EVALUATION OF DIMENSIONAL STABILITY OF FOUR COMMERCIALLY AVAILABLE ADDITION SILICONE INTEROCCLUSAL RECORD MATERIALS - IN VITRO STUDY

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CERTIFICATE

This is to certify that this dissertation titled **"EVALUATION OF DIMENSIONAL STABILITY OF FOUR COMMERCIALLY AVAILABLE ADDITION SILICONE INTEROCCLUSAL RECORD MATERIALS - IN VITRO STUDY"** is a bonafide record of work done by **Dr. RASHMI KUMARI** under my guidance during her postgraduate period between 2008- 2011. This Dissertation is submitted to **THE TAMILNADU Dr. M.G.R. MEDICAL UNIVERSITY**, in Partial fulfilment of requirements for the Degree of **Master of Dental Surgery in Prosthodontics and Crown & Bridge (Branch I).**

It has not been submitted (partial or full) for the award of any other degree or diploma.

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DECLARATION

I, **Dr. Rashmi kumari**, do hereby declare that the dissertation titled **"Evaluation of dimensional stability of four commercially available addition silicone interocclusal record materials- In vitro study"** was done in the Department of Prosthodontics, Tamil Nadu Government Dental College & Hospital, Chennai - 600 003. I have utilized the facilities provided in the Government Dental College for this study in partial fulfillment of the requirements for the degree of **Master of Dental Surgery** in the speciality of **Prosthodontics and Crown & Bridge (Branch I)** during the course period 2008-2011 under the conceptualization and guidance of my dissertation guide, **Dr. *A. Meenakshi,* M.D.S.**

I declare that no part of the dissertation will be utilized for gaining financial assistance for research or other promotions without obtaining prior permission from the Tamil Nadu Government Dental College & Hospital.

I also declare, that no part of this work will be published either in the print or electronic media except with those who have been actively involved in this dissertation work, and I firmly affirm that the right to preserve or publish this work rests solely with the permission of the Principal, Tamil Nadu Government Dental College & Hospital, Chennai 600 003, but with the vested right that I shall be cited as the author(s).

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Contents

INTRODUCTION

Diagnosis and treatment of a patient for prosthetic rehabilitation requires the clinician to fabricate diagnostic casts, as well as master casts, and articulate them on an articulator. For this reason it is necessary to record maxillomandibular relationship accurately and transfer it to the articulator.[1] An interocclusal record is a precise recording of a maxillomandibular position.[2]

The interocclusal records used for the edentulous and dentulous patients must be stable with good strength and able to reproduce the same maxillomandibular relation in the articulator.

Some clinical situation where the operator is not able to provide adequate thickness to this interocclusal record due to reduced inter ridge distance .These clinical situation become a challenging task to the operator and the technician. The need of interocclusal recording material with good strength and dimensional stability will play a major role in these type of clinical situation.

The ideal material-technique combination for making interocclusal records would allow the placement of indirectly fabricated prostheses in the patient's mouth without making any major occlusal adjustment. However, errors are often induced by the biologic characteristics of the stomatognathic system and by the dentist. In addition, inaccuracies of the cast and the properties of the interocclusal recording material may induce an incorrect placement of the mandibular cast in relation to the maxillary cast on an articulator.[3]

Diagnosis and treatment planning procedures may be impaired if casts are fixed in a malrelated position. To prevent clinical error, the procedure used to record and fix interocclusal relations should be performed with the utmost care and understanding.[4]

It has been described in literature that the interocclusal records should have minimum of 3 to 4mm thickness to resist distortion and avoid breakage, but because of reduced inter-ridge distance we were not able to provide 3-4mm thickness. So it becomes mandatory to identify a suitable material to overcome this problem.

Plaster, Modeling compound, Waxes, Acrylic resin and Zinc oxide-eugenol Paste are the materials that have been in use for recording maxillomandibular relations for several years.[1] The introduction of polyether and polyvinylsiloxane interocclusal recording media has made clinicians to think about the choice which material to be used. These elastomeric materials are chemically similar to the impression materials that have been used successfully for many years.[5] Modifications have been made by adding plasticizers and catalysts to the impression materials in order to convert them as interocclusal recording media. Recent years the Addition silicone has gained a good popularity because of its good dimensional stability and strength even in thin sections (i.e)less than 3mm thickness.

On many occasions the articulation of maxillary-mandibular casts may not be done immediately following the clinical procedure. So, the interocclusal records must be dimensionally stable in those situation.

Moreover these records must be dimensionally stable for a given period of time before they are used to mount the casts in the articulator. Apart from dimensional variation the

compressive force is also commonly exerted on the recording material during the articulation procedure which may cause inaccuracies in relating the casts in centric and other excursive position.

Each of these interocclusal recording materials exhibits a degree of deformation when compressed under a load. The deformation may vary depends upon the hardness and the properties of the recording materials used.[7] At the same time the degree of deformation of interocclusal record must be minimal or negligible and should not affect the accuracy of mounting the maxillary-mandibular casts in the articulator.

The present study was undertaken to evaluate the dimensional stability and hardness of four commercially available elastomeric interocclusal recording materials. The null hypothesis of this present study was ,there is no difference in the dimensional stability of all the four commercially available addition silicone bite registration materials.

AIMS AND OBJECTIVES

AIM:

To evaluate the dimensional stability of four different commercially available addition silicone interocclusal recording materials

OBJECTIVES OF THIS STUDY :

1. To evaluate the dimensional stability of four different commercially available polyvinyl siloxane inter-occlusal recording materials.
2. To compare the dimensional variations occurred in four different commercially available polyvinyl siloxane inter-occlusal recording materials.
3. To evaluate the hardness of four different commercially available polyvinyl siloxane inter-occlusal recording materials.

REVIEW OF LITERATURE

Millstein PL, Kronman JH, Clark RE (1971)[12] established a method whereby various materials used to register interocclusal recordings may be tested, measured and compared. Two brands of wax (S.S White pink base plate wax and Hygienic extra tough baseplate wax) were tested in storage environments of air, tap water, and cold water at four storage time intervals of 2, 6, 24 and 48 hours under seating pressures ranging from no pressure to heavy pressure. Using a factorial experimental design for the investigation of the main and interactive effects of these variables, they observed that complete closure under a pressure comparable to those of a clinical setting (172 p.s.i) was not achieved when wax was present. Storage of the wax registration in cold water showed the greatest change, while air cooling showed the least change. There was a considerable vertical and slight horizontal change when the model was gently placed into a previously formed wax registration.

Upon application of pressure, there was a reduction of vertical change followed by a proportional increase in horizontal displacement. The accuracy of an interocclusal

recording wax must be considered in terms of the many variables responsible for dimensional change. Even under the highly controlled conditions of the study, exact reproduction of the original wax recordings was never achieved.

Wirth CG, Aplin AW (1971)[13] described an improved centric interocclusal record by using No. 7 Ash's metal, a soft pliable metal that can easily be adapted to the wax reinforced arch wafer (Aluwax cloth form). The desirable characteristics found in this record were

The record had dimensional stability at temperatures tolerated in the mouth provided reasonable care in handling was used.

1. It was an accurate record of centric jaw relation.
2. The record had complete flexibility for modification, verification and reuse as an expanding range of clinical needs dictates.
3. It had the capacity for careful, short term storage on an accurate cast.
4. It had the capacity to verify the accuracy of casts.

The record had also few undesirable qualities such as, restricting tongue pressure, which displaced the record into the palatal vault. Consequently tooth indentations were not

stretched lingually, making subsequent interpretation of seating on the teeth more difficult.

Millstein PL, Clark RE, Kronman JH (1973)[11] described the effects of initial heating temperatures, initial closing pressures, storage environments, and storage time intervals on the accuracy of recordings made with single and double - thickness samples of S.S White pink base plate wax and Hygienic extra tough base plate wax. A factorial experimental design for the investigation of the main and interactive effects of these variables were used and they observed that complete closure into the waxes was not achievable under pressures comparable to those of a clinical setting.

Storage of wax records in water produced the greatest change while air cooling produced the least. Considerable vertical and rotational changes occurred when the test model was replaced in a previously formed wax registration. Exact reproduction of the original wax recordings was never achieved.

Millstein PL, Clark RE, Myerson RL (1975)[2] related the accuracy of silicone body interocclusal records to their

associated weight loss due to volatiles. The results showed that a direct relationship existed between dimensional change and percent of weight loss and minimizing the weight loss of standing silicone impressions enhanced their accuracy.

Balthazar-Hart Y et al (1981)[15] examined the accuracy and dimensional stability of four interocclusal recording materials, zinc oxide - eugenol paste, eugenol - free - zinc oxide paste, a silicone putty and a polyether jaw relation registration material, in a controlled laboratory environment over 1-week period. The results showed that the eugenol - free zinc oxide paste was the only material which exhibited no statistically significant difference between the die scribes and those of the sample. The setting reaction of the eugenol - free - zinc oxide paste was a saponification reaction, resulting in the production of an insoluble soap. With polyether, silicone putty and zinc oxide - eugenol paste, there was a statistical difference between the die and the respective samples at the immediate reading and throughout the experiment. Polyether showed the least difference, and zinc oxide - eugenol paste the greatest.

Millstein PL (1981)[16] described a simplified method for testing the accuracy of interocclusal recording media that is readily accomplished in the dental office by using a semiadjustable articulator with a fixed hinge axis, mounting stone, a set of stone casts, a split cast mounting system, and varied recording materials. It was recognized that this technique was qualitative and that, without the use of an incubator, setting times for the materials may be altered. Despite the limitations, the method offered the clinician an inexpensive way to obtain information concerning the accuracy and related handling properties of interocclusal recording materials.

Sindledecker L (1981)[17] measured the effect of three different interocclusal centric relation records (wax, zinc oxide - eugenol paste and acrylic resin) on the pantographic representation of centric relation. He found that centric relation is recorded within an area, rather than as a precise point. The range of this area depends on the materials used ; Wax 0.21 mm; zinc oxide - eugenol paste 0.12 mm, and acrylic resin 0.11 mm. Wax was found to be the least reliable material tested and the least accurate for recording centric relation.

Mullick SC, Stackhouse JA, Vincent GR (1981)[18] determined the vertical assembly error in mounting dentulous casts on an articulator as affected by three parameters: the materials, the distance between the prepared and the opposing teeth, and the operator variability. The results showed that Aluwax was the most variable and least reliable of all materials. Superbite (zinc oxide - eugenol pate) consistenly resulted in open cast relationships. The five elastomers (Input silicone putty, Coltoflax silicone putty, Reprosil silicone putty, Flexane silicone putty and Ramitec polyether) resulted in the least amount of errors. The two different thicknesses of elastomeric records resulted in statistically significant different mounting discrepancies. On an average, an inexperienced student performed as well as the two experienced dentists.

