of change of dimensions at coordinate 11.

Table 23 shows Bonferroni test. To find out which group has greater accuracy with Group I, Bonferroni correction was done. Bonferroni correction test shows that:

1. Group IIC samples were most accurate with group I followed by Group IIA samples.
2. Group IIB samples vary significantly with Group I at coordinates 6, 7, and 10.
3. Group IID samples are least accurate. They vary significantly with Group I samples at coordinates 1,2,3,5,7,9,10,11.

Figure 16 shows the dimensional variation at coordinate 1(18-22) between Group I and Group II A,B,C and D at 95% confidence interval distance. Maximum dimensional variation is seen in descending order of triple tray, plastic tray, and metal tray with minimal variation in custom tray.

Figure 17 shows the dimensional variation at coordinate 2(20-24) between Group I and Group II A,B,C and D at 95% confidence interval distance. Maximum dimensional variation is seen in descending order of triple tray, plastic tray, and metal tray with minimal variation in custom tray.

Figure 18 shows the dimensional variation at coordinate 3(15-17) between Group I and Group II A,B,C and D at 95% confidence interval distance. Maximum dimensional variation is seen in descending order of triple tray, plastic tray, and metal tray with minimal variation in custom tray.

Figure 19 shows the dimensional variation at coordinate 4(14-15) between Group I and Group II A,B,C and D at 95% confidence interval distance. Maximum dimensional variation is seen in descending order of triple tray, plastic tray, and metal tray with minimal variation in custom tray.

Figure 20 shows the dimensional variation at coordinate 5(15-12) between Group I and Group II A,B,C and D at 95% confidence interval distance. Maximum dimensional variation is seen in descending order of triple tray, plastic tray, and metal tray with minimal variation in custom tray.

Figure 21 shows the dimensional variation at coordinate 6(10-7) between Group I and Group II A, B, C and D at 95% confidence interval distance. Maximum dimensional variation is seen in descending order of triple tray, plastic tray, and metal tray with minimal variation in custom tray.

Figure 22 shows the dimensional variation at coordinate 7(4-3) between Group I and Group II A,B,C and D at 95% confidence interval distance. Maximum dimensional variation is seen in descending order of triple tray, plastic tray, and metal tray with minimal variation in custom tray.

Figure 23 shows the dimensional variation at coordinate 8(4-2) between Group I and Group II A,B,C and D at 95% confidence interval distance. Maximum dimensional variation is seen in descending order of triple tray, plastic tray, and metal tray with minimal variation in custom tray.

Figure 24 shows the dimensional variation at coordinate 9(4-1) between Group I and Group II A,B,C and D at 95% confidence interval distance. Maximum dimensional variation is seen in descending order of triple tray, plastic tray, and metal tray with minimal variation in custom tray.

Figure 25 shows the dimensional variation at coordinate10 (15-3) between Group I and Group II A,B,C and D at 95% confidence interval distance. Maximum dimensional variation is seen in descending order of triple tray, plastic tray, and metal tray with minimal variation in custom tray.

Figure 26 shows the dimensional variation at coordinate11 (22-10) between Group I and Group II A,B,C and D at 95% confidence interval distance. Maximum dimensional variation is seen in descending order of triple tray, plastic tray, and metal tray with minimal variation in custom tray.

TABLE 6

BASIC DATA OBTAINED BY MEASURING THE DISTANCE FOR ELEVEN DIFFERENT COORDINATES IN STANDARD TYPHODONT MODEL (GROUP I S1-S10)

Coordinates	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	Mean value MS (in mm)
1(18-22)	8.4	8.41	8.4	8.4	8.4	8.4	8.41	8.4	8.41	8.4	8.403
2(20-24)	8.34	8.33	8.34	8.33	8.34	8.34	8.34	8.34	8.34	8.33	8.337
3(15-17)	4.31	4.31	4.31	4.32	4.31	4.31	4.31	4.31	4.3	4.31	4.31
4(14-15)	4.37	4.36	4.37	4.37	4.36	4.37	4.37	4.37	4.37	4.37	4.368
5(15-12)	7.34	7.34	7.33	7.34	7.33	7.34	7.33	7.34	7.34	7.34	7.337
6(10-7)	4.25	4.25	4.25	4.24	4.25	4.26	4.25	4.26	4.25	4.25	4.251
7(4-3)	1.69	1.69	1.69	1.68	1.69	1.69	1.68	1.69	1.69	1.69	1.688
8(4-2)	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79	1.79
9(4-1)	2.7	2.7	2.7	2.7	2.69	2.7	2.7	2.7	2.7	2.71	2.7
10(15-3)	23.25	23.25	23.25	23.25	23.25	23.25	23.24	23.25	23.25	23.25	23.249
11(22-10)	26.53	26.53	26.53	26.53	26.53	26.54	26.53	26.53	26.53	26.53	26.531

TABLE 7

BASIC DATA OBTAINED BY MEASURING THE DISTANCE FOR ELEVEN DIFFERENT COORDINATES FROM THE SPECIMENS OF GROUP IIA (SAMPLES M1-M10)

Coordinates	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	Mean value - MM (in mm)
1(18-22)	8.44	8.45	8.45	8.42	8.41	8.46	8.4	8.4	8.43	8.4	8.426
2(20-24)	8.4	8.4	8.41	8.39	8.34	8.41	8.35	8.34	8.39	8.34	8.377
3(15-17)	4.34	4.34	4.37	4.35	4.31	4.34	4.32	4.31	4.34	4.32	4.334
4(14-15)	4.38	4.37	4.36	4.38	4.39	4.38	4.37	4.37	4.36	4.36	4.372
5(15-12)	7.72	7.45	7.4	7.39	7.35	7.39	7.34	7.34	7.37	7.34	7.409
6(10-7)	4.3	4.3	4.25	4.26	4.27	4.49	4.24	4.25	4.25	4.26	4.287
7(4-3)	1.7	1.69	1.7	1.71	1.71	1.74	1.69	1.69	1.7	1.69	1.702
8(4-2)	1.8	1.82	1.8	1.82	1.79	1.8	1.79	1.79	1.8	1.79	1.8
9(4-1)	2.75	2.74	2.73	2.7	2.72	2.75	2.74	2.7	2.7	2.7	2.723
10(15-3)	23.28	23.3	23.29	23.3	23.25	23.3	23.25	23.25	23.38	23.25	23.285
11(22-10)	26.59	26.59	26.6	26.61	26.54	26.57	26.53	26.54	26.53	26.54	26.564

TABLE 8

BASIC DATA OBTAINED BY MEASURING THE DISTANCE FOR ELEVEN DIFFERENT COORDINATES FROM THE SPECIMENS OF GROUP IIB (SAMPLES P1-P10)

Coordinates	P1	P2	P3	P4	P5	P6	P7	P8	P9	P10	Mean value-MP (in mm)
1(18-22)	8.48	8.47	8.48	8.43	8.41	8.45	8.47	8.46	8.43	8.4	8.448
2(20-24)	8.4	8.41	8.4	8.37	8.36	8.41	8.36	8.34	8.35	8.36	8.376
3(15-17)	4.38	4.34	4.37	4.37	4.35	4.33	4.38	4.35	4.33	4.32	4.352
4(14-15)	4.37	4.39	4.4	4.56	4.4	4.43	4.4	4.43	4.37	4.39	4.414
5(15-12)	7.45	7.74	7.5	7.49	7.35	7.49	7.44	7.74	7.57	7.34	7.511
6(10-7)	4.3	4.34	4.34	4.26	4.56	4.49	4.34	4.15	4.27	4.26	4.331
7(4-3)	1.72	1.75	1.76	1.73	1.74	1.74	1.69	1.72	1.73	1.71	1.729
8(4-2)	1.81	1.7	1.64	1.67	1.82	1.84	1.82	1.84	1.8	1.81	1.775
9(4-1)	2.73	2.78	2.79	2.72	2.74	2.78	2.64	2.75	2.67	2.72	2.732
10(15-3)	23.4	23.33	23.32	23.43	23.45	23.46	23.5	23.43	23.25	23.34	23.391
11(22-10)	26.69	26.64	26.66	26.46	26.53	26.32	26.59	26.45	26.56	26.55	26.545

TABLE 9

BASIC DATA OBTAINED BY MEASURING THE DISTANCE FOR ELEVEN DIFFERENT COORDINATES FROM THE SPECIMENS OF GROUP IIC (SAMPLES C1-C10)

