A COMPARATIVE EVALUATION OF THE COMPRESSION RESISTANCE AND DIMENSIONAL STABILITY BETWEEN THREE ELASTOMERIC INTEROCCLUSAL RECORDING MATERIALS – AN *IN VITRO* STUDY

By

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2019-2022

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I hereby declare that this dissertation entitled "**A Comparative Evaluation Of The Compression Resistance And Dimensional Stability Between Three Elastomeric Interocclusal Recording Materials – An In Vitro Study**" is a bonafide and genuine research work carried out by me under the guidance of **Prof. Dr. Mathew M Alani**, Department of Prosthodontics and Crown & Bridge, St Gregorios Dental College, Chelad, Kothamangalam.

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ABSTRACT

Background and Objectives: The resistance of interocclusal recording materials to compressive forces and its linear dimensional stability is critical, because any deformation during the recording or mounting process would result in, inaccurate articulation of casts and faulty fabrication of restorations. So this invitro study was conducted to compare and evaluate the compression resistance and linear dimensional stability of different elastomeric interocclusal recording materials.

Methods: Three commonly used interocclusal recording materials were used for this study: Ivoclar Virtual Cadbite Registration polyvinyl siloxane (Group A), GC Exabite II polyvinyl siloxane (Group B), and 3M Ramitec polyether bite registration paste (Group C). A total of 108 specimens were fabricated and divided into 6 sub groups with 18 samples each. Standard cylindrical stainless steel die, was loaded with 18 samples each, from the three groups, was loaded on the Universal Testing Machine and subjected to a constant compressive force of 25 N for a duration of 60 seconds. The deformation of each specimen was measured to obtain compression distance values. Also, 18 samples each from the three groups were loaded in the standard stainless-steel die with ADA Specification No.19, for evaluating linear dimensional stability, by using Toolmaker's microscope, at time intervals of 1 hour, 24 hours and 48 hours. The results obtained was statistically analysed using ANOVA and Post Hoc tests.

Results and Conclusion: It was found that the groups showed different mean values and the test shows that the differences were statistically significant. Among all the groups, the maximum compression resistance was exhibited by Cadbite polyvinyl siloxane interocclusal recording materal, followed by Exabite polyvinyl siloxane and Ramitec polyether interocclusal recording material. The linear dimensional stability was maximum for Ramitec polyether material followed by Exabite and Cadbite polyvinyl siloxane bite registration materials, at time intervals of 1 hour, 24 hours, and 48 hours.

Key words: **Compression resistance, Linear dimensional, Polyvinyl siloxane, Polyether, Interocclusal recording materials.**

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INTRODUCTION

INTRODUCTION

Diagnosis and treatment planning of a patient for a prosthetic rehabilitation requires the clinician to fabricate diagnostic casts, as well as master casts and articulate them on articulators. For this reason, it is necessary to record maxillo-mandibular relationship and accurately transfer it to the articulator[1]. In some cases, the mounting of the casts into maximum intercuspation can be easily done by hand articulation and stabilizing the casts. While in few other cases in order to transfer the maxillomandibular relationship accurately to the articulator it is required to have appropriate interocclusal record materials. Interocclusal bite registration materials are responsible for precision and occlusal quality of final prosthetic restoration when used for mounting casts on articulators. Correct interocclusal records give the clinician opportunity to make only minimal adjustments to the restoration.

When the maxillary and the mandibular casts are to be held together in a stable and reproducible manner, a tripod of vertical support as well as a satisfactory horizontal stability is necessary. Tripod of vertical support is essential to prevent the rocking of the casts during mounting. Horizontal stability is essential to prevent the horizontal rotation or translation between the casts and is generally present when good intercuspation exists between the two opposing arches. An interocclusal record is mainly used to achieve the horizontal stability.[2]

Philip Pfaff made the first interocclusal registration in 1756 using natural waxes, since then many materials and techniques have been used for recording maxillomandibular relationship. These materials are basically impression materials which has been modified to give better handling characteristics. These include impression plaster, waxes, zinc oxide eugenol, acrylic resin, hydrocolloids. More recently elastomeric materials like polyether and polyvinyl siloxane have been widely used. [3]

The maxillary and mandibular arches are brought into a relationship with or without tooth contact, the recording material, which is initially soft, fills the spaces between the teeth, hardens, and records the specific relationship of the arches. The hardened material is then transferred on to the casts to be mounted on to an articulator.