Millstein PL, Clark RE (1981)[19] tested the accuracy of silicone body(Optosil and Optosil Hard) and self curing resin (Myoprint and Relate) interocclusal records to their respective and associated weight loss due to volatiles. They found that the silicone body interocclusal records were shown to be more reliable than self curing resin records. However, all of the materials tested exhibited some degree of weight loss and dimensional change over time.

Millstein PL, Clark RE (1983)[20] determined the effects of initial heating, intraoral withdrawal, storage environments, storage times, and seating forces on the accuracy of laminated and nonlaminated, metalized and nonmetalized wax interocclusal wafers. The results showed that laminated wax interocclusal wafers were highly technique sensitive and variations in treatment and handling procedures are important factors in assessing their accuracy. Wafers that were both laminated and metalized were found to the most accurate and dimensionally stable. However, exact reproductions of the original wax recordings were unlikely and was not achieved.

Christensen LC (1983)[21] described a technique that used an existing centric stop to relate the working casts for a fixed prosthodontic unit. This technique reduced the possibility of dimensional changes and inaccurate cast relationships often observed with conventional materials.

Fattore L et al (1984)[22] determined the clinical accuracy of waxes, zinc oxide - eugenol paste, and polyether materials for recording interarch relationships. The results indicated that polyether interocclusal recording medium without a carrier was the most accurate. Polyether and zinc oxide - eugenol pastes

with carriers were the next most accurate recording mediums, but they required a disciplined technique. Recording waxes were consistenly unreliable. Distortion occurred more frequently in a vertical direction, followed by an anteroposterior direction.

Lassila V, McCabe JF (1985)[23] studied the setting characteristics, dimensional stability, compressibility and elasticity of polyether (Ramitec), condensation silicone putty (Optosil plus), eugenol - free zinc oxide paste (Nogenol) and zinc oxide and eugenol paste(Kerr bite registration paste) interocclusal recording materials. The results indicated that the elastomers and eugenol free zinc oxide paste had a brief working time. The increase in viscosity for zinc oxide and eugenol paste was slower than that of other materials. The temperature of the mouth markedly accelerated setting. Elastomers and eugenol - free zinc oxide material showed marked shrinkage during setting. Dimensional changes of elastomers can be reduced by storage in a sealed, dry container. Elastomeric materials acquired relatively good elastic properties in approximately 30 minutes.

Millstein PL (1985)[4] determined the effects on cast position with the use of different types of wax interocclusal records (D.P metalized interocclusal wax and Kerr white laminated interocclusal wafers) combined with the use of the dental plaster to mount the casts. The results indicated that a difference in the type of wax record was not a significant factor in cast fixation.

Hansen PA, Huff TL, Trebilcock CE (1985)[24] described a new device for analyzing centric interocclusal records that is easily adapted to a Whip-Mix articulator using items available in the dental supply catalogs and flags readily cast in any dental laboratory. This device determined the accuracy of centric interocclusal records by permitting evaluation of the position of the mandible in relation to the maxilla in three planes. The direction of the error in record making can be determined, the accuracy of the hinge axis location can be evaluated, the changes in the hinge axis during temporomandibular joint resolution can be recorded, and the difference in materials used to make interocclusal records can be evaluated. In addition, the analyzer can be used as a teaching aid to analyze operator variability in making centric relation records. This analyzing device was able to compare centric

interocclusal records only, and this will not guarantee that the same recording was not duplicated. However the probability of making accurate records was vastly increased when this procedure was followed.

Lassila V (1986)[25] compared the clinically important properties such as resistance to closure, thermal expansion, setting, and storage under various conditions of five types of recording materials, polyether (Ramitec), zinc oxide and eugenol paste (Kerr paste), eugenol - free zinc oxide paste (Nogenol), acrylic resin (Paladur) and baseplate wax (Astynax). The results indicated that the initial resistance of interocclusal recording materials to closure changed from 0.5 N to 13.8 N, and a rapid rise in the working time was seen in all elastomers. The resistance exhibited by wax at 60^0C was about 7N. The volumetric contraction of elastomers in polymerization was clinically slight. The dimensional stability of rigid materials, acrylic resin, and zinc oxide pastes was good. Elastomers maintained their reliability for a relatively long time when stored in tightly sealed plastic bag.

Assif D, Himel R, Grajower Y (1988)[26] described the use of an electromechanical device to measure changes in the

vertical dimension and the accuracy of various materials during the transfer of the interocclusal records to an articulator. Polyether (Ramitec) was the most precise material tested. Its accuracy was in 20 to 30 μm range. The accuracy of the remaining materials from displacement was, in descending order, Dura - Lay acrylic resin, Basewax (Dental modelling wax) and Basewax plus zinc oxide (Temp-Bond). The electromechanical system was tested and verified as accurate, reliable, convenient and easy to use. This system also possessed the potential for laboratory use and simultaneous measurement of deviations in all spatial dimensions, while overcoming technical difficulties to perform direct, intraoral recordings.

Muller J et al (1990)[27] determined the three – dimensional errors in mounting dentulous casts on an articulator, as affected by the interocclusal record materials [impression plaster, Palavit G self-curing resin, Palavit G resin combined with Temp-Bond zinc oxide-eugenol paste, Beauty pink wax, Beauty pink wax combined with Temp Bond material, impression compound, impression compound combined with Temp Bond material, and polyether (Ramitec)], storage time of the registrations (30min, 6hrs, 24hrs) and the precision of the teeth impressions. The result showed that the interocclusal

recording materials induced asymmetric three - dimensional deviations of the condyles because of different tooth preparations on contra lateral sides of the test model. The least three - dimensional changes after 30 minutes of storage were recorded by plaster, polyether, and corrected beauty pink wax. The plaster was dimensionally stable for more than 24 hours. Registrations made with polyether must be used within 6 hours for reliability. Beauty pink wax wafers required correction with zinc oxide - eugenol paste and usage within the first 30 minutes.

Muller J et al (1990)[28] compared the three - dimensional errors during the mounting of dentulous casts on an articulator affected by four parameters: the registration materials [impression plaster, impression compound (Kerr), Kerr compound combined with zinc oxide - eugenol paste (Temp Bond) and Beauty pink wax], accuracy of the working casts, storage time of the registrations (30 min 6 hrs, 24 hrs,) and the precision of the teeth impressions. The results showed that the accuracy of the transferred jaw relations was critically influenced by the derived casts. The greatest three dimensional deviations were evident in plaster recordings. Impression compound was the most accurate of the materials tested, but

deviations to 300 µm needed review. None of the materials tested or combinations of two materials tested were consistently accurate even after limited storage of 30 minutes.

Muller J et al (1990)[29] compared the three - dimensional errors during the mounting of dentulous casts on an articulator affected by four parameters, the registration materials [polyether (Ramitec), self curing acrylic resin (Palavit G), Palavit G resin with zinc oxide-eugenol paste (Temp Bond) and Beauty pink wax with Temp Bond], accuracy of the working casts, storage time of the registrations (30 min, 6 hrs, 24 hrs), and the precision of the teeth impressions. The results showed that all of the materials tested induced asymmetric three dimensional deviations for the simulated patient and the derived stone casts. The deviations of the derived casts were more pronounced than the deviations of the original models. The critical influence of the derived casts must be considered in evaluating the accuracy of any recording material. None of the materials tested or combinations of two materials tested were consistently accurate even after limited storage of 30 minutes. The smallest deviations were recorded by the polyether interocclusal material.

Warren K, Capp N (1990)[30] reviewed the principles and techniques for making interocclusal records for mounting working casts. They recommended that before undertaking restorative therapy, any dysfunction should be eliminated. The use of an anterior positioning device and recording at the intended vertical dimension of occlusion was advised. A fluid record medium and bimanual mandibular guidance with light patient closure should be used. Shimstock should be used to verify cast mounting and, for complex therapy, a separate interocclusal registration appointment was strongly recommended.

Muller J et al (1991)[3] determined the vertical errors in mounting dentulous casts on an articulator as affected by three parameters, the registration materials [impression plaster, impression compound (Kerr), Kerr compound combined with zinc oxide - eugenol paste (Temp Bond), polyether (Ramitec), Beauty pink wax plus Temp Bond material], the storage time of the records (30 min, 6 hrs and 24 hrs), and the points from which the measurements were made (anterior, premolar, molar and condyle). The results indicated that measurements at the condyles cannot detect deviations in the vertical direction induced at the occlusal surface. Detection of changes of vertical

dimension should be done at more than one measuring point on the occlusal surface .None of the materials tested gave reliable results at all occlusal surfaces. The lowest vertical deviations at the occlusal surfaces were induced by the corrected wax wafer after a short storage for 30 minutes. Polyether was the second most accurate material and the only one with clinically sufficient dimensional stability up to 24 hours.

Walls AWG, Wassell RW, Steele JG (1991)[31] compared the accuracy of mounting casts in the intercuspal position using hand articulation, and using a low viscosity polyether registration material (Ramitec) by employing a single blind, cross - over study design. The results showed that hand articulation of casts was a more reliable method of obtaining mounted casts in the intercuspal position than the use of a polyether registration material, provided that the anatomical relationship of the teeth permit the location of intercuspal position by visual and tactile methods. In cases where the anatomical relationship was difficult to locate by these means, an interocclusal registration is of some benefit. Neither method was capable of producing 100% accuracy in the location of the opposing casts.

Urstein M et al (1991)[32] compared the accuracy of three recording media (impression plaster, dental baseplate wax and duralay acrylic resin) used to relate artificial stone casts at the maximum intercuspation (IC) and retruded contact (RC) position with the use of the Lucia programming jig. The results showed that, where a complete or nearly complete dentition is present and the occlusion is stable, the most accurate method of articulating study casts at the IC position was by hand articulation. Plaster was a more accurate interarch recording material at the IC and RC positions than either wax or duralay resin. The wax record was slightly more accurate than the duralay resin record at IC and RC positions. It was not possible to reproduce exactly the same intercast relationship when different materials were used to record interjaw relationship at the IC and RC positions.