Coordinates	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	Mean value- MC (in mm)
1(18-22)	8.4	8.41	8.39	8.4	8.45	8.42	8.4	8.43	8.42	8.4	8.412
2(20-24)	8.33	8.34	8.35	8.32	8.33	8.35	8.33	8.34	8.33	8.33	8.335
3(15-17)	4.28	4.31	4.29	4.33	4.31	4.31	4.31	4.33	4.33	4.31	4.311
4(14-15)	4.37	4.38	4.39	4.37	4.38	4.39	4.37	4.4	4.37	4.37	4.379
5(15-12)	7.34	7.35	7.43	7.34	7.63	7.38	7.35	7.34	7.38	7.34	7.388
6(10-7)	4.24	4.26	4.25	4.24	4.4	4.28	4.26	4.26	4.27	4.25	4.271
7(4-3)	1.69	1.7	1.66	1.69	1.69	1.7	1.69	1.71	1.72	1.7	1.695
8(4-2)	1.79	1.79	1.78	1.79	1.8	1.81	1.78	1.81	1.79	1.79	1.793
9(4-1)	2.71	2.72	2.72	2.71	2.7	2.73	2.7	2.72	2.73	2.7	2.714
10(15-3)	23.24	23.26	23.2	23.24	23.24	23.25	23.26	23.25	23.24	23.25	23.243
11(22-10)	26.54	26.53	26.5	26.52	26.52	26.64	26.55	26.56	26.54	26.53	26.543

TABLE 10

BASIC DATA OBTAINED BY MEASURING THE DISTANCE FOR ELEVEN DIFFERENT COORDINATES FROM THE SPECIMENS OF GROUP IID (SAMPLES T1-T10)

Coordinates	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	Mean value-MT (in mm)
1(18-22)	8.49	8.48	8.37	8.45	8.37	8.54	8.43	8.53	8.54	8.42	8.462
2(20-24)	8.45	8.29	8.32	8.37	8.4	8.41	8.45	8.42	8.43	8.3	8.384
3(15-17)	4.33	4.39	4.4	4.43	4.54	4.34	4.28	4.26	4.45	4.38	4.38
4(14-15)	4.47	4.45	4.25	4.34	4.23	4.45	4.34	4.24	4.47	4.49	4.373
5(15-12)	7.24	7.74	7.45	7.46	7.35	7.49	7.46	7.29	7.45	7.43	7.436
6(10-7)	4.33	4.43	4.47	4.2	4.45	4.26	4.25	4.15	4.32	4.35	4.321
7(4-3)	1.59	1.75	1.67	1.56	1.67	1.68	1.69	1.74	1.73	1.68	1.676
8(4-2)	1.84	1.87	1.75	1.45	1.8	1.85	1.84	1.83	1.68	1.76	1.767
9(4-1)	2.78	2.69	2.64	2.79	2.84	2.83	2.89	2.84	2.65	2.74	2.769
10(15-3)	23.49	23.43	23.15	23.27	23.47	23.58	23.56	23.21	23.54	23.45	23.415
11(22-10)	26.34	26.73	27.54	26.48	26.54	26.65	27.79	26.64	26.49	26.54	26.765

TABLE 11

COMPARISON OF MEAN VALUES OF COORDINATES MEASURED FROM SAMPLES OF DIFFERENT GROUPS (GROUP I, GROUP IIA, GROUP IIB, GROUP IIC & GROUP IID).

Coordinates	Mean value MS (in mm)	Mean value MM (in mm)	Mean value MP (in mm)	Mean value MC (in mm)	Mean value MT (in mm) -
1(18-22)	8.403	8.426	8.448	8.412	8.462
2(20-24)	8.337	8.377	8.376	8.335	8.384
3(15-17)	4.31	4.334	4.352	4.311	4.38
4(14-15)	4.368	4.372	4.414	4.379	4.373
5(15-12)	7.337	7.409	7.511	7.388	7.436
6(10-7)	4.251	4.287	4.331	4.271	4.321
7(4-3)	1.688	1.702	1.729	1.695	1.676
8(4-2)	1.79	1.8	1.775	1.793	1.767
9(4-1)	2.7	2.723	2.732	2.714	2.769
10(15-3)	23.249	23.285	23.391	23.243	23.415
11(22-10)	26.531	26.564	26.545	26.543	26.765

TABLE 12A

MEAN AND STANDARD DEVIATION OF DIFFERENT GROUPS AT COORDINATE 1 (18-22)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Mean		Minimum	Maximum
					Lower	Upper		
Group I	10	8.403	4.830E-	1.528E-	8.399	8.406	8.4	8.4
Group IIA	10	8.426	2.319E-	7.333E-	8.409	8.442	8.4	8.4
Group IIB	10	8.448	2.898E-	9.165E-	8.427	8.468	8.4	8.4
Group IIC	10	8.412	1.814E-	5.735E-	8.399	8.425	8.3	8.4
Group IID	10	8.462	6.477E-	2.048E-	8.415	8.508	8.3	8.5
Total	50	8.430	3.977E-	5.624E-	8.418	8.441	8.3	8.5

TABLE 12B

ANOVA TEST FOR COORDINATE 1 (18-22)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.417E-02	4	6.042E-03	5.098	0.002
Within Groups	5.333E-02	45	1.185E-03		
Total	7.750E-02	49			

TABLE 13A

MEAN AND STANDARD DEVIATION OF DIFFERENT GROUPS AT COORDINATE 2 (20-24)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Mean		Minimum	Maximum
					Lower	Upper		
Group I	10	8.3370	4.830E-03	1.528E-03	8.3335	8.3405	8.33	8.34
Group IIA	10	8.3770	3.057E-02	9.667E-03	8.3551	8.3989	8.34	8.41
Group IIB	10	8.3760	2.633E-02	8.327E-03	8.3572	8.3948	8.34	8.41
Group IIC	10	8.3350	9.718E-03	3.073E-03	8.3280	8.3420	8.32	8.35
Group IID	10	8.3840	6.077E-02	1.922E-03	8.3405	8.4275	8.29	8.45
Total	50	8.3618	3.821E-02	5.404E-03	8.3509	8.3727	8.29	8.45

TABLE 13B

ANOVA TEST FOR COORDINATE 2 (20-24)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.259E-02	4	5.647E-03	5.191	0.002
Within Groups	4.895E-02	45	1.088E-03		
Total	7.154E-02	49			

TABLE 14A

MEAN AND STANDARD DEVIATION OF DIFFERENT GROUPS AT COORDINATE 3 (15-17)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Mean		Minimum	Maximum
					Lower	Upper		
Group I	10	4.3100	4.714E-03	1.491E-03	4.3066	4.3134	4.30	4.32
Group IIA	10	4.3340	1.897E-02	6.000E-03	4.3204	4.3476	4.31	4.37
Group IIB	10	4.3520	2.201E-02	6.960E-03	4.3363	4.3677	4.32	4.38
Group IIC	10	4.3110	1.663E-02	5.260E-03	4.2991	4.3229	4.28	4.33
Group IID	10	4.3800	8.300E-02	2.625E-02	4.3206	4.4394	4.26	4.54
Total	50	4.3374	4.677E-02	6.614E-03	4.3241	4.3507	4.26	4.54

TABLE 14B

ANOVA TEST FOR COORDINATE 3 (15-17)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.487-02	4	8.718E-03	5.427	0.001
Within Groups	7.229E-02	45	1.606E-03		
Total	0.107	49			

TABLE 15A

MEAN AND STANDARD DEVIATION OF DIFFERENT GROUPS AT COORDINATE 4 (14-15)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Mean		Minimum	Maximum
					Lower	Upper		
Group I	10	4.3680	4.216E-03	1.333E-03	4.3650	4.3710	4.36	4.37
Group IIA	10	4.3720	1.033E-02	3.266E-03	4.3646	4.3794	4.36	4.39
Group IIB	10	4.4140	5.522E-02	1.746E-02	4.3745	4.4535	4.37	4.56
Group IIC	10	4.3790	1.101E-02	3.480E-03	4.3711	4.3869	4.37	4.40
Group IID	10	4.3730	0.1053	3.330E-02	4.2977	4.4483	4.23	4.49
Total	50	4.3812	5.412E-02	7.654E-03	4.3658	4.3966	4.23	4.56

TABLE 15B

ANOVA TEST FOR COORDINATE 4 (14-15)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.407E-02	4	3.517E-03	1.223	0.315
Within Groups	0.129	45	2.877E-03		
Total	0.144	49			