Requirements for ideal interocclusal registration material include: a) It should have limited resistance before setting to avoid displacement of teeth or mandible during closure. b) It should become rigid and exhibit minimal dimensional change after setting. c) It should produce accurate record of the incisal and occlusal surface of the teeth d) It should be easy to manipulate e) It should not produce adverse effects on the tissues involved in procedure and it should allow easy verification.[1]

The direct interocclusal record during the 19th century, was a non-precision jaw record obtained by placing a thermoplastic material, usually wax or compound, between the edentulous ridge and having the patient close into the material. This was known as the "Mush, "Biscuit", or "Squash" Bite.[4]

Wax is probably the most maligned, yet the most versatile, recording material. Waxes vary greatly in quality and in working properties, and unless they are properly handled, their value as recording agents may be completely invalidated. A fairly hard wax of good quality that softens uniformly and that remains soft for an adequate working time is used. Although resistance to closure into a recording material may lead to an incorrect registration, this factor is of no great importance if the resistance is minimal.[5] Wax as interocclusal record material when compared with other materials is inferior, inaccurate, unstable, and inconsistent with distortion more frequently in a vertical direction followed by an anteroposterior direction.[6]

Zinc oxide eugenol is an impression material which has been used traditionally used for a long time and has gained wide acceptance as impression as well as bite registration material. It has a great ease of manipulation and is economical. The zinc oxide eugenol impression paste offers almost no resistance to closing of the mandible, thus allowing a more accurate interocclusal relationship record to be formed.[7] However, zinc oxide eugenol paste have a lengthy setting time, significant brittleness; they stick to the teeth and are unreliabile to reuse. As it sets by chelation reaction, the by-products formed may undergo evaporation leading to dimensional change. Vital portions of the record can be lost through breakage on removal from the mouth. Once zinc oxide eugenol record has been used to mount the casts, it is rarely used again. Unless trimmed, flash around the teeth can prevent the accurate seating of casts. Thus, it is advisable to use a minimal amount of zinc oxide eugenol to avoid excess flash.[8]

Polyether and addition silicones have been used for many years as impression materials and have gained popularity because of their excellent accuracy, dimensional stability, and quick recovery. These impression materials have been modified with the addition of plasticizers and fillers in order to confer the appropriate viscosity and provide required strength respectively. Catalysts have also been added in order to accelerate their polymerization reactions.[1]

Elastomers as interocclusal record materials consistently yielded the least error among the materials studied. They are easy to manipulate and offer little or no resistance to closure, set to a consistency that makes them easy to trim without distortion, and accurately reproduce tooth details. Furthermore, among the elastomers, addition silicones exhibit least amount of distortion. The excellent dimensional stability of addition silicones is attributed to the fact that it sets by addition polymerization reaction. Therefore, no by-products and no loss of volatiles occur in addition silicones. Accuracy, minimal resistance to closure and easy manipulation are the main advantages of addition silicones as interocclusal recording material. However, its major disadvantage is that any compressive force exerted on these materials during mounting procedures may cause inaccuracies during mounting of the casts. Spring action found in these materials may cause inaccuracies during mounting of the casts. The spring action found in these materials caused the articulated cast to open in centric relation position. Thus, the records should be trimmed and carefully seated over the occlusal surface to minimize the negative spring action.[8]

Polyether interocclusal registration material consists of the basic impression material augmented by plasticizers and fillers. The advantages of this material as an interocclusal registration material are accuracy, stability after polymerization and during storage, fluidity and minimal resistance to closure, can be used without a carrier. Disadvantages are that resiliency and accuracy may exceed the accuracy of the plaster casts. Both these factors can interfere with the placement of the plaster cast into the recording medium during mounting procedures. The records are trimmed to remove excess material and preserve only the teeth indentations, avoiding distortions.[2]

The resistance of interocclusal bite registration materials to compressive forces and its dimensional stability is critical, because any deformation during the recording or mounting process could result in inaccurate articulation of casts and faulty

fabrication of restorations. This study is to compare and evaluate the compression resistance and linear dimensional stability of different elastomeric interocclusal recording materials.