Freilich MA, Altieri JV, Wahle JJ (1992)[32] defined and reviewed principles such as the tripod of vertical support and adequate horizontal stability, which enabled opposing dental casts to be held together in a stable and reproducible manner at the time the mandibular cast is mounted to the articulator. During the restoration of the dentate or partially dentate patient, where restoration is to be coincident with pretreatment

maximum intercuspation, the goal of the interocclusal record is to provide stability or support for the casts. The types of interocclusal records were organized into two categories, a record made in the presence of an existing tripod and a record that must create a tripod based upon the remaining vertical support and horizontal stability of the dentition.

Breeding LC, Dixon DL (1992)[6] compared the deformation of designated thicknesses (2mm, 5mm, 10mm and 20mm) of three vinyl polysiloxane interocclusal recording materials (Blue- Mousse, Stat BR, Regisil) and one polyether interocclusal recording material (Ramitec) when subjected to a constant compressive load of 25N. Compressive distortions of clinical significance were recorded for all the materials with various thicknesses. The Blue-Mousse vinyl polysiloxane registration material exhibited the greatest resistance to compression for the designated thicknesses, and these resistance values were significantly lower than those of the other recording materials with thicknesses of 5, 10 and 20mm.

Breeding LC, Dixon DL, Kinderknecht KE (1994)[34] developed a methodology to measure the three-dimensional accuracy of interocclusal recording materials, at the prepared

tooth level, with a computerized recording device and used this methodology to compare the accuracy of three interocclusal recording materials (thermoplastic resin, acrylic resin and vinyl polysiloxane).The investigation showed that the axiotron computer provided a simple and quick method to evaluate the accuracy of mounted working casts. The thermoplastic resin-generated mounting errors were significantly greater than those generated by the acrylic resin and vinyl polysiloxane materials.

Millstein PL, Hsu CC (1994)[35] evaluated the dimensional stability and associated weight change of five polyvinyl siloxane interocclusal recording materials (Blue Velvet, Coe Bite Crème, Blue-Mousse, Memosil CD, Correct Bite) and one polyether interocclusal recording material (Ramitec). The results showed that all brands were found to be accurate and dimensionally stable over a 48-hr time period. Negligible weight change did not affect dimensional stability.

Pence BA, Baum L, Li T (1994)[36] described the art of utilizing impression plaster for bite registration and suggested certain conditions where its use is indicated. In partially edentulous mouths, however, where some anterior vertical stops remain but where long ridge areas extend distalward;

impression plaster is the material of choice. Edentulous areas may be unilateral or bilateral or they may be opposing each other or opposing natural teeth. The rationale in these instances was to establish vertical dimension and anterior stops through the natural dentition, then record with plaster the related ridge areas.

Tripodakis AP, Vergos VK, Tsoutsos AG (1997)[37] determined the accuracy of the fit of interocclusal records on the working casts and compared the accuracy between a classic and modified recording technique. A metallic apparatus was used to represent the opposing arches, its epoxy resin duplicate represented the working casts and polyether was used as the recording material. In the modified recording technique, after polymerization if the record material stayed in contact with one jaw, an irreversible hydrocolloid impression was made that incorporated the record. A cast in direct contact with the record was then poured in this impression. The results showed that the observed vertical discrepancies in recording maxillomandibular relations were caused by the interference of the interocclusal records and repositioning or transferring the records aggravated these inaccuracies. The modified technique that limited

transferring of the record only on the working cast reduced the inaccuracies but did not completely eliminate them.

Gregory G et al (1999)[38] described the construction of a nostril splint made from polyvinylsiloxane bite registration material (President Jet Bite). This bio-compatible material supported a large chondrocutaneous auricular graft during early healing. The splint immobilized and maintained the shape of the alar rim and was further used nightly during the expected period of wound contraction.

Campos AA, Nathanson D (1999)[8] examined the compressibility of 2 addition silicones (Blue-Mousse and 3M Fast Set Bite Registration Material) as interocclusal record materials, analyzing the changes of maxillomandibular relations at the condyle region when different compressive forces were used to stabilize articulated casts. They also analyzed the changes in recorded maxillomandibular relations during the mounting procedure with polyvinyl siloxane interocclusal recording materials, as a consequence of the compressibility of the material. They concluded that Blue-Mousse interocclusal record material had a greater dimensional stability when compressive forces were applied from 0 to 6 Kgf when

compared with 3M Fast Set Bite Registration material. There was no significant difference in the maxillomandibular positional changes when 1Kgf was used to stabilize casts articulated with Blue-Mousse, 3M Fast Set Bite Registration material, or without interocclusal recordings.

Ockert-Eriksson G et al (2000)[39] examined if accuracy and dimensional stability of vinyl polysiloxanes and irreversible hydrocolloids stabilized by a tray used for fixed prosthodontics, removable partial, and complete denture cases were comparable to those of waxes and record rims and if storage periods of 24 hours or 6 days affected dimensional stability by taking direct measurements in a controlled laboratory environment. The results of the study showed that the accuracy of vinyl polysiloxanes and irreversible hydrocolloids reinforced by a tray were superior to that of the record rims for complete dentures and among the most accurate for removable partial dentures. For fixed prosthodontics, however, reinforcement was not necessary.

Eriksson A et al (2002)[40] assessed the reproducibility of the interocclusal records in three dimensions using mounted casts and they compared the reproducibility of conventional

recording materials, waxes and record rims with impression materials stabilized by a tray. They also examined how mandibular positions (intercuspal position or retruded contact position), materials used and clinical variation influenced the precision regarding reproducibility, when mounting casts. They found that clinical variation seem to dominate the variation in positions of mounting casts when making interocclusal records. Concerning the reproducibility, the results showed that impression materials stabilized by a tray did not differ significantly from waxes and record rims. Therefore the stabilized impression materials were an alternative that also gave additional advantages like reduction of appointments as well as superior accuracy.

Vergos VK, Tripodokis AD (2003)[41] evaluated four recording materials (polyether, polyvinyl siloxane, acrylic resin, and wax) for their ability to accurately record, maintain and reproduce the vertical interocclusal relationship. A metallic apparatus was used to represent the opposing arches; its epoxy resin duplicate represented the working casts. The vertical discrepancies produced because of the presence of the records were measured both after repositioning them on the metal apparatus and after transferring them onto the casts. They

concluded that simple closure through an interocclusal record produced vertical discrepancies in the procedure of recording maxillomandibular relationships. These inaccuracies were aggravated when transferring the record onto casts. The order in producing minimum vertical errors during simple closure related to different materials were PVS, polyether, acrylic resin, and wax, in a magnitude of less than 0.1 mm, which was estimated to be clinically insignificant. Record of all materials tested, when transferred on casts, produced equal inaccuracies of approximately 0.5 mm, which was estimated to be clinically significant.

Curtis SR (2003)[42] described the use of a vacuum - formed matrix to make an interocclusal record. After tooth preparation was complete, the matrix was seated onto the opposing teeth and adjusted so that it was out of occlusion. Then autopolymerizing acrylic resin was added to the surface of the matrix to record a cusp of the preparation in maximum intercuspation or centric occlusion. The advantage of this technique was that the area recorded by the acrylic resin was small, making it relatively easy to ensure an accurate and passive fit onto the master cast.

Michalakis KX et al (2004)[1] evaluated the consistency prior to the setting of one polyether (Ramitec) and four polyvinylsiloxane interocclusal recording materials (3M, Stat - BR, Blu - Mousse and Regisil 2X) in comparison with a wax (Alminax) and a zinc oxide - eugenol paste (ZOE-SSW). This property is related to the viscosity, as well as to the working and setting time. The result showed that zinc oxide - eugenol paste exhibited the greatest flow characteristics of all materials tested. Polyether (Ramitec) exhibited greater flow characteristics than the addition silicones. Regisil 2X and Stat BR exhibited greater flow characteristics than the remainder of the addition silicone materials. 3M exhibited the least flow characteristics of all interocclusal recording media tested.

Hsu YT (2004)[40] presented a simple technique utilizing silicone occlusal registration material (Regisil) to evaluate occlusal clearance. This technique may be used for evaluation of a crown preparation, as well as rest seat preparation for a removable partial denture.

Michalakis KX et al (2004)[5] evaluated the linear dimensional change and accompanying weight changes of one polyether (Ramitec) and four polyvinylsiloxane interocclusal

recording materials (3M, Stat-BR, Blu - Mousse and Regisil 2X) in comparison with a wax (Alminax) and a zinc oxide-eugenol paste (ZOE-SSW) at 0, 1, 24, 48, and 72 hours. The results showed that Ramitec (polyether) presented the smallest linear changes of all materials tested, at all time intervals. Addition reaction silicones presented statistically significant differences in recordings of linear changes among them, at the 1st and 24th hour. However, they did not present statistically significant differences after the 48th hour. Addition silicones, as a group, presented smaller linear changes when compared to wax and zinc-oxide eugenol paste. Linear changes did not seem to be correlated with weight changes.

Petridis HP (2004)[43] described a technique that utilized plastic burnout abutments for recording maxillomandibular relationship with vinyl polysiloxane (President Jet Bite) interocclusal recording material at the same appointment that the definitive impression is made of the implants. This technique provides stable interocclusal records for implant patients who present with a unilateral or bilateral distal extension situation.

Michalakis KX et al (2004)[5] evaluated the resistance to compression after setting of one polyether (Ramitec) and four polyvinylsiloxane interocclusal recording materials (Blue - Mousse, Stat - BR, 3M and Regisil 2X) in comparison with a wax (Alminax) and a zinc oxide - eugenol pate (ZOE-SSW). Testing of the resistance to compression after setting was performed following a modification of the method described in ADA specification No. 19 for the elastomeric impression materials-one cylindrical stainless steel mold with an internal diameter of 20 mm and a height of 20 mm was constructed for the fabrication of the samples. Two subsequent loads, one of 100 g/cm^2 and a second of 1000 g/cm^2 were exerted on each sample.

The deformation of each sample was calculated using a vertical traveling micrometer microscope. Polyvinylsiloxane Blue Mousse displayed the greatest resistance to compression, when compared to other elastomers, a zinc oxide-eugenol paste, and a wax. The material with the least resistance to compression after setting was zinc oxide eugenol paste followed by Regisil 2X polyvinyl siloxane.

Savabi O, Nejatidanesh F (2004)[44] described a method for interocclusal registration with the impression copings for a fixed implant - supported prosthesis using a putty type vinyl polysiloxane impression material (Speedex; Coltene AG). Although this technique was presented using ITI Dental implant system, the technique may be modified and used with other implant systems, when there are definitive occlusal contacts between opposing teeth.