TABLE 16A

MEAN AND STANDARD DEVIATION OF DIFFERENT GROUPS AT COORDINATE 5 (15-12)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Mean		Minimum	Maximum
					Lower	Upper		
Group I	10	7.3370	4.830E-03	1.528E-03	7.3335	7.3405	7.33	7.34
Group IIA	10	7.4090	.1147	3.628E-02	7.3269	7.4911	7.34	7.72
Group IIB	10	7.5110	.1388	4.388E-02	7.4117	7.6103	7.34	7.74
Group IIC	10	7.3880	8.979E-02	2.839E-02	7.3238	7.4522	7.34	7.63
Group IID	10	7.4360	.1350	4.269E-02	7.3394	7.5326	7.24	7.74
Total	50	7.4162	.1190	1.683E-02	7.3824	7.4500	7.24	7.74

TABLE 16B

ANOVA TEST FOR COORDINATE 5 (15-12)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.165	4	4.125E-02	3.511	0.014
Within Groups	.529	45	1.175E-02		
Total	.694	49			

TABLE 17A

MEAN AND STANDARD DEVIATION OF DIFFERENT GROUPS AT COORDINATE 6 (10-7)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Mean		Minimum	Maximum
					Lower	Upper		
Group I	10	4.2510	5.676E-03	1.795E-03	4.2469	4.2551	4.24	4.26
Group IIA	10	4.2870	7.424E-02	2.348E-02	4.2339	4.3401	4.24	4.49
Group IIB	10	4.3310	.1181	3.734E-02	4.2465	4.4155	4.15	4.56
Group IIC	10	4.2710	4.701E-02	1.487E-02	4.2374	4.3046	4.24	4.40
Group IID	10	4.3210	.1076	3.404E-02	4.2440	4.3980	4.15	4.47
Total	50	4.2922	8.387E-02	1.186E-02	4.2684	4.3160	4.15	4.56

TABLE 17B

ANOVA TEST FOR COORDINATE 6 (10-7)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.509E-02	4	1.127E-02	1.693	0.168
Within Groups	.300	45	6.657E-03		
Total	.345	49			

TABLE 18A

MEAN AND STANDARD DEVIATION OF DIFFERENT GROUPS AT COORDINATE 7 (4-3)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Mean		Minimum	Maximum
					Lower	Upper		
Group I	10	1.6880	4.216E-03	1.333E-03	1.6850	1.6910	1.68	1.69
Group IIA	10	1.7020	1.549E-02	4.899E-03	1.6909	1.7131	1.69	1.74
Group IIB	10	1.7290	2.025E-02	6.403E-03	1.7145	1.7435	1.69	1.76
Group IIC	10	1.6950	1.581E-02	5.000E-03	1.6837	1.7063	1.66	1.72
Group IID	10	1.6760	6.114E-02	1.933E-02	1.6323	1.7197	1.56	1.75
Total	50	1.6980	3.429E-02	4.849E-03	1.6883	1.7077	1.56	1.76

TABLE 18B

ANOVA TEST FOR COORDINATE 7 (4-3)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.570E-02	4	3.925E-03	4.215	0.006
Within Groups	4.190E-02	45	9.311E-04		
Total	5.760E-02	49			

TABLE 19A

MEAN AND STANDARD DEVIATION OF DIFFERENT GROUPS AT COORDINATE 8 (4-2)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Mean		Minimum	Maximum
					Lower	Upper		
Group I	10	1.7900	2.630E-16	8.318E-17	1.7900	1.7900	1.79	1.79
Group IIA	10	1.8000	1.155E-02	3.651E-03	1.7917	1.8083	1.79	1.82
Group IIB	10	1.7750	7.487E-02	2.368E-02	1.7214	1.8286	1.64	1.84
Group IIC	10	1.7930	1.059E-02	3.350E-03	1.7854	1.8006	1.78	1.81
Group IID	10	1.7670	.1254	3.967E-02	1.6773	1.8567	1.45	1.87
Total	50	1.7850	6.415E-02	9.072E-03	1.7668	1.8032	1.45	1.87

TABLE 19B

ANOVA TEST FOR COORDINATE 8 (4-2)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	7.380E-03	4	1.845E-03	.427	0.788
Within Groups	.194	45	4.317E-03		
Total	.202	49			

TABLE 20A

MEAN AND STANDARD DEVIATION OF DIFFERENT GROUPS AT COORDINATE 9 (4-1)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Mean		Minimum	Maximum
					Lower	Upper		
Group I	10	2.7000	4.714E-03	1.491E-03	2.6966	2.7034	2.69	2.71
Group IIA	10	2.7230	2.163E-02	6.839E-03	2.7075	2.7385	2.70	2.75
Group IIB	10	2.7320	4.826E-02	1.526E-02	2.6975	2.7665	2.64	2.79
Group IIC	10	2.7140	1.174E-02	3.712E-03	2.7056	2.7224	2.70	2.73
Group IID	10	2.7690	8.621E-02	2.726E-02	2.7073	2.8307	2.64	2.89
Total	50	2.7276	4.959E-02	7.013E-03	2.7135	2.7417	2.64	2.89

TABLE 20B

ANOVA TEST FOR COORDINATE 9 (4-1)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.701E-02	4	6.753E-03	3.250	0.020
Within Groups	9.350E-02	45	2.078E-03		
Total	.121	49			

TABLE 21A

MEAN AND STANDARD DEVIATION OF DIFFERENT GROUPS AT COORDINATE 10 (15-3)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Mean		Minimum	Maximum
					Lower	Upper		
Group I	10	23.2490	3.162E-03	1.000E-03	23.2467	23.2513	23.24	23.25
Group IIA	10	23.2850	4.035E-02	1.276E-02	23.2561	23.3139	23.25	23.38
Group IIB	10	23.3910	7.781E-02	2.461E-02	23.3353	23.4467	23.25	23.50
Group IIC	10	23.2430	1.703E-02	5.385E-03	23.2308	23.2552	23.20	23.26
Group IID	10	23.4150	.1517	4.799E-02	23.3064	23.5236	23.15	23.58
Total	50	23.3166	.1051	1.486E-02	23.2867	23.3465	23.15	23.58

TABLE 21B

ANOVA TEST FOR COORDINATE 10 (15-3)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.262	4	6.551E-02	10.562	0.000
Within Groups	.279	45	6.202E-03		
Total	.541	49			

TABLE 22A

MEAN AND STANDARD DEVIATION OF DIFFERENT GROUPS AT COORDINATE 11 (22-10)

	N	Mean	Std. Deviation	Std. Error	95% Confidence Mean		Minimum	Maximum
					Lower	Upper		
Group I	10	26.5310	3.162E-03	1.000E-03	26.5287	26.4333	26.53	26.54
Group IIA	10	26.5640	3.134E-02	9.911E-03	26.5416	26.5864	26.53	26.61
Group IIB	10	26.5450	.1119	3.538E-02	26.4650	26.6250	26.32	26.69
Group IIC	10	26.5430	3.802E-02	1.202E-02	26.5158	26.5702	26.50	26.64
Group IID	10	26.7740	.4853	.1535	26.4269	27.1211	26.34	27.79
Total	50	26.5914	.2337	3.305E-02	26.5250	26.6578	26.32	27.79

TABLE 22B

ANOVA TEST FOR COORDINATE 11 (22-10)

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.422	4	.106	2.108	0.095
Within Groups	2.254	45	5.009E-02		
Total	2.676	49			