AIM AND OBJECTIVES

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To evaluate the compression resistance and dimensional stability between three elastomeric interocclusal recording materials.

a) To evaluate the deformation to compressive load and linear dimensional stability for Ivoclar Virtual Cadbite Registration (polyvinyl siloxane).

b) To evaluate the deformation to compressive load and linear dimensional stability for GC Exabite II (polyvinyl siloxane).

c) To evaluate the deformation to compressive load and linear dimensional stability for 3M Ramitec polyether bite registration paste.

d) To compare the compressive resistance between two polyvinyl siloxanes and polyether bite registration material.

e) To compare the linear dimensional stability between two polyvinyl siloxanes and polyether bite registration material.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

- **Berman MH (1960)** conducted a study to test resistance to closure of various waxes and zinc oxide eugenol bite registration material. A device was designed to test the relative resistance to penetration of various dental waxes used for recording tooth and jaw relationships. A platform was mounted on top of a rod that was calibrated and marked to a depth of ½ inch at the tip. Penetration by the rod of a ½ inch thickness of warmed wax was considered full penetration. The weight of the rod was established as zero. By adding weight to the platform, a load was built up sufficient to effect full penetration of the wax. The load required for full penetration was considered to be the resistance of the wax to penetration. Tests with various waxes indicate that all offer some resistance to closure. Zinc oxide and eugenol impression paste offered no resistance to closure.[9]

- **Skurnik H (1969)** described about the various materials available for making interocclusal records. Wax interocclusal records was the most versatile recording materials. A fairly hard wax of good quality that softens uniformly and that remains soft for an adequate working time was used. Zinc oxide and eugenol registration paste were simple to use, and their storage poses no problems. Plaster was the most exacting material available for interocclusal records. However, the use of plaster was more complicated than the use of wax or zinc oxide eugenol paste. Acrylic resin interocclusal record presents no storage problem after it has permanently set. Disadvantages was that fixed restorations cannot be completed on the cast because of the inaccuracy of the resin record which was due to its shrinkage.[5]

- **Millstein *et al* (1971)** conducted a study to determine the optimal procedures to be used in making wax interocclusal records. Two brands of wax were used for this study. These samples 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. A pressure of 172 psi was chosen, because it approximates human biting pressure. In this test it was found that complete closure under a pressure comparable to those of a clinical setting 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.[10]

- **Millstein *et al* (1973)** conducted a study for recording of two brands of baseplate wax which was tested by varying thickness, initial heating temperature and closing pressures. Controlled water bath heating temperature of 121°F, 126°F and 131°F were used to soften the wax for two minutes prior to making registration. Then the samples were tested for one minute under closing pressure of 102, 136, and 172 psi. The findings were 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.[11]

- **Millstein PL *et al* (1975)** studied on 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.[12]

- **Balthazar *et al* (1981)** conducted a study on four bite registration materials which include zinc oxide eugenol paste, eugenol free zinc oxide paste, a silicon and a polyether to determine the accuracy and stability in intervals over a week period. A Teflon die was used for the preparation of the specimens. The die with the impression material was submerged in a 32°C water bath to simulate open mouth condition. Upon removal from the bath, the material was separated from the die resulting in a disk measuring 0.3cm in thickness and 3cm in diameter with two parallel lines on the surface. The distance between these lines was measured utilizing the travelling microscope. Five disks per material were measured at six time intervals 0, 1 hr, 24 hr, 48, 72, and 168 hr. Samples were stored at room temperature. Result showed that the eugenol free zinc oxide paste was the only material which exhibited no statistically significant distance between the die scribes and those of the samples. Polyether was the second most accurate and stable material. And zinc oxide eugenol paste was the least accurate of the materials tested exhibiting an initial expansion at the end of the first hour.[13]

- **Millstein PL (1981)** described a simplified method for testing the accuracy of interocclusal recording media that is readily accomplished in the dental office by using a semi adjustable 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.[14]

- **Sindledecker L (1981)** 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.[15]

- **Millstein PL *et al* (1981)** 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.[16]

- **Millstein PL *et al* (1983)** determined the effects of initial heating, intraoral withdrawal, storage environments, storage times, and seating forces on the accuracy of laminated and non laminated, metalized and non metalized 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.[17]

- **Christensen LC (1983)** 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.[18]

- **Fattore *et al* (1984)** conducted an in vivo study to determine the clinical accuracy of waxes, zinc oxide-eugenol and polyether dental materials for recording inter arch relationships. Interocclusal records of 31 patients were placed on an arcon articulator with an arbitrary face-bow to measure the magnitude and direction of distortion. With hand articulation the mandibular cast was mounted to the maxillary cast in centric occlusion. Five types of interocclusal records were taken of each patient with two thicknesses of pink base plate wax, reinforced wax, zinc oxide- eugenol paste, a modified non-rigid polyether recording medium with a carrier and polyether without a carrier. All measurements with the four selected recording materials were compared with those of the hand-articulated full arch models in centric occlusion or maximum interdigitation. Polyether interocclusal recording medium without a carrier was the most accurate followed by polyether and then zinc oxide eugenol pastes with carriers. It was seen that recording waxes were consistently unreliable.[19]