Maj P Dua,HS Sandhu[2007][7] Described the method of the transfer of interocclusal records from patient's mouth to semiadjustablearticulators using different kinds of recording media. Any inaccuracy in these interocclusal records leads to occlusal errors in the final prosthesis. This study was conducted to evaluate the dimensional changes occurring in the interocclusalrecording material over a given period of time and the material's resistance to compression during the cast mounting on the articulator.

K.Karthikeyan,H.Annapurani[2008][45] evaluated and compare the dimensional stability of addition silicone, zinc oxide eugenol, and wax at various time interval using a mold of ADA specification no.19 .they found addition silicone, zinc

oxideeugenol,wax are more dimensionally stable respectively. They found dimensional stability is influenced by both material and time factor.

Chun JH, Pae A, Kim SH.Dent Mater [2009][10] investigate the polymerization shrinkage behavior and to measure the polymerization shrinkage-strain of interocclusal recording materials. The materials investigated in this study were five polyvinylsiloxane (Imprint Bite, Silagum Auto mix Bite, OBiteBlu-Mousse Classic and Exabite II), one polyether (Ramitec) and one dimethacrylatebased (Luxabite) materials. The polymerization shrinkage values of ten specimens for each material were measured by the Bonded-disk method at1, 3, 5, 7 and 10 min after mixing at 37°C. The amount of shrinkage-strain (%) was derived and all data were statistically analyzed by one-way ANOVA and the multiple comparison Scheffé test (=0.05). and found the shrinkage-strain values (0.18 ± 0.03 – 0.16 ± 0.03%) of O-Bite at 5, 7 and 10 min were significantly lower than the other materials, but Luxabite exhibited the highest values(3.10 ± 0.17 – 3.30 ± 0.16%).

MATERIALS AND METHODS

The present in vitro study was conducted to evaluate the dimensional stability and hardness of four types of commercially available addition silicone interocclussal recording materials at various time intervals.

MATERIALS USED IN THIS STUDY:

Four commercially available addition silicones bite registration materials

Sl.no	Materials	Manufacture
1	O bite	DMG chem. Pharm, Germany
2	Jet bite	Coltene whaledent Switzerland
3	CAD bite	Virtual Ivoclar vivadent,USA
4	ExabiteII	GC ,USA

EQUIPMENTS USED IN THIS STUDY:

1. Optical Microscope with Micrometer
2. Thermostat controlled water bath unit.

INSTRUMENTS USED IN THIS STUDY:

1. Stainless Steel Die.
2. Glass Plate.

3. Polyethylene sheet.
4. Stop Clock.
5. 5ml Glass syringe.
6. Auto mixing dispensing gun.
7. Scalpel and Blade.
8. 500 gm weighing stone.
9. Spatula and glass slab.
10. Digital VernierCaliper.

GROUPING OF SAMPLES

This study is categorized based on the different types of commercially available addition silicone inter-occlusal recording materials. And classified into four groups of 5 specimens each. So, a total of 20 specimens were prepared.

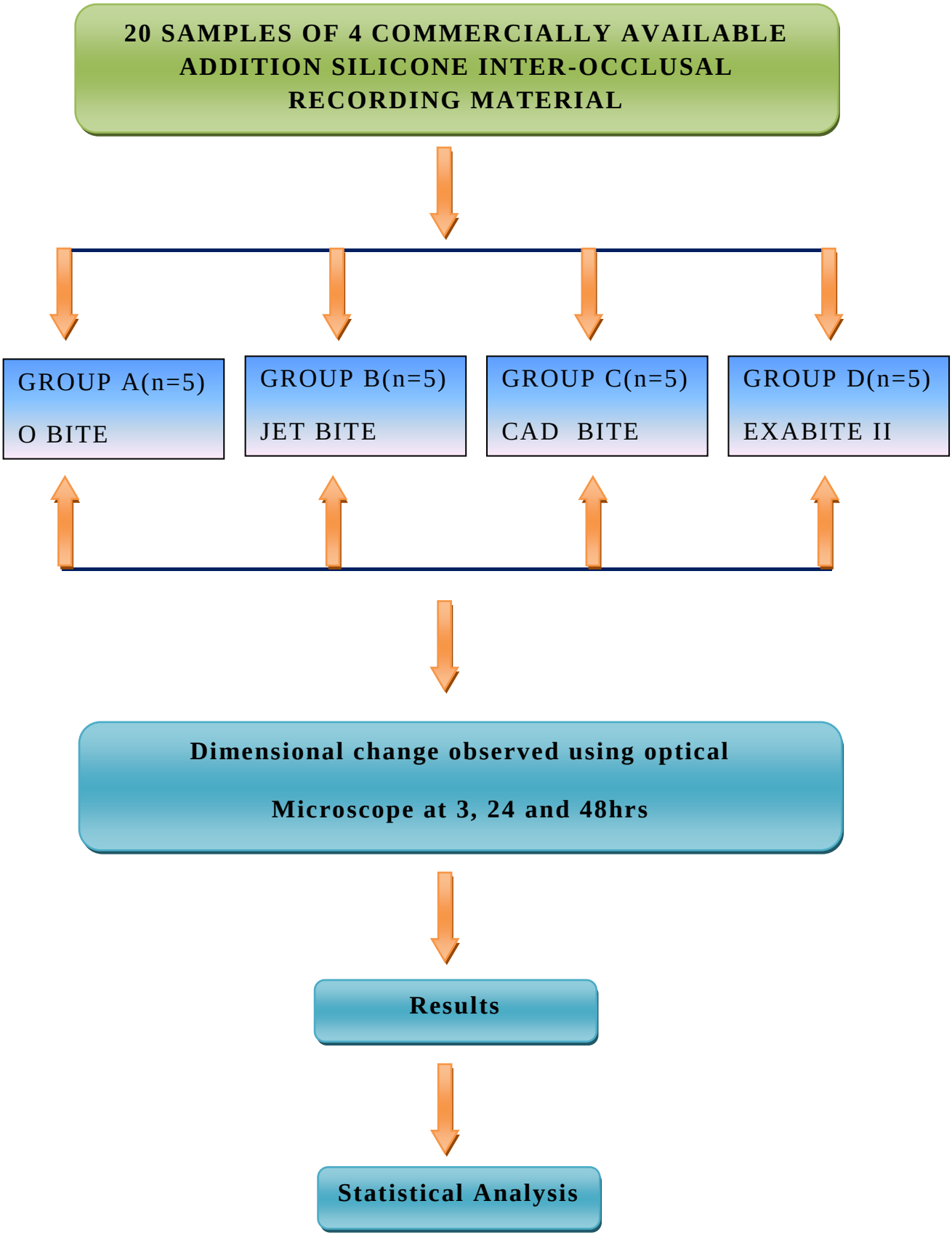
Group A: 5 Samples of O bite addition silicone inter-occlusal recording material

Group B: 5 Samples of Jet bite addition silicone inter-occlusal recording material

Group C: 5 Samples of CAD bite addition silicone inter-occlusal recording material

Group D: 5 Samples of Exabite II additionasilicone inter-occlusal recording material

FLOW CHART


20 SAMPLES OF 4 COMMERCIALLY AVAILABLE ADDITION SILICONE INTER-OCCLUSAL RECORDING MATERIAL
GROUP A(n=5)
O BITE
GROUP B(n=5)
JET BITE
GROUP C(n=5)
CAD BITE
GROUP D(n=5)
EXABITE II
Dimensional change observed using optical
Microscope at 3, 24 and 48hrs
Results
Statistical Analysis

METHODOLOGY

1. Fabrication of metal master die
2. Fabrication of test specimens
3. Measurement of samples
4. Evaluation of dimensional changes
5. Statistical Analysis

1. FABRICATION OF THE METAL MASTER DIE

A stainless steel master die was fabricated similar to ADA specification no 19**.** The master die consists of a ruled block and a mold ring.

Dimension of the metal master die:

Ruled Block

Height –31mm

Width – 38mm

A 3mm height and 29.97 ± 0.01 mm diameter step has been made on one side of the die to which the metallic mold ring fits. The die consist of three parallel lines A, B, C which are spaced equally by 2.5 mm from each other.

Mold Ring

Outer ring diameter - 38mm

Inner ring diameter - 30mm

Height - 6mm

2. FABRICATION OF THE TEST SPECIMENS

The individual Materials were manipulated according to manufacturer's instructions. Materials that were supplied in auto mixing cartridges were dispensed through the cartridges.

After homogenous mixing, the materials were carried to the die. The die was inverted on to a 4X4 inch square glass plate covered with polyethylene sheet. Hand pressure was applied for 5seconds to initially express the materials; this was followed by application of a 500gm weight to further eliminate excess materials.

The mold, the stainless steel die and the weight were submerged in a $36 \pm 1^{0}C$ water bath to simulate oral condition.

Each assembly remained in the bath for the manufacturer's suggested setting time plus an additional 3 minutes to ensure polymerization of material. Upon removal

from the water bath, the mold assembly was removed from the stainless steel die and all the excess material (Flash) was trimmed by using a Bard Parker knife. The material was separated from the mold, the resulting specimens were in the form of a disc measuring 3mm in thickness and 3 cm in diameter with 3 parallel lines on the surface. Three lines were named as A, B and C and these lines were 2.5mm apart from each other.

3. MEASUREMENT OF THE TEST SAMPLES

The distance between the parallel lines A and C was measured utilizing optical microscope with a provision of micrometer. The magnification used for the measurement was 10 X.

The distance between the two parallel reference lines A and C was measured at five fixed points. These reference points were scribed in the metallic die and were copied in the samples during its fabrication.

The mean of the five readings was used for calculation in each sample. Readings was recorded for all the five samples of each group at an interval of 3 hr, 24hrs, and 48 hrs.

The mean measurement of the distance AC in each sample was compared to the corresponding measurement of 5000.200 micron meter in the standard stainless steel die measured under the same optical microscope.

4. EVALUATION OF DIMENSIONAL CHANGE

The change in the Dimension is calculated by using the formula

$$\text{Dimensional change \%} = \frac{(X-Y)}{X} \times 100$$

Where, X is the standard measurement (μm) of AC in the Die.

Y is the observed measurement (μm) of AC in the sample.

5. STASTICAL ANALYSIS

Statistical analysis was performed using analysis of variance (ANOVA) with repeated measures tests for comparisons among groups at the .01 level of significance.