TABLE NO 23-POSTHOCTESTS

GROUP I	GROUP II	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
Standard	A	-2.3000E-02	1.540E-02	1.000	-6.8449E-02	2.245E-02
	B	-4.5000E-02	1.540E-02	.054	-9.0449E-02	4.488E-04
	C	-9.0000E-03	1.540E-02	1.000	-5.4449E-02	3.645E-02
	D	-5.9000E-02*	1.540E-02	.004	-.1044	-1.3551E-02
StandardI	A	-4.0000E-02	1.475E-02	.094	-8.3542E-02	3.542E-03
	B	-3.9000E-02	1.475E-02	.112	-8.2542E-02	4.542E-03
	C	2.000E-03	1.475E-02	1.000	-4.1542E-02	4.554E-02
	D	-4.7000E-02*	1.475E-02	.026	-9.0542E-02	-3.4575E-03
Standard	A	-2.4000E-02	1.792E-02	1.000	-7.6915E-02	2.891E-02
	B	-4.2000E-02	1.792E-02	.236	-9.4915E-02	1.091E-02
	C	-1.0000E-03	1.792E-02	1.000	-5.3915E-02	5.191E-02
	D	-7.0000E-02*	1.792E-02	.003	-.1229	-1.7085E-02
Standard	A	-4.0000E-03	2.399E-02	1.000	-7.4812E-02	6.681E-02
	B	-4.6000E-02	2.399E-02	.615	-.1168	2.481E-02
	C	-1.1000E-02	2.399E-02	1.000	-8.1812E-02	5.981E-02
	D	-5.0000E-03	2.399E-02	1.000	-7.5812E-02	6.581E-02
Standard	A	-7.2000E-02	4.847E-02	1.000	-.2151	7.109E-02
	B	-.1740*	4.847E-02	.008	-.3171	-3.0914E-02
	C	-5.1000E-02	4.847E-02	1.000	-.1941	9.209E-02
	D	-9.9000E-02	4.847E-02	.470	-.2421	4.409E-02
Standard	A	-3.6000E-02	3.649E-02	1.000	-.1437	7.172E-02
	B	-8.0000E-02	3.649E-02	.336	-.1877	2.772E-02
	C	-2.0000E-02	3.649E-02	1.000	-.1277	8.772E-02
	D	-7.0000E-02	3.649E-02	.614	-.1777	3.772E-02
Standard	A	-1.4000E-02	1.365E-02	1.000	-5.4285E-02	2.629E-02
	B	-4.1000E-02*	1.365E-02	.043	-8.1285E-02	-7.1496E-04
	C	-7.0000E-03	1.365E-02	1.000	-4.7285E-02	3.329E-02
	D	1.200E-02	1.365E-02	1.000	-2.8285E-02	5.229E-02
Standard	A	-1.0000E-02	2.938E-02	1.000	-9.6744E-02	7.674E-02
	B	1.500E-02	2.938E-02	1.000	-7.1744E-02	.1017
	C	-3.0000E-03	2.938E-02	1.000	-8.9744E-02	8.374E-02
	D	2.300E-02	2.938E-02	1.000	-6.3744E-02	.1097
Standard	A	-2.3000E-02	2.039E-02	1.000	-8.3179E-02	3.718E-02
	B	-3.2000E-02	2.039E-02	1.000	-9.2179E-02	2.818E-02
	C	-1.4000E-02	2.039E-02	1.000	-7.4179E-02	4.618E-02
	D	-6.9000E-02*	2.039E-02	.015	-.1292	-8.8213E-03
Standard	A	-3.6000E-02	3.522E-02	1.000	-.1400	6.797E-02
	B	-.1420*	3.522E-02	.002	-.2460	-3.8030E-02
	C	6.000E-03	3.522E-02	1.000	-9.7970E-02	.1100
	D	-.1660*	3.522E-02	.000	-.2700	-6.2030E-02
Standard	A	-3.3000E-02	.1001	1.000	-.3285	.2625
	B	-1.4000E-02	.1001	1.000	-.3095	.2815
	C	-1.2000E-02	.1001	1.000	-.3075	.2835
	D	-.2430	.1001	.192	-.5385	5.246E-02