Poly vinyl siloxane Bite registration material

O bite

jet bite

ExabiteII

CADbite

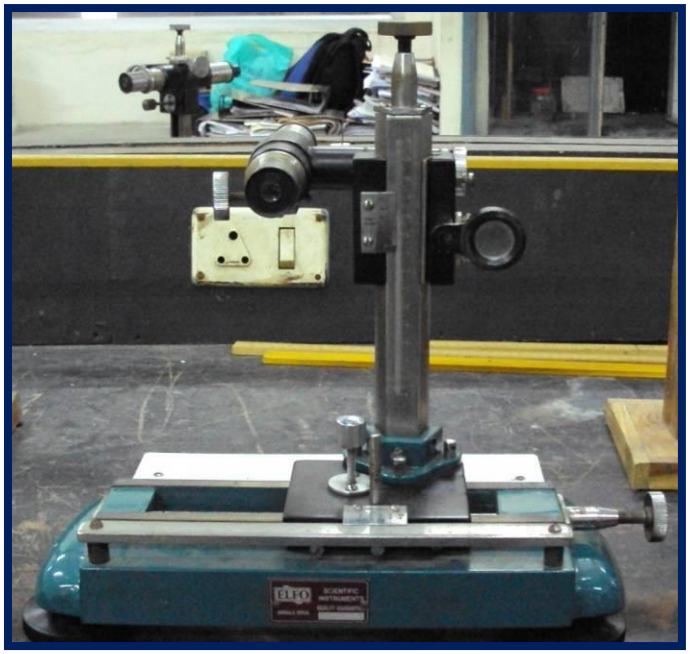
Armamentarium

Stainless steel Die

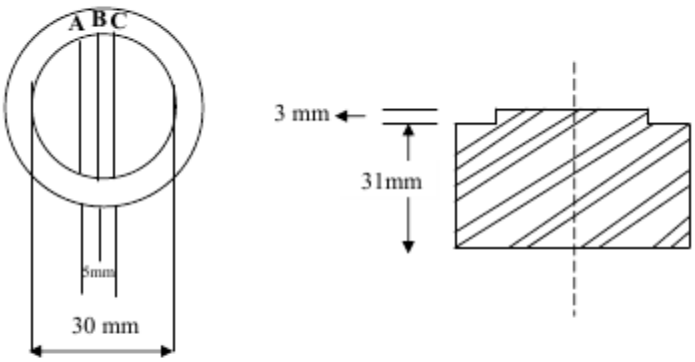
Thermostat and controlled water bath

Durometer

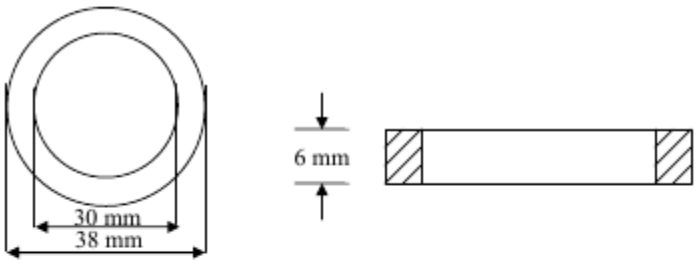
Optical microscope



20 samples

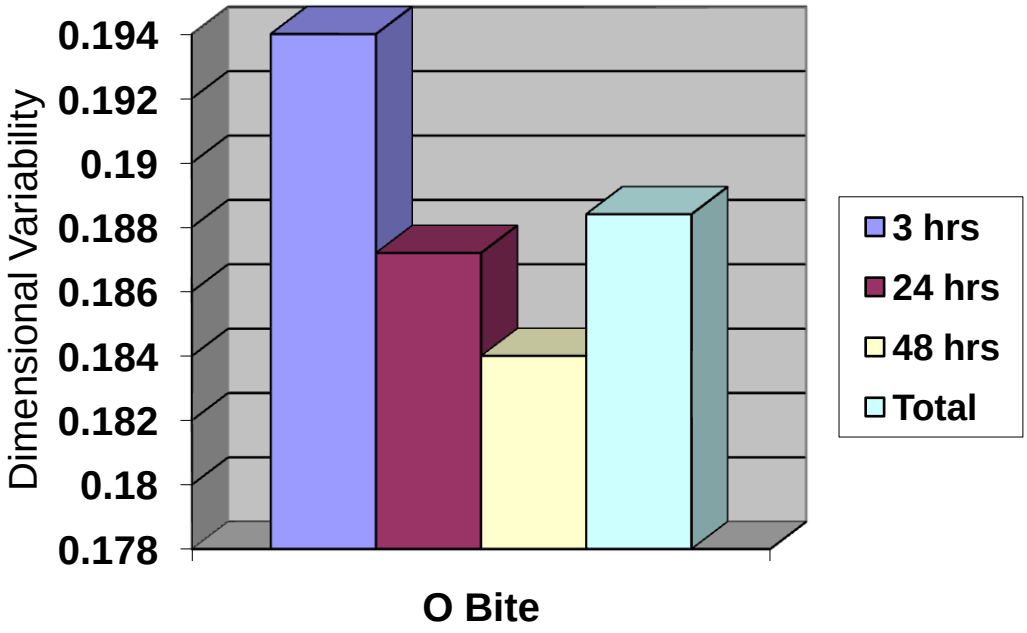


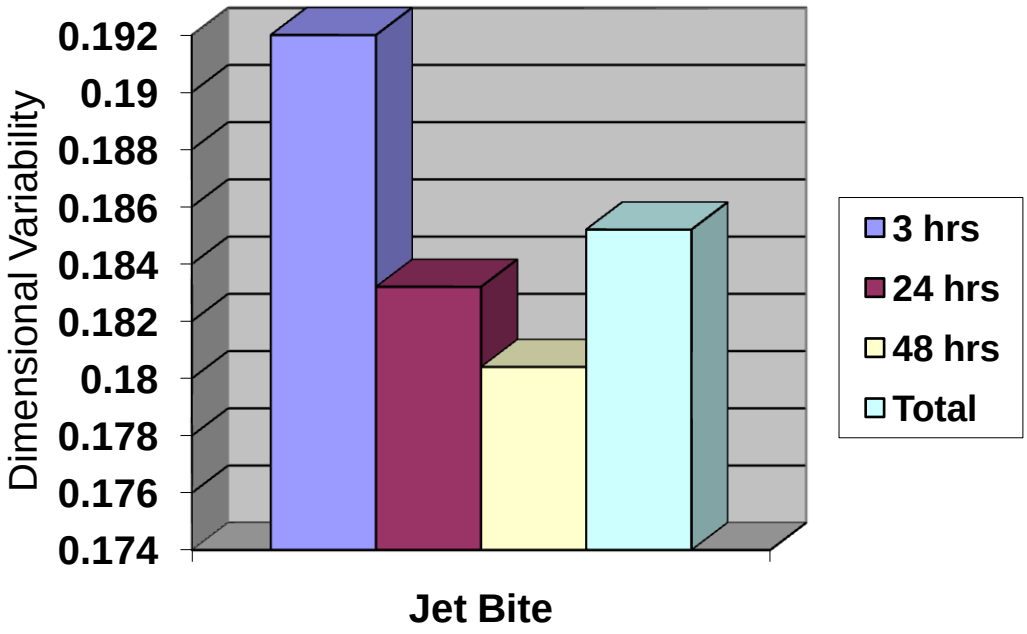
a) Ruled Block **b) Cross Section of the Ruled Block**

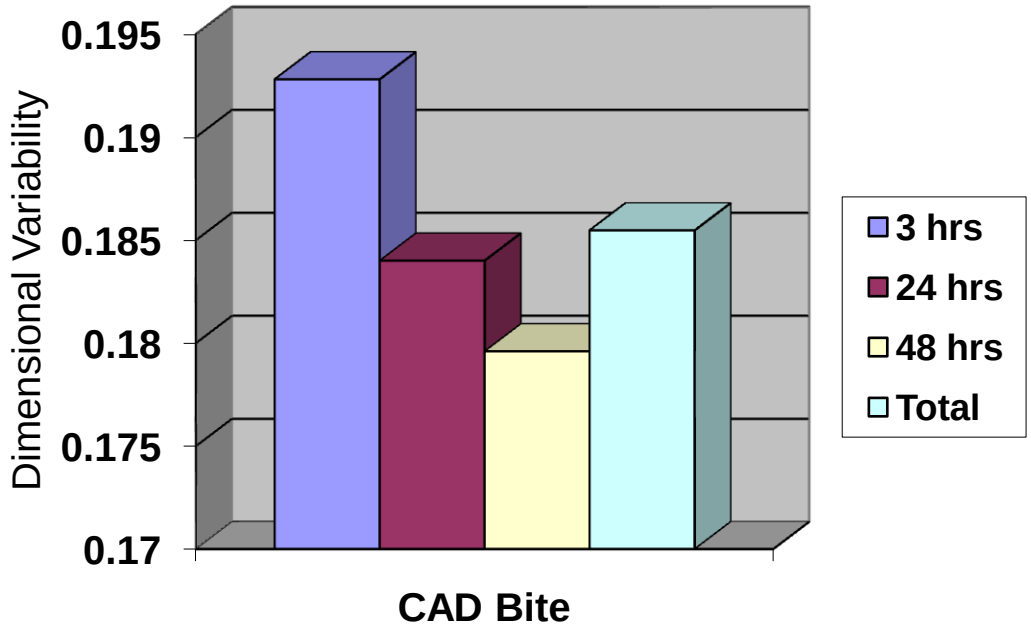


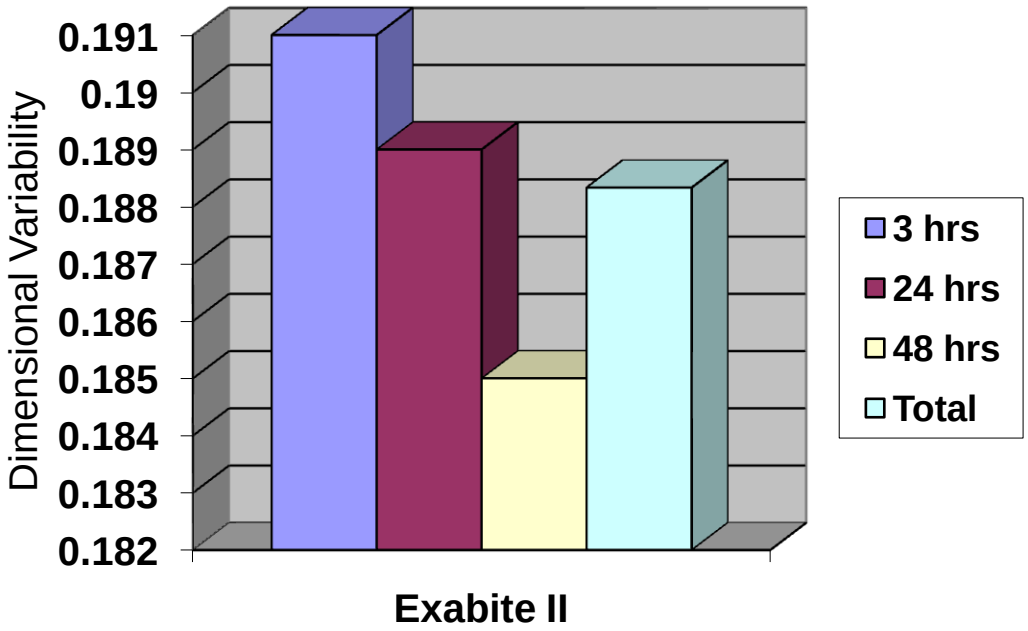
c) Mold Ring **d) Cross Section of the Mold Ring**