GRAPHS

FIGURE 16 DIMENSIONAL VARIATION COMPARISION AT COORDINATE 1 WITH DIFFERENT IMPRESSION TRAYS

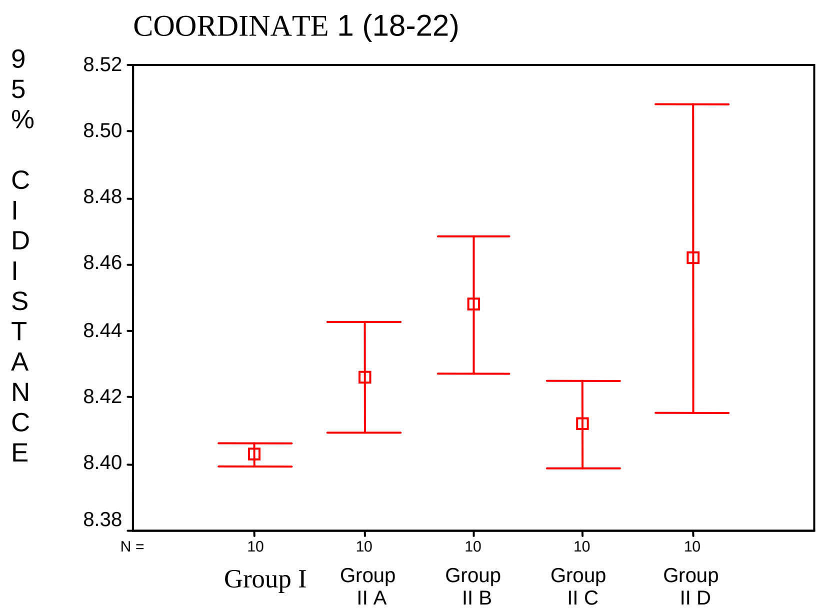


FIGURE 17 DIMENSIONAL VARIATION COMPARISION AT COORDINATE 2 WITH DIFFERENT IMPRESSION TRAYS

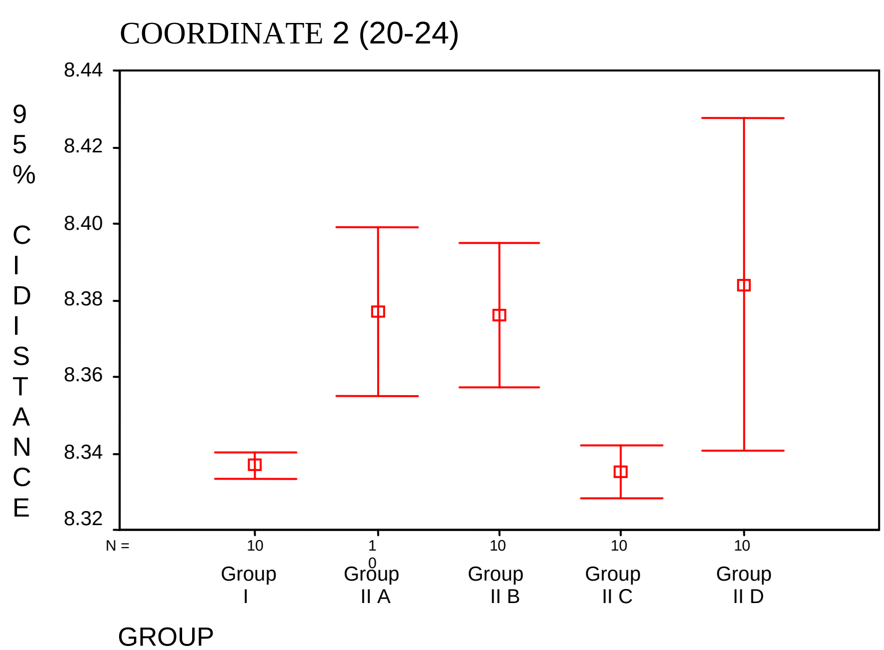


FIGURE 18 DIMENSIONAL VARIATION COMPARISION AT COORDINATE 3 WITH DIFFERENT IMPRESSION TRAYS

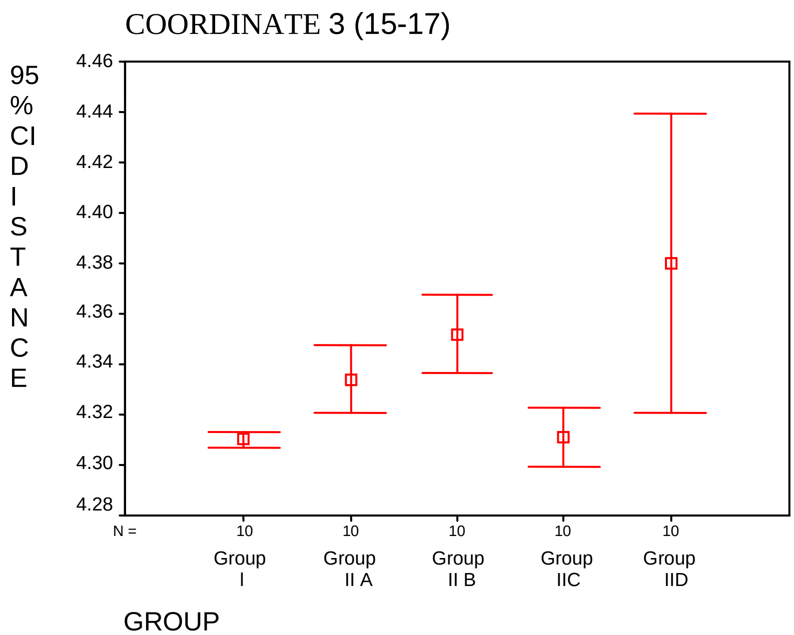


FIGURE 19 DIMENSIONAL VARIATION COMPARISION AT COORDINATE 4 WITH DIFFERENT IMPRESSION TRAYS

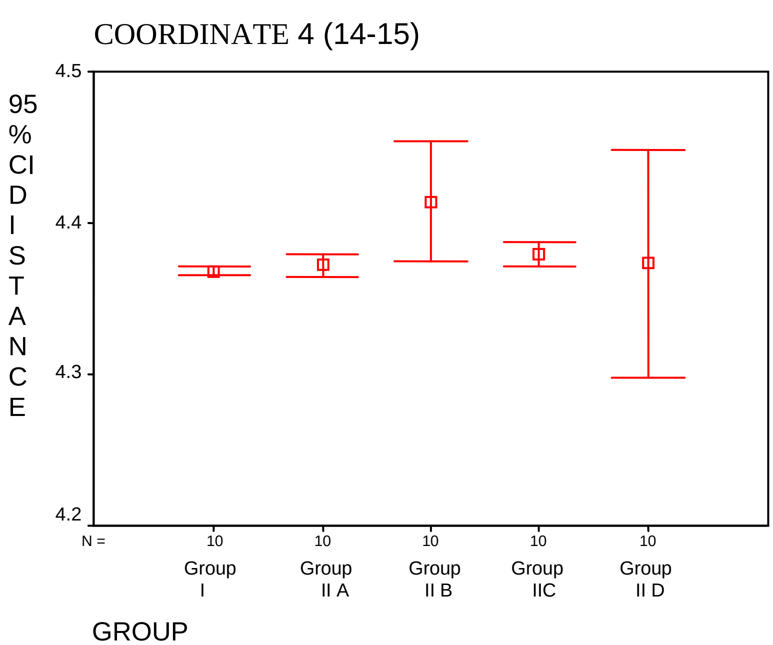


FIGURE 20 DIMENSIONAL VARIATION COMPARISION AT COORDINATE 5 WITH DIFFERENT IMPRESSION TRAYS

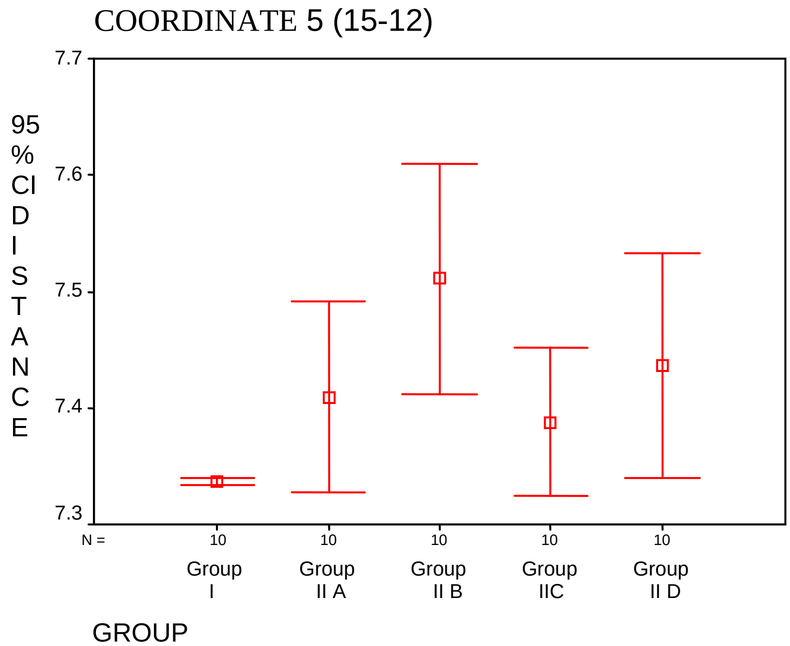


FIGURE 21 DIMENSIONAL VARIATION COMPARISION AT COORDINATE 6 WITH DIFFERENT IMPRESSION TRAYS

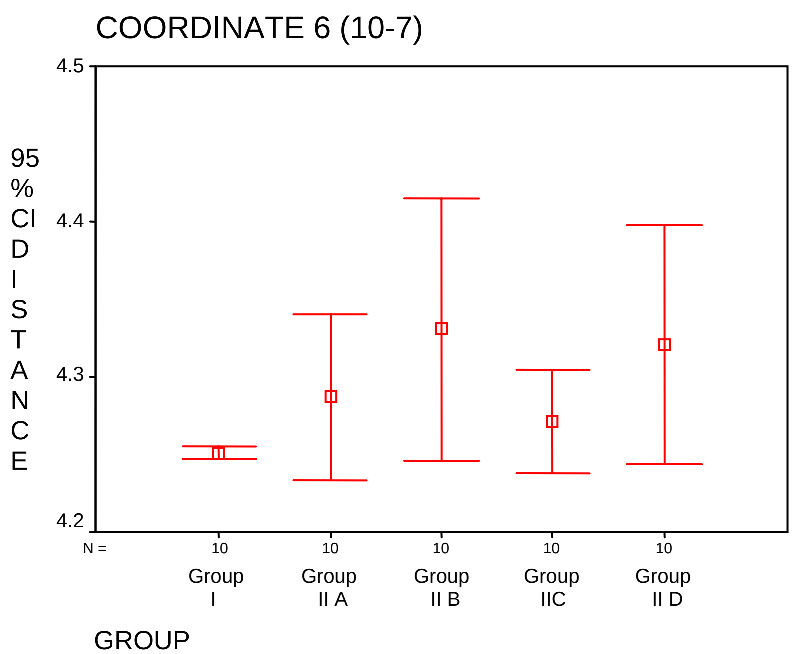


FIGURE 22 DIMENSIONAL VARIATION COMPARISION AT COORDINATE 7 WITH DIFFERENT IMPRESSION TRAYS

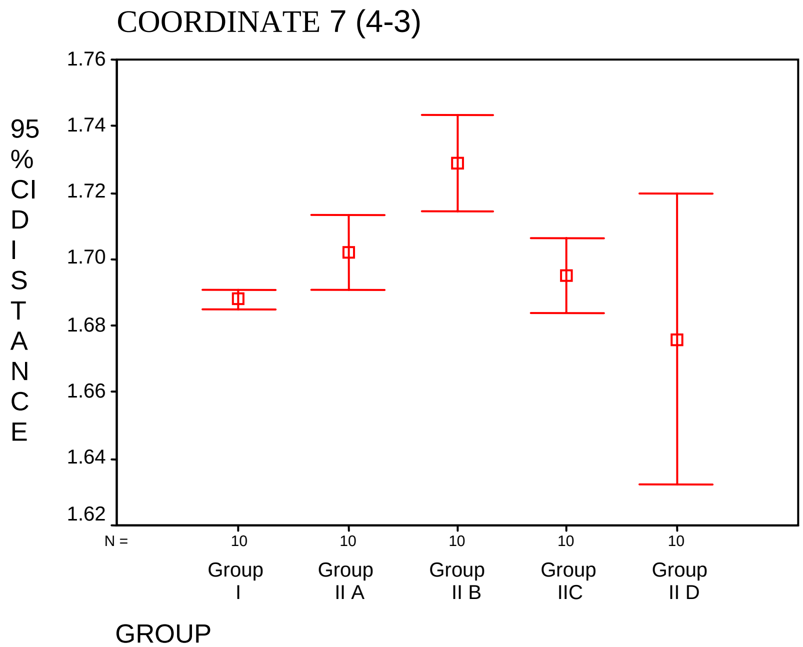


FIGURE 23 DIMENSIONAL VARIATION COMPARISION AT COORDINATE 8 WITH DIFFERENT IMPRESSION TRAYS

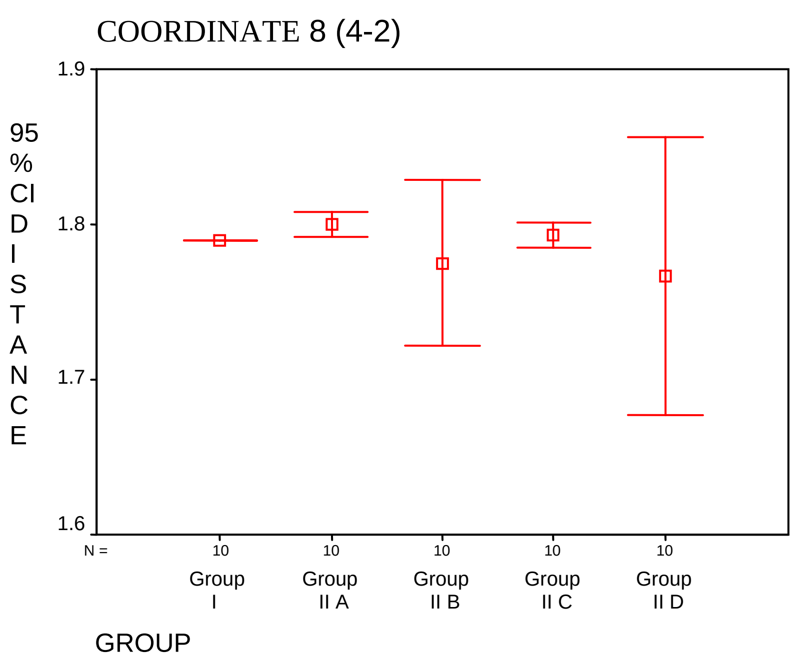


FIGURE 24 DIMENSIONAL VARIATION COMPARISION AT COORDINATE 9 WITH DIFFERENT IMPRESSION TRAYS

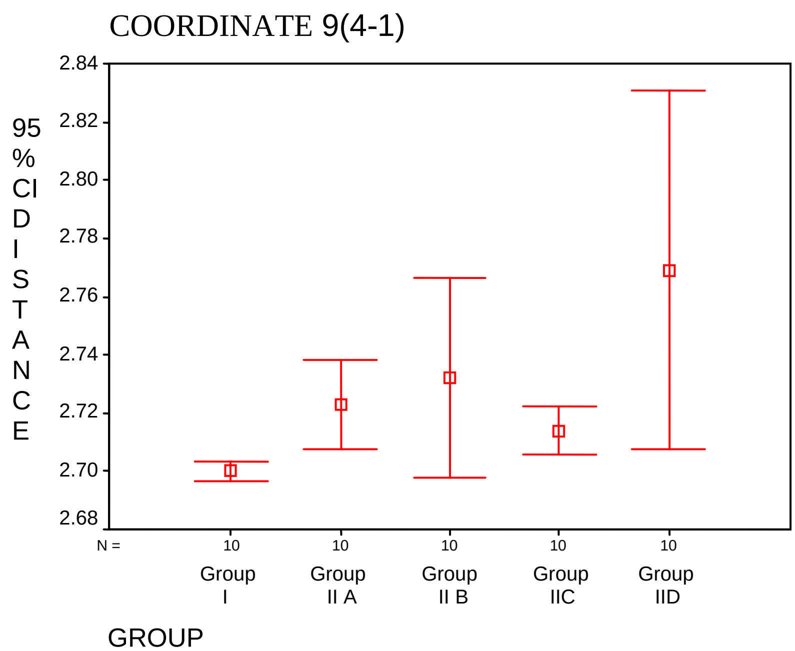


FIGURE 25 DIMENSIONAL VARIATION COMPARISION AT COORDINATE 10 WITH DIFFERENT IMPRESSION TRAYS

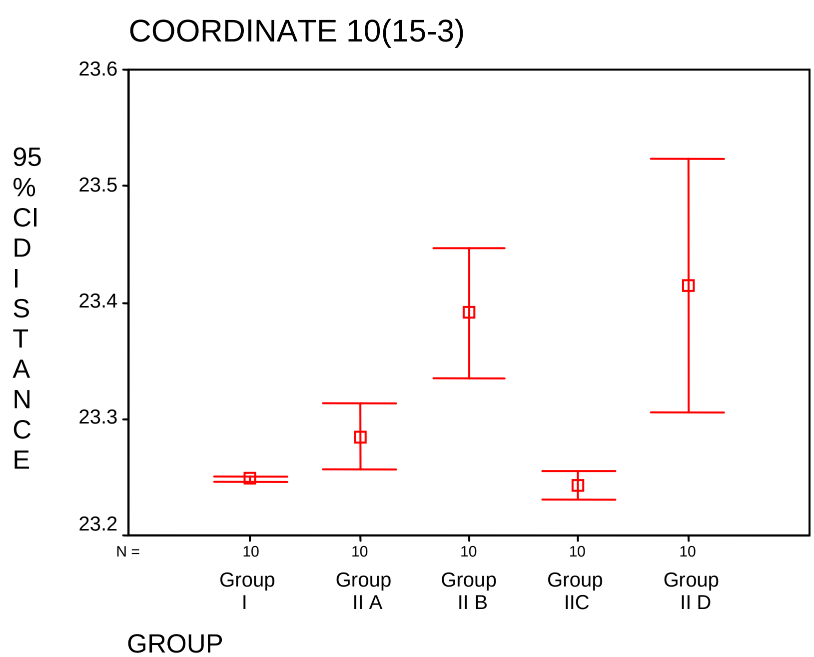
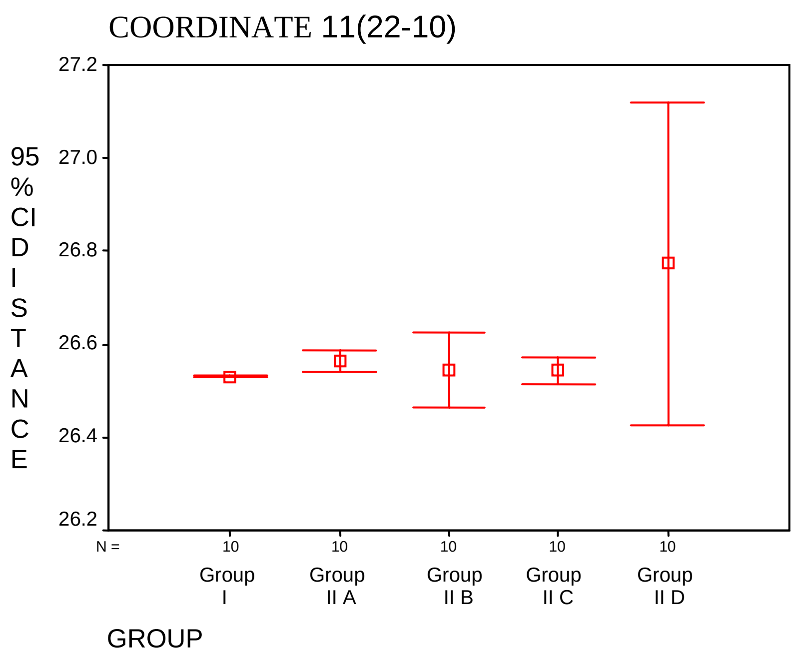


FIGURE 26 DIMENSIONAL VARIATION COMPARISION AT COORDINATE 11 WITH DIFFERENT IMPRESSION TRAYS



DISCUSSION

The accurate reproduction of dies is of paramount importance in determining the precise adaptation and marginal accuracy of cast restorations in prosthetic dentistry. The traditional goals of research focused by the manufacturers of impression materials were to produce materials which maintain the dimensional stability and accuracy of adaptation during and after the impressions are made. The physical properties such as flow, reproduction of surface details, the dimensional stability, tensile and marginal strength of the impression material is totally dependent upon utilization of the device called as impression tray, with which the impression material is loaded for making the impressions. These impression trays have been made with different types of materials, adaptive modalities, extensions, requirement variations and to the impression materials of choice selected. There are various concepts and theories, in the literature for making impressions.

The structure and quality of impression materials have put before the operators, a difficult choice, both in selecting the type of tray and the impression material. Whatever may be the type of the tray used and the choice of the material utilized, the ultimate goal is to produce an accurate cast with dimensions that do not deviate from the natural tissues on which the impressions are made. Most of the manufacturers of the impression materials suggest their own method of manipulation and application of the materials, with specific instructions to choose and select the trays and at the same time claiming superiority of the physical properties of their impression materials from the precise nature of reproducing the details, over the other type of impression materials that are available for making the impressions.

The present study has been done using different types of impression trays such as metal, plastic, custom and triple trays and choice of the impression material was addition silicone of various viscosities following putty wash impression techniques and monophase single mix impression technique.

The primary purpose of the study was to evaluate the dimensions of dies fabricated from addition silicone impression material with the selected impression techniques by using different types of trays. One of the trays used in the study were perforated stock metal tray and the impressions were made by following the two-step putty wash impression technique. The second type of tray was perforated stock plastic tray and the impressions made by following the two-step putty wash impression technique. For both the trays addition silicone putty and addition silicone light body impression materials were used. The other tray which was used in the study was a custom made tray with a spacer of 2 mm made utilizing monophase addition silicone following single mix impression technique. Another type of tray used for study was triple tray utilizing addition silicone putty and light body, employing one-step impression technique.

The objective of using any impression material is that it must be stable enough, maintain its dimensions over an extended period of time and should be compatible to that of die material which is used to produce the cast. It has been observed that elastic impression materials which were introduced in 1970's have been found to be more satisfactory in producing accurate and more stable impressions. Among the various elastomers used, addition silicone had been considered in the study, either of monophase or putty and light body viscosities for the reason that it exhibits minimum dimensional changes as compared to condensation silicone, polysulfides and polyether impression materials[48]. Further the manipulation as well as its adaptation to the tray has been considered superior to other elastomers[37].

The dimensional accuracy of addition silicones is attributed to the absence of volatile reaction byproducts such as water or alcohol which are normally produced by polysulphides and condensation silicones during setting.[3, 53,59]

The work of **Johnson and Craig**[28] has indicated the vertical and horizontal dimension of stone dies made with addition silicone have shown the least change in the dimension. It was mandatory to use an adhesive to the stock metal tray, plastic tray and custom made tray for the adhesiveness of the impression material to the tray, prevent pulling away of the material from the tray. Addition silicone requires a bonding of the material to the tray in spite of the mechanical retention obtained from the perforations present in the tray selected for the study. The necessity of such a bonding system is that, it maintains its dimensional stability and prevents contraction especially at the margins of the tray as well as at the binding border of the tray to the material. Hence in order to maintain the accuracy of the impression the adhesive yields a satisfactory result, contributing to minimising distortion of the material.

The traditional way of making impressions in any prosthodontic work is to make primary impressions with stock tray. This necessitates prolonging the chair side time, as well as the laboratory stage or making a preliminary cast and then making other tray suitable to the dentulous or edentulous dental arches. The other method followed is modifying the stock tray for the impression of dental arches by making it partly suitable for producing satisfactory impression. However, the advent of elastomeric impression materials which are available in different consistencies such as putty and light body, makes it convenient for the operator subjecting them to single stage especially for dental arches, requiring a restorative and for crown and bridge prosthodontic work. Hence, heavy body or moderately rigid material is definitely required for the gross adaptation as well as the extension of the material to the required areas. However, for obtaining the accurate detailed surface, a free flowing and light body material is mandatory. The putty and light body material have the capacity to get adapted and also bond to each other, hence they can be used either as a two-step or one-step technique, both of which were utilized in this study.

The stock trays available for making impressions of dentulous arch vary from highly rigid metal trays to resilient plastic trays. The rigid metal stock trays are useful for some procedures of making impressions, have their disadvantage of inaccuracy of fit. But the rigidity of the tray maintains its dimensions during application of pressure which is exerted when using heavy bodied impression material. Further it has the advantage of sterilization by all methods. Plastic stock trays have come into existence and application in prosthetic dentistry because of the time and cost required to construct custom trays. Considering their usefulness, the manufacturers have attempted to provide quick and less expensive alternatives to metal stock trays. But the flexibility and the construction vary according to the arch form and size. Even though rigid metal trays have the advantage of maintaining the dimensional stability, the fear of cross contamination and also for aseptic reasons, disposable plastic trays have been employed in modern Prosthodontic clinical work. Hence an attempt is made in this study to prove the worthiness of plastic trays for producing stable impressions.

Johnson, Craig[28] and **Eames**[18] have suggested that the variable thickness of impression material may result in dimensional changes and inaccuracies in the cast. It is generally agreed that a custom tray is advisable for procedures requiring the utmost accuracy of impressions.

A rigid special tray with relief of 2-3mm is considered as the standard[33]. Autopolymerizing resin is the preferred material of choice.

Further, the custom tray also has the advantages. It improves the accuracy of elastomeric impression by limiting the volume of the material, thereby reducing two sources of error, namely stresses during thermal contraction of the impression material and stresses released during removal of the impression .[48]

Hence in this study custom tray as suggested above have been considered as another choice of the tray for the evaluating the dimensions of the dies produced from the impressions made. The impressions made with custom tray employed monophase addition silicone material in a single stage.

When making an impression in open mouth technique two variables have to be considered. The first is the physical deformation of the mandible during eccentric or opening movements.[9,47,67] The second is physical displacement of teeth under an occlusal load.[32] **Demarco, Payne**[67] reported mandibular flexure after 28% of mouth opening. An average of 0.78 $\pm$ 0.05 mm contraction of mandible is present during maximum opening. This change in mandibular width is attributed to the stresses exerted by the muscles of mastication responsible for the depression of the mandible. **Goto**[32] found shifting of the teeth occurs when dentition assumes maximum interdigitation. Casts made of teeth resting in unstrained periodontal membranes cannot be placed in maximum interdigitation.

To significantly control mandibular distortion and record teeth at maximum intercuspation, a technique must register arch form at or near the vertical dimension of occlusion.[24]

The double arch impression is a closed mouth impression technique that controls mandibular distortion and records the teeth at maximum intercuspation. It utilizes dual arch trays. The currently popular disposable dual arch tray (triple tray) was introduced in 1983. As three records are made simultaneously it has also been referred to as triple tray technique as reported by **Kapolwitz,**[43,44] **Bass**[5] and **Wilson and Werin.**[20]

Advantages of this technique are the savings in time and material, patient comfort and ease of use.[8] The disadvantages of this technique are the absence of contralateral teeth which may lead to the incorporation of eccentric occlusal interferences in the final restoration[38] and extremely thin areas are present where opposing teeth occlude in dual arch impressions.[49]

The dual arch impression technique was designed for impressions of single unit crowns with well established intercuspal position and anterior guidance and for short span fixed partial dentures, where the most posterior teeth in the arch is not prepared for the restoration and provides a distinct vertical stop.[49]

The putty wash impression technique was used with metal and plastic stock perforated trays and triple tray. The putty wash impression technique was originally recommended to overcome the problems associated with polymerization shrinkage of condensation silicone impression material. This technique has been recommended for addition silicone impression material also, even though these materials appear to be dimensionally stable.[14]

The putty wash impression technique can be made as a one-step or as a two-step technique. One-step putty wash impression technique is used with triple tray as recommended by manufacturer and mentioned in the literature. Less chair side time and saving of impression material are the advantages of this technique. The disadvantage is that there is occasional ledge at the junction of the putty and wash material.

Two-step putty wash impression technique is used with metal and plastic complete arch perforated trays. An advantage of putty wash two-step impression technique is that the impression of the teeth captured with the wash material. The disadvantages of putty wash two-step impression technique are distortion, extra chair side time and extra material needed. Ideally wash material should cover the entire preparation for both techniques.

Shirley Hung et al[63] in their comparative study of accuracy of one-step putty wash impression technique with two step putty wash impression technique using addition silicone impression material indicated that the accuracy of the impression material is affected more by material than by technique and the accuracy of one step putty wash impression technique was not different from two step putty wash impression technique.

The results of the study have been taken by obtaining the data and measurements from the coordinate values of the groups of samples made. The importance of making the coordinate values is to go into the detail results of each area by area, as all the samples are of three dimensional objects. The standard or the control study samples have been obtained from the prepared typhodont teeth and not from the dies made from the impressions. All other groups of sample results were compared with the control group results. It has been observed from the results that the co-ordinate values of the study group samples does not show the same equal values to any of the coordinate areas with the standard or control group.

The results of the study when looking at random, the measurements taken from the margins of coordinate 1(18-22) for the standard sample was shown to be 8.403 mm. The minimal variation to this value was shown at 8.412mm for the same coordinate obtained from custom tray. Whereas a larger difference of values have been shown as 8.426mm with metal tray and 8.448 mm with plastic tray and 8.462 with triple tray. In the same way inter marginal values (inter-abutment distance) between teeth prepared at coordinate 11(10-22) showed least discrepancy value of 26.543mm with custom tray, when compared to standard value of 26.531 mm. As shown in the results there is a gross difference of nearly 0.234 mm with triple tray, a marginal variation of 0.033mm with metal tray and 0.014mm of discrepancy with plastic tray at coordinate 11, where as the difference was only 0.012mm for the custom tray.