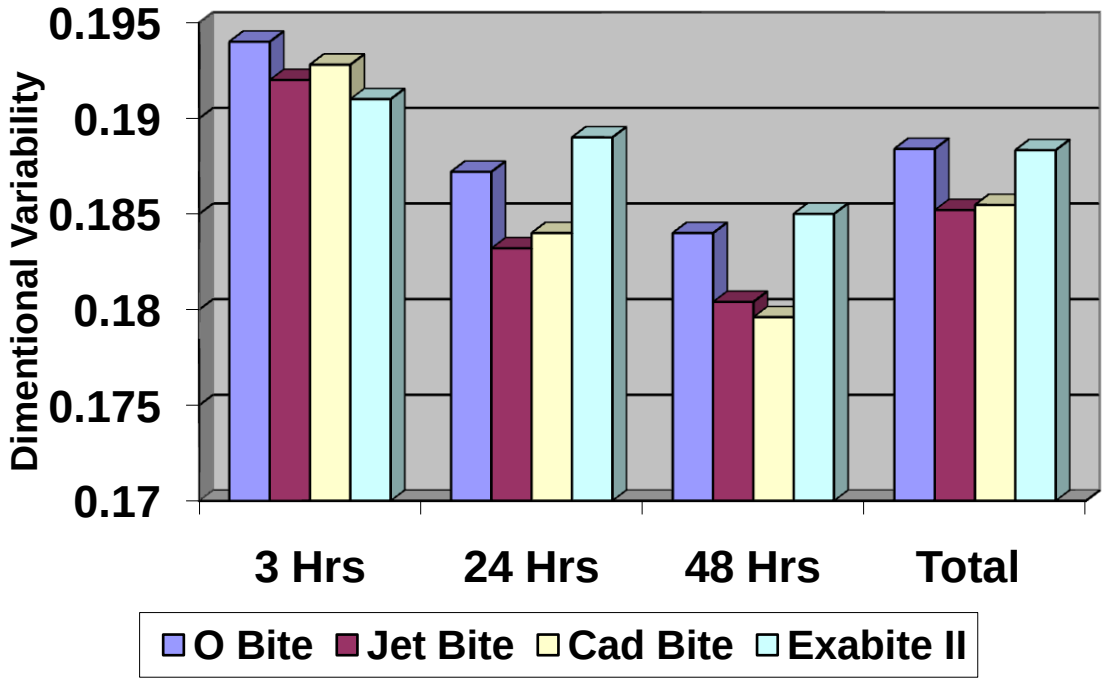
***Fig 11*: Schematic representation of the Die**


0.194
0.192
0.19
0.188
0.186
0.184
0.182
0.18
0.178
Dimensional Variability
3 hrs
24 hrs
48 hrs
Total
O Bite


0.192
0.19
0.188
0.186
0.184
0.182
0.18
0.178
0.176
0.174
Dimensional Variability
3 hrs
24 hrs
48 hrs
Total
Jet Bite


0.195
0.19
0.185
0.18
0.175
0.17
Dimensional Variability
CAD Bite
3 hrs
24 hrs
48 hrs
Total


0.191
0.19
0.189
0.188
0.187
0.186
0.185
0.184
0.183
0.182
Dimensional Variability
Exabite II
3 hrs
24 hrs
48 hrs
Total


0.195
0.19
0.185
0.18
0.175
0.17
Dimentional Variability
3 Hrs
24 Hrs
48 Hrs
Total
O Bite
Jet Bite
Cad Bite
Exabite II

RESULTS

The following results were obtained from this study which evaluated the dimensional stability of four different types of commercially available addition Silicone interocclusal recording materials. The materials were divided into four Groups as Group A (O-bite), Group B (Jet Bite), Group C (CAD Bite).and Group D (ExabiteII bite). Each Group had 5 samples. Five readings were made per sample at each time interval of 3hrs, 24hrs, 48hrs, and the average obtained was taken for calculating the Percentage Dimensional change at various time intervals.

Hardness of material was measured with the help of durometer.

Statistical analysis was performed using analysis of variance (ANOVA) with repeated measures for comparisons among groups at the .01 level of significance.

The Mean Percentage Dimensional changes for Group A, Group B Group C and Group D at various time intervals are shown in the tables II to V.

TABLE I

Hardness Test results

S. No	Property	Standard	units	Result obtained				Specified requirement
				(1) O bite	(2) jet bite	(3) CAD bite	(4) Exabite II	
1.	Shore-A Hardness	ASTM D2240	-	87	84	85	83	-
2.	Dimensional Measurement Studies	-	-	Results obtained				-

Sample Details:

1. O Bite
2. Jet Bite
3. CAD Bite
4. ExabiteII

INFERENCE

O –Bite showed highest hardness followed by CAD Bite, JET Bite, and Exabite II

TABLE II: ***Dimensional change for Group A (O BITE) at various time intervals***

SAMPLE	AFTER 3 HRS			AFTER 24 HRS			AFTER 48 HRS		
	Line1	Line2	L1-L2	LINE1	LINE2	L1-L2	LINE1	LINE2	L1-L2
O Bite	7.995	7.801	.194	7.599	7.410	.189	6.597	6.412	.185
	8.392	8.200	.192	7.147	6.961	.186	7.064	6.882	.182
	8.034	7.838	.196	7.257	7.069	.188	6.534	6.450	.184
	8.005	7.812	.193	7.541	7.354	.187	7.087	6.902.	.185
	7.635	7.442	.195	7.485	7.299	.186	7.037	6.853	.184

TABLE-III: ***Dimensional change for Group B (JET bite) at various time intervals***

SAMPLE	AFTER 3 HRS			AFTER 24 HRS			AFTER 48 HRS		
	Line1	Line2	L1-L2	LINE1	LINE2	L1-L2	LINE1	LINE2	L1-L2
Jet Bite	7.340	7.148	.192	7.192	7.010	.182	6.689	6.509	.180
	8.145	7.955	.190	7.533	7.353	.180	7.089	6.911	.178
	7.816	7.622	.194	7.687	7.503	.184	6.686	6.504	.182
	7.397	7.206	.191	7.726	7.540	.186	7.035	6.853	.182
	8.073	7.882	.193	7.352	7.168	.184	6.798	6.618	.180

Table-IV: ***Dimensional change for Group C (CAD bite) at various time intervals***

SAMPLE	AFTER 3 HRS			AFTER 24 HRS			AFTER 48 HRS		
	Line1	Line2	L1-L2	LINE1	LINE2	L1-L2	LINE1	LINE2	L1-L2
CAD Bite	7.762	7.569	.193	7.626	7.442	.184	6.379	6.199	.180
	7.211	7.006	.195	7.173	6.987	.186	7.077	6.899	.178
	7.999	7.808	.191	7.397	7.215	.182	7.090	6.908	.182
	7.560	7.372	.188	7.042	6.855	.187	6.530	6.352	.178
	8.001	7.804	.197	7.678	7.497	.181	7.082	6.902	.180

Table-V: ***Dimensional change for Group D (Exabite II) at various time intervals***

SAMPLE	AFTER 3 HRS			AFTER 24 HRS			AFTER 48 HRS		
	Line1	Line2	L1-L2	LINE1	LINE2	L1-L2	LINE1	LINE2	L1-L2
Exabite II	7.498	7.307	.191	7.233	7.144	.189	6.536	6.451	.185
	7.865	7.772	.193	7.661	7.470	.191	6.892	6.705	.187
	7.609	7.420	.189	7.298	7.111	.187	6.503	6.320	.183
	7.045	6.855	.190	7.745	7.557	.188	7.088	6.904	.184
	7.716	7.524	.192	7.200	7.110	.190	6.521	6.335	.186

Statistical Analysis

All the data obtained were subjected to ANOVA with repeated measures to find out the statistical significance between groups and within groups.

Table-VI: ***Mean, Standard deviation between FOUR different types of commercially available Addition silicone Interocclussal recording materials at3 hours***

	mean	**Std. Deviation**	**N**
O bite	.194000	.0015811	5
JET bite	.192000	.0015811	5
CAD bite	.192800	.0034928	5
ExabiteII	.191000	.0015811	5
Total	.192450	.0023278	20

INFERENCE

The statistical analysis for 3 hrs is as follows. Mean of Group A (o bite) is .194, Group B, (jet bite).192, Group C(CAD bite) .193, Group D (ExabiteII).191.

Standard deviation of Group A is .0016, Group B .0016, Group C .0035, Group 016. It is observed that all the standard deviation is <.001. And it is found to be statistically significant at 1% level.

Table-VII: ***Mean, Standard deviation between FOUR different types of commercially available Interocclussal recording materials at 24 hour***

24 HRS	Bite registration materials	Mean	Std. Deviation	N
	O bite	.187200	.0013038	5
	Jet bite	.183200	.0022804	5
	Cad bite	.184000	.0025495	5
	ExabiteII	.189000	.0015811	5
	Total	.185850	.0030310	20

INFERENCE

The statistical analysis for 24 hrs is as follows.

Mean of Group A (O bite) is .187, Group B(jet bite) .183,GroupC (CAD Bite).184,GroupD.(ExabiteII).189.

Standard deviation of Group A(O Bite) is .0013, Group B (Jet Bite) .0022, Group C (CAD Bite) .0026, Group D (Exabite II) .0016.It is observed all the standard deviation is <.001 and it is found to be statistically significant at 1% level.