There seems to be a consistent variation in other coordinates in values obtained with a gradation of marginal difference with custom tray followed by metal tray and subsequently with plastic tray and the gross difference of values are obtained from triple tray with any of the coordinate values obtained in different locations of both prepared teeth as well as inter teeth values. The results have shown clearly that none of the values were coinciding with any of the coordinate values from one study group with other group and also with control group.

This may be because of the discrepancy in the technique that follows from impression making to the procedure of cast preparation. Apart, from this there is an inevitable dimensional change likely in the material itself due to changes in the atomic structure of the material during curing or setting process. However, the observations have to be taken into consideration as to the material and the type of the tray used in the study procedure.

The least discrepancy values obtained with custom tray is considered logical because of closer adaptation and fit of the tray to the impression surface. The closer adaptation makes the use of reduced thickness of material and also equal thickness of material through out the impression surface. The equal thickness of material definitely prevents dragging of the material haphazardly in all directions and also minimizes the release of stresses through out the impression surface. Further the technique used with special tray also prevents excessive pressure applied on the tray as well as the material where the impression was made.

Metal perforated trays were considered as one of the choice of the trays used in the study. A two stage putty wash impression procedure was followed. The perforations in the tray not only give additional retention to the impression material, but also minimize the pressure applied on to the impression tray. Due to the rigidity of the metal structure, it maintains dimensions within the intaglio surface of the impression and at the same time keeping the material intact and minimizing the dimensional variation of the material. However the technique employed inducted a light body material as a relining to the putty impression in the first stage by adopting a two-step impression procedure. There is a possibility of inaccuracy in seating the impression tray with the impressions, resulting in the discrepancy rate.

Looking at random the values are found to have very least dimensional variation. There was least discrepancy at coordinate8(4-2) and the maximum discrepancy is found at coordinate 5(15-12) with a mean difference of 0.072mm.But the post hoc test at this coordinate showed a p value of 1 which means the values are clinically acceptable.

The work of **Valderhaug *et al***[69] and **Monica J Cayouette *et al***[49] showed that the metal stock perforated trays produced acceptable clinical results even though they are not as accurate as custom tray.

The plastic perforated trays have come into as a choice of device as impression trays especially as a disposable tray as it is very difficult to use it again because of adhesive properties as well as the inability to sterilize it efficiently. The plastic perforated trays has an inherited quality of resiliency at the time of pressure applied resulting in permitting dimensional changes. Same putty wash impression technique was followed in the study utilizing this type of tray. The analysis has shown that the discrepancy rate is marginally higher than the metal perforated tray.

Looking at random, the values are found to have dimensional variation. The maximum discrepancy is found at coordinate 5(15-12) with a difference of mean 0.174mm, and at coordinate 10(15-3) with a mean difference of 0.142mm. The post hoc test at coordinates 5, 7, 10 showed a p value of <0.05 which means the values are clinically significant, the dies produced by plastic perforated trays exhibited a significant dimensional variation.

The work of **Ceyhan *et al***[38] states that the dies produced by plastic trays are more acceptable in buccolingual direction when compared with metal trays**.** **Monica J Cauyouette *et al***[49] in his study of different impression trays found that the plastic trays also produce dies which are clinically acceptable.

The other impression tray used in the study was the triple tray. The very name suggests the impressions of both maxillary and mandibular impressions can be made maintaining the vertical dimensions. A one-step putty wash impression procedure was followed to make impressions with this tray. The advocates of triple tray feel it is more comfortable to make an impression of both arches at one time; there is a definite difficulty in keeping the tray in the required area of impression. This may be because of the design as well as the materials used for formation of the tray itself. Further, both the dental arches have to be maintained at heavy pressure to maintain the vertical dimension till the material sets. It is also noted that the thickness of the material itself may drag the impression surface during closure of the jaws in centric. These difficulties inevitably would have been the causes for gross discrepancy values obtained with this type of tray and the impression procedures

Looking at random the values are found to have very greater dimensional variation with triple tray. The maximum discrepancy is found at coordinate 11(22-10) with a difference of mean 0.234 mm, at coordinate 10(15-3) with a mean difference of 0.166 mm, coordinate 5(15-12) with a mean difference of 0.099mm, at coordinate 6(10-7) with a mean difference of 0.070mm and at coordinate 9(4-1) with a mean difference of 0.069 mm. The post hoc test at coordinates 1,2,3,5, 9, and 11 showed a p value of <0.05 which means the values are clinically significant and at coordinate 1 and coordinate3 the p value is <0.01 the value which shows a very high significance. There is a decrease in the dimension at coordinate 7and 8. The dies produced by triple trays exhibited a significant dimensional variation.

These results seem to be in concurrence to the results obtained by **Cox *et al***[39] that the impressions made by plastic dual arch trays are least accurate. **Larson *et al***[68] also supports that the accuracy of the triple tray is adversely affected due to its flexibility. But **Monica J Cauyouette *et al***[49] and **Ceyhan *et al***[38] obtained dies which were clinically acceptable with dual arch trays. Further the difficulties experienced in forming the cast also could have resulted in gross differences.

Impression procedures are inevitable in restorative dentistry especially in prosthodontics. From time to time innovations of impression material have come into existence with the manufacturers claiming superiority over the others. But it is not only the impression material, but also the technique followed which plays a major role in determining the accuracy and the preciseness of the restorations. There are various impression techniques followed in fixed prosthodontics to ensure the accuracy of marginal fit and adaptation of the prosthesis.

There are various views of thoughts regarding the type of tray and the design of the tray used to make the impressions. It is also been noted that the tray material as well as the design is considered mainly based on the impression material of choice as well as the technique followed. Even though the review of literature shows the advantages of each tray and the technique followed, none of them seems to be producing a satisfactory outcome of results as regarding the maintenance of the prepared teeth as well as the health of gingival tissues while fitting the prosthesis made out of the impression technique followed. However, this study is only considered for the dies prepared out of the different impression trays.

As far as the results are concerned, single stage impression technique with monophase material using the custom tray appears to be showing minimum discrepancy due to the reasons mentioned. The closer adaptation of the tray makes use of reduced thickness and equal thickness of impression material through out the impression surface. Further the technique used with special tray also prevents excessive pressure applied on the tray as well as material where the impression was made. It is also to be noted that the perforated metal and plastic trays can also be utilized with two-step putty wash impression technique. The results have shown variations with minimum significance compared to the control group. However it is up to the operators' choice at the time of impression making depending on the feasibility, convenience and the comfort of patient to select a tray type or impression material. Further investigations and any other method may be followed in future course in determining the tray selection as well as technique to be employed.

CONCLUSION

The conclusions drawn from the study are:

1. None of the values obtained by measurements of Group II samples coincide with that of the standard group, which are the measurements from the prepared typhodont teeth.

2. The values obtained from the dies made from custom tray with monophase addition silicone material are nearer to the standard.

3. The values obtained from the dies made from triple tray with putty, light- body, one-step putty wash impression technique show maximum variation from the standard.

4. The values obtained from the dies made from metal, plastic stock perforated trays with putty, light-body, two-step putty wash impression technique show moderate deviation from the standard but the values are not as satisfactory as that of custom tray.

5. The order of accuracy of the dies obtained from different impression trays are:

    - Custom tray
    - Metal stock perforated tray
    - Plastic stock perforated tray
    - Triple tray

SUMMARY

A study was been undertaken for determining the accuracy of dies made from different impression trays. In this study, four types of impression trays were used for making impression of prepared typhodont teeth attached to the articulator. The trays were complete-arch stock perforated metal and plastic trays, complete-arch custom tray and triple tray. Addition silicone impression material with different viscosities of putty, light-body and monophase were used according to the type of the tray used. Impressions were made by two-step putty wash impression technique in metal and plastic trays and one-step putty wash impression technique for triple tray. A single mix technique with monophase was followed for custom tray. A total of fourty impressions were made, in which ten impressions were made from each impression tray. Casts were poured with Type IV dental stone.

The dimensions of the resultant dies were measured under travelling microscope. The dimensions of the dies obtained with custom tray were found to be closest to the dimensions of the prepared typhodont teeth, in comparision to the dies, obtained from other trays used in this study. The dimensional accuracy of the dies obtained from addition silicone impression material with stock metal and plastic trays and custom trays, was within acceptable limits, except those obtained with triple tray impressions.

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