Table-VIII: ***Mean, Standard deviation between FOUR different types of commercially available addition silicone interocclussal recording materials at48 hours***

	Bite registration materials	**Mean**	**Std. Deviation**	**N**
48 hours	O BITE	.184000	.0012247	5
	Jet bite	.180400	.0016733	5
	Cad bite	.179600	.0016733	5
	Exabite II	.185000	.0015811	5
	Total	.182250	.0027506	20

INFERENCE

The statistical analysis for 48 hrs is as follows.

Mean of Group A (O-Bite) is .180, Group B (Jet Bite) .181, Group C (CAD Bite) .185, Group D (Exabite II).189.

Standard deviation of Group A (OBite) is .0012, Group B (Jet Bite) .0016, Group C (CAD Bite) .0016, Group D (Exabite II) .006.

It is observed all the standard deviation is <.001 and it is found to be statistically significant at 1% level.

TABLE IX Statistical analysis between the groups

(I) colors	(J) colors				95% Confidence Interval	
		Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
O -bite	Jet bite	.003200*	.0008320	.009	.000697	.005703
	Cad bite	.002933*	.0008320	.017	.000430	.005436
	Exabite	.000067	.0008320	1.000	-.002436	.002570
Jet bite	O bite	-.003200*	.0008320	.009	-.005703	-.000697
	Cad bite	-.000267	.0008320	1.000	-.002770	.002236
	ExabiteII	-.003133*	.0008320	.010	-.005636	-.000630
CAD bite	O bite	-.002933*	.0008320	.017	-.005436	-.000430
	Jet bite	.000267	.0008320	1.000	-.002236	.002770
	Exabite II	-.002867*	.0008320	.020	-.005370	-.000364
Exabite II	O bite	-.000067	.0008320	1.000	-.002570	.002436
	Jet bite	.003133*	.0008320	.010	.000630	.005636
	CAD bite	.002867*	.0008320	.020	.000364	.005370

INFERENCE OF THE RESULTS

1. On comparing Group A (O Bite) with Group B (JET Bite) the mean difference was found to be significant at 1% level.
2. On comparing Group A (O Bite) with Group C (CAD Bite) the mean difference was found to be significant at 1% level.
3. On comparing Group A (O Bite) with Group D (EXABITE II Bite) the mean difference was found to be insignificant at 1% level.
4. On comparing Group B (JET Bite) with Group C (JET Bite) the mean difference was found to be insignificant at 1% level.
5. On comparing Group B(JET Bite) with Group D (EXABITE II Bite) the mean difference was found to be significant at 1% level.
6. On comparing Group C (CAD Bite) with Group D (EXABITE II Bite) the mean difference was found to be significant at 1% level.

DISCUSSION

An accurate transfer of maxillomandibular relations from the mouth to the articulator is highly essential in the treatment of any kind of prosthetic rehabilitation. The face bow transfer and the centric, excentric jaw relation records together establish the simulation of mandibular function on the articulator. However, the degree of correlation between the patient and articulator depends on many factors, including biologic considerations and the properties of the materials used during the process of transferring maxillomandibular relations from the patient to the articulator.

The usage of interocclusal records in the most accepted method of transfer of maxillomandibular relations from the mouth to the articulator. Comparative studies of various interocclusal record materials have shown that the selection of the record material play an important role in the accurate transferring procedure of maxilla- mandibular relation to the articulator. If the selected material is dimensionally unstable, it will have its own impact in causing inaccuracy to reproduce the correct maxillomandibular relationship on the articulator.

Walls et al demonstrated the problems of inaccuracy in the transfer of maxillomandibular relations from the mouth to a semiadjustable articulator. When the teeth do not offer vertical and horizontal stability between the arches, or during registration of centric relation position without tooth contact, an interocclusal record is needed to relate the casts.

PITFALLS NOTICED IN COMMONLY USED INTEROCCLUSAL RECORD MATERIALS

WAX:

It has been widely used as an interocclusal recording material because of its ease of manipulation. However, some properties of this material, such as a high coefficient of thermal expansion and high resistance to closure, have classified this material as the most inaccurate among the interocclusal record materials studied. Changes of vertical dimension may occur by these thermal effects when compound and wax recording materials are used.

"Additional correction of compound recordings with zinc oxide-eugenol paste creates an increase of the vertical distance of more than 100 mm in the anterior region after storage for 30 minutes." Assif etal also found that wax plus a zinc oxide-

eugenol paste resulted in an increased vertical dimension, which was attributed to distortion of the wax material.

IMPRESSION PLASTER:

It is essential that the interocclusal record material used for recording centric relation position provides limited resistance before setting to avoid displacing the mandible during closure. Records of impression plaster provide this limited resistance before setting and are rigid after setting; however, the plaster is difficult to handle in the mouth and the final interocclusal record is brittle if adequate bulk is not provided.

Muller et al found an increase of the vertical dimension of occlusion induced by recordings with impression plaster and attributed the increase to the setting expansion of gypsum.

ZINC OXIDE-EUGENOL BITE REGISTRATION PASTE:

Zinc Oxide-Eugenol Bite Registration Pastes are considered to be effective interocclusal record materials because of the fluidity of the pastes before setting, zinc oxide-eugenol ensures minimal interference with mandibular closure and it is rigid after final set and the expansion of the material is

also negligible. However, zinc oxide eugenol pastes have a lengthy setting time, significant brittle in thin section and they stick to the teeth. Vital portions of the record can be lost through breakage on removal from the mouth.

ELASTOMERS:

Elastomers as interocclusal record materials consistently yielded the least error among the materials studied. They are easy to manipulate and do not need a carrier when used in the mouth. They offer little or no resistance to closure, set to a consistency that makes them easy to trim without distortion, and accurately reproduce tooth details.

Flattore et al compared. **polyethers** with and without a carrier, pink baseplate wax, reinforced wax, and zinc oxide-eugenol paste, and concluded that the polyether without a carrier was the most reliable interocclusal material in his study. However, a bounce back action found in the polyether interocclusal records caused articulated casts to “open” in the centric relation position. which in turn increased the vertical height.

They recommended that the records should be trimmed and carefully seated over the occlusal surfaces to minimize this negative bounce back action.

Lassila and McCabe found that polyether interocclusal records expanded considerably when stored in water 1.4% of expansion was observed after 72 hour.

Millstein et al evaluated 2 types of **condensation silicone** and 2 brands of **self-cured resins** and reported that all tested materials exhibited some degree of weight loss as a result of volatile and concomitant change over time. Although the condensation silicones can present significant distortion due to the liberation of byproducts during setting.

ADDITION SILICONES: (polyvinyliloxanes)

Addition silicones exhibit the least amount of distortion when compared with other elastomeric impression materials. Accuracy, stability after setting, minimal resistance to closure, and easy manipulation are the main advantages of addition silicones as interocclusal record materials.[8]

Above mentioned studies reveals that addition silicone is found to be the best among other bite registration material used in routine clinical work.

Bite registration material are basically impression material which has been modified with addition of plasticizer , fillers and accelerator in order to be used as interocclusal recording media with short setting time. These modifications may be act as an attributable cause for the dimensional changes in set material, but still it is not confirmed by different studies performed.

Along with dimensional stability hardness is another important property of bite registration material to withstand the distortion. Due to high hardness, bite registration material are easy to trim and grind. Moreover, undesirable shifts are prevented when adjusting the position of the bite registration material in the articulator. High hardness bite registration material can be easily removed without breaking or wrapping from the patient's mouth

In the above context, the present in vitro study was conducted with the aim of evaluating and comparing the

dimensional stability and hardness of four types of commercially available addition silicone interocclusal recording materials at time interval of 3, 24, and 48hrs.

In present study, 5 specimen of each material were prepared and a total number of 20 specimens were prepared and divided into four subgroups: Group A, Group B, Group C, and Group D.

Konstantinos et al conducted a test to evaluate the linear shrinkage of addition silicone by using a steel die of 40 mm length and the groove depth of the grove is 0.25mm. In this study also the same method was followed but with different dimension of 3mm in thickness and 3 cm in diameter samples were used.[5] These samples were having three lines on the surface named as A, B, and C. These lines were placed at equal distance of 2.5mm from each other.

After homogenous mixing, the materials were carried to the die. The die was inverted on to a 4X4 inch square glass plate covered with polyethylene sheet. Hand pressure was applied for 5seconds to initially express the materials; this was

followed by application of a 500gm weight to further eliminate excess mater.

Breeding LC, Dixon DL. et al have stated that rubber bands are commonly used to sustain the contact of opposing casts during mounting procedures. The maximal force exerted by the use of one standard office supply rubber band (No. 19) to position a maxillary cast to a mandibular cast mounted on an articulator was approximately 25 N[8] .So 500gm weight value was selected in this study. Finally the mold, the stainless steel die and the weight were submerged in a 36 ± 1^0C water bath to simulate oral condition.

Specimens having 3 mm thickness was considered for measurement because the accuracy may vary with time intervals and at different thickness. Maj P Dua et al have concluded that the compressive resistance of each elastomeric was inversely proportional to the thickness of the sample. This implies that minimum thickness of the recording materials should be used for recording maxillomandibular relations without sacrificing the strength of the interocclusal record[7]. So for this purpose, a digital Vernier caliper was used to measure the thickness, 3mm thickness sample was used in this study.

The linear dimensional changes of four types of commercially available addition Silicone interocclusal recording material were measured at 3,24 and 48 hrs of time interval in this study. The abovementioned time intervals were selected based on time taken to mount the casts in the articulator with interocclusal records in situation where the mounting not done immediately following the recording procedure.

As the present study measure only linear changes, an optical microscope with a micrometer provision was chosen for the measurement as per testing methodology for ADA specification No.19.

The distance between the lines on the surface of the specimens were measured to evaluate the dimensional stability by optical microscope at interval of 3hrs, 24hrs and 48hrs. The results were obtained and subjected to analysis of variance (ANOVA) tests were done for comparisons among groups at the .01 level of significance. The result showed statistically significant difference in dimensional stability.

After 3hrs Group A shows least dimensional change, followed by Group C, Group B, and Group D .Similarly after 24hrs, Group A O bite showed least dimensional change, followed by Group D, Group B, Group C. After 48 hrs Group A showed least dimensional change followed by Group D, Group B than Group C.

When all bite registration materials were compared, Group A showed least dimensional change of 0 .06% followed by Group D 0.065%and Group B. 0.07% and Group C 0.08% after 48 hrs .The results does not support null hypothesis.

The change in the minimal dimensional variation of Group A with other groups may be attributed to the incorporation of percentage of modifiers into the material by the manufacturers. when the modifiers are incorporated to improve the setting time and the other properties, the international standard specifications has to observed strictly, if there is a lack in this, that itself will cause adverse affects.

These results are in agreement with the other studies suggesting difference in polymerization kinetics of the materials.[9]

Few authors have suggested ideal time taken up for articulation of cast with respect to the type of interocclusal records used. The study by Muller et al showed that Polyvinylsiloxane interocclusal records must be articulated within 1hr to get accurate results.[10]

These results of this present study are in accordance with the previous study. Thus, it becomes mandatory to choose a material depending not only on the clinical situation but also on the time taken for articulation after completing the interocclusal recording of maxilla-mandibular relations.

The modifiers used in the bite registration materials may be played a role in altered dimensional stability but it is not confirmed. So further studies may be helpful to evaluate the chemical analysis to find out the percentage of each ingredient of these interocclusal recording materials.

SUMMARY AND CONCLUSION

The present in vitro study was conducted to evaluate the dimensional Stability of four types of Interocclusal recording materials at various time intervals.

The materials used in the study were four commercially available Addition silicones (O –bite, jet bite, CAD bite, and, Exabite II). The test was carried using a mold similar to that of ADA specification No. 19.A total of 20 samples were made and each group consists of 5samples. The samples were measured using an optical microscope with micrometer provision. The measurements were made at a time interval of 3hrs, 24 hrs, and 48 hrs.

The results were obtained and subjected to statistical analysis. From the analysis the following conclusions were drawn:

- Dimensional stability is influenced by both “material” factor and “time” factor.
- Dimensional stability decreased as the time factor increased.

- O bite was most dimensionally stable followed by jet bite, ExabiteII, and CAD bite.
- Ideal time for articulation based on the type of inter occlusal record used is less than 24hr.
- Bite showed highest hardness followed by CAD Bite, Jet Bite, ExabiteII bite registration material.

BIBLIOGRAPHY

1. **Michalakis KX, Pissiotis A, Anastasiadou V, Kapari D.** An experimental study on particular physical properties of several interocclusal recording media. Part I: Consistency prior to setting. J Prosthodont 2004; 13(1): 42-6.
2. **Millstein PL, Clark RE, Myerson RL.** Differential accuracy of silicone-body interocclusal records and associated weight loss due to volatiles. J Prosthet Dent 1975 ; 33 (6) : 649-54.
3. **Muller J, Gotz G, Bruckner G, Kraft E.** An experimental study of vertical deviations induced by different recording materials. J Prosthet Dent 1991; 65 (1) : 43-50.
4. **Millstein PL.** Accuracy of laminated wax interocclusal wafers. J Prosthet Dent 1985; 54 (4) : 574-7.
5. **Michalakis KX, Pissiotis A, Anastasiadou V, Kapari D.** An experimental study on particular physical properties of several interocclusal recording medisa. Part II : Linear dimensional change and accompanying weight change. J Prosthodont 2004; 13(3): 150-9.

6. **Breeding LC, Dixon DL.** Compression resistance of four interocclusal recording materials. J Prosthet Dent 1992; 68(6) : 876-8.
7. **Maj P Dua,Gp Capt SH Gupta**. Evaluation of four elastomeric interocclusal recording materials MJAFI 2007,63: 237-240.
8. **Campos AA, Nathanson D.** Compressibility of two polyvinyl siloxane interocclusal record materials and its effect on mounted cast relationships. J Prosthet Dent 1999; 82(4) : 456-61.
9. **Chun JH, Pae A, Kim SH.** Polymerization shrinkage strain of interocclusal recording materials Dent Mater 2009;25:115-20. Epub 2008 Jul 9.
10. **K.karthikeyen H.** Annapurni comparative evaluation of dimensional stability of three types of interocclusal recording materials J prosthodontics 2008 7(1) 24-27.
11. **Millstein PL, Clark RE, Kronman JH.** Determination of the accuracy of wax interocclusal registrations. Part II. J Prosthet Dent 1973 ; 29(1):40-5.
12. **Millstein PL, Kronman JH, Clark RE.** Hydroptic measuring system for testing the accuracy of interocclusal recording mediums. J Dent Res 1970; 49:462.

13. **Wirth CG, Aplin AW.** An improved interocclusal record of centric relation. J Prosthet Dent 1971; 25 (3): 279-86.

14. **Millstein PL, Kronman JH, Clark RE.** Determination of the accuracy of wax interocclusal registrations. J Prosthet Dent 1971; 25 (2): 189-96.

15. **Balthazar-Hart Y, Sandrik JL, Malone WFP, Mazur B, Hart T.** Accuracy and dimensional stability of four interocclusal recording materials. J Prosthet Dent 1981 ; 45 (6) : 586-91.

16. **Millstein PL.** A simplified method for testing the accuracy of interocclusal recording media. J Prosthet Dent 1981; 46 (1) : 107.

17. **Sindledecker L.**Effect of different centric relation registrations on the pantographic representation of centric relation. J Prosthet Dent 1981 ; 46 (3) : 271-9.

18. **Mullick SC, Stackhouse JA, Vincent GR.** A study of interocclusal record materials. J Prosthet Dent 1981; 46 (3): 304-7.

19. **Millstein PL, Clark RE.** Differential accuracy of silicone-body and self-curing resin interocclusal records and associated weight loss. J Prosthet Dent 1981 ; 46 (4) : 380-4.

20. **Millstein PL, Clark RE.** Determination of the accuracy of laminated wax interocclusal wafers. J Prosthet Dent 1983 ; 50 (3) : 327-31.

21. **Christensen LC.** Preserving a centric stop for interocclusal records. J Prosthet Dent 1983; 50 (4) : 558-60.

22. **Fattore L, Malone WF, Sandrik JL, Mazur B, Hart T**. Clinical evaluation of the accuracy of interocclusal recording materials. J Prosthet Dent 1984; 51(2) : 152-7.

23. **Lassila V, McCabe JF.** Properties of interocclusal registration materials. J Prosthet Dent 1985; 53 (1) : 100-4.

24. **Hansen PA, Huff TL, Trebilcock CE.** Centric interocclusal record analyzer. J Prosthet Dent 1985; 54 (6) : 851-3.

25. **Lassila V.** Comparison of five interocclusal recording materials. J Prosthet Dent 1986; 55 (2) : 215-8.

26. **Assif D, Himel R, Grajower Y.** A new electromechanical device to measure the accuracy of interocclusal records. J Prosthet Dent 1988; 59(6) : 672-6.

27. **Muller J, Gotz G, Horz W, Kraft E.** Study of the accuracy of different recording materials. J Prosthet Dent 1990; 63 (1) : 41-6.

28. **Muller J, Gotz W, Horz W,Kraft E**. An experimental study on the influence of the derived casts on the accuracy of different recording materials. Part I: Plaster, impression compound, and wax. J Prosthet Dent 1990; 63 (3) : 263-9.

29. **Muller J, Gotz G, Horz W, Kraft E.** An experimental study on the influence of the derived casts on the accuracy of different recording materials. Part II: Polyether, acrylic resin, and corrected wax wafer. J Prosthet Dent1990; 63(4) : 389-95.

30. **Warren K, Capp N.** A Review of Principles and Techniques for making Interocclusal Records for mounting Working Casts. Int J Prosthodont 1990; 3(4) : 341-8.

31. **Walls AWG, Wassell RW, Steele JG.** A comparison of two methods for locating the intercuspal position (ICP) whilst mounting casts on an articulator. J Oral Rehab 1991; 18(1) : 43-8.

32. **Urstein M, Fitzig S, Moskona D, Cardash HS.** A clinical evaluation of materials used in registering interjaw relationships. J Prosthet Dent 1991; 65(3) : 372-7.

33. **Freilich MA, Altieri JV, Wahle JJ.** Principles for selecting interocclusal records for articulation of dentate and partially dentate casts. J Prosthet Dent 1992; 68(2) : 361-7.

34. **Breeding LC, Dixon DL, Kinderknecht KE.** Accuracy of three interocclusal recording materials used to mount a working cast. J Prosthet Dent 1994; 71(3) : 265-70.

35. **Millstein PL, Hsu CC.** Differential accuracy of elastomeric recording materials and associated weight change. J Prosthet Dent 1994; 71(4) : 400-3.

36. **Pence BA, Baum L, Li T.** Bite registration using impression plaster. Oper Dent 1994; 19(3) : 102-5.

37. **Tripodakis AP, Vergos VK, Tsoutsos AG.** Evaluation of the accuracy of interocclusal records in relation to two recording techniques. J Prosthet Dent 1997; 77(2) : 141-6.

38. **Gregory G, Gupta RD, Morgan B, Bounds G.** Polyvinylsiloxane dental bite registration material used to splint a composite graft of the nasal rim. Br J Oral Maxillofac Surg 1999; 37(2) : 139-41.

39. **Ockert-Eriksson G, Eriksson A, Lockowandt P, Eriksson O.** Materials for interocclusal records and their ability to reproduce a 3-dimensional jaw relationship. Int J Prosthodont 2000; 13(2) : 152-8.

40. **Eriksson A, Ockert-Eriksson G, Lockowandt P, Eriksson O.** Clinical factors and clinical variation influencing the reproducibility of interocclusal recording methods. Br Dent J 2002; 192(7) : 395-400.

41. **Vergos VK, Tripodakis AD.** Evaluation of vertical Accuracy of interocclusal records. Int J Prosthodont 2003; 16(4) : 365-8.

42. **Curtis SR**. Interocclusal registration technique with a vacuum-formed matrix. J Prosthet Dent 2003; 90(3) : 308-9.

43. **Hsu YT.** Using silicone occlusal registration material as a guide for tooth preparation. J Prosthet Dent 2004; 92(3) : 341. **Petridis HP.** Stable interocclusal records for implant patients with posterior edentulism. J Prosthet Dent 2004; 92 (5) : 503.

44. **Savabi O, Nejatidanesh F**. Interocclusal record for fixed implant – supported prosthesis. J Prosthet Dent 2004; 92 (6): 602 – 3.

45. **Craig RG, Sun Z.** Trends in Elastomeric Impression Materials. Oper Dent 1994; 19: 138-45.

46. **Craig RG.** Restorative Dental Materials, ed 10. St. Louis, MO, Mosby, 1997, pp 314.

47. **Chai J, Tan E, Pang IC.** A study of the surface hardness and dimensional stability of several intermaxillary registration materials. Int J Prosthodont 1994; 7(6) : 538-42.