- **Lassila V *et al* (1985)** 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.[20]

- **Millstein PL (1985)** 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.[21]

- **Hansen *et al* (1985)** described a new device for analysing centric interocclusal records that is easily adapted to a Whip-Mix articulator using items available in the dental supply catalogues 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.[22]

- **Lassila V (1986)** 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 600C 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.[23]

- **Assif *et al* (1988)** conducted a study using 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. This device monitored accuracy and vertical displacement of various dental materials during the transfer of interocclusal relationships to an articulator. Polyether was the most precise

material tested. Its accuracy was in the 20 to 30 μm range and also recommended for use because of other desirable characteristics. The accuracy of the remaining materials from displacement were, in descending order, Dura-Lay acrylic resin, wax, and wax plus zinc oxide.[24]

- **Muller *et al* (1990)** conducted a study to determine the three dimensional errors in mounting casts affected by the interocclusal recording materials. The inaccuracies attributed to the interocclusal record can be divided into three categories. The first is the biological characteristics of the stomatognathic system and second is related to manipulation of material. Last, the properties of the interocclusal record material may also induce incorrect mounting of the maxillary cast to the mandibular cast on an articulator. Eight commonly used materials or combination were tested after various storage periods. The results indicated that all the materials induced asymmetric deviations of the condyles after each storage period. Impression plaster was the most accurate and dimensionally stable material. Polyether was the second most accurate material, but it must be used within 6 hours. Correction of the teeth imprints with a low-viscosity was beneficial only in combination with wax wafers.[25]

- **Warren K *et al* (1990)** 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.[26]

- **Muller J *et al* (1990)** 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 withTemp 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 allof the materials tested induced asymmetric three dimensional deviations for the

simulated patient and the derived stone casts. The deviations of the derived casts weremore 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.[27]

- **Urstein *et al* (1991)** conducted an in vivo study where three recording media used to relate stone casts for 15 dentate patients were compared for accuracy. Inter jaw relationships at the maximum intercuspation position and the retruded contact position were recorded using impression plaster, wax, and Duralay acrylic resin. A Lucia programming jig was used in the retruded contact position. The vertical distance and horizontal deviation between the casts were measured from reference points on the casts using each recording material. The average percentage differences between the recording materials were calculated. Hand articulation was the most accurate method of relating the casts at maximum intercuspation. The most accurate recording medium was impression plaster, followed by dental wax and Duralay resin at the maximum intercuspation and retruded contact positions.[28]

- **Breeding LC and Dixon DL (1992)** conducted study to compare the deformation of various thicknesses of three vinyl polysiloxane material (Blu-Mousse, Stat BR, and Regisil) and one polyether interocclusal recording material (Ramitec) under a constant compressive load. This investigation compared the deformation of designated thicknesses (2 mm, 5 mm, 10 mm and 20 mm) for four elastomeric interocclusal recording materials when subjected to a 25 N compressive load by means of an Instron Universal testing machine. Compressive distortions of clinical significance were recorded for all the materials with various thickness. The Blu-Mousse vinyl polysiloxane registration material exhibited the greatest resistance to compression for the designated thickness, and these resistance values were significantly lower than those of the other recording materials with thicknesses of 5, 10 and 20 mm.[29]

- **Freilich *et al* (1992)** reviewed and discussed principles such as the tripod of vertical support (three widely spaced occlusal contacts) and adequate horizontal stability, which enable opposing dental casts to be held together in a stable and reproducible manner at the time the mandibular cast was mounted to the articulator. During the restoration of the dentate or partially dentate patient, where restoration was to be coincident with pre-treatment maximum intercuspation, the goal of the interocclusal record was to provide stability and/or support for the casts. The types of interocclusal records were organized into categories and designs based upon the remaining vertical support and horizontal stability of the dentition. The clinical indications, limitations, design, and composition of a variety of records for each of these categories were reviewed and discussed.[30]

- **Bezzon OL *et al* (1994)** proposed a procedure for retruded contact mounting of casts, based on a tripod of contacts with a combination of wax and acrylic resin, permitting great accuracy in a short period of time. Maxillary cast was mounted in an articulator with a facebow transfer. A jig was prepared with Duralay acrylic resin, in the mouth and adjusted to the amount of thickness required to avoid premature contact of the posterior teeth. A small amount of Duralay acrylic resin was placed at the palatal portion of the jig and patient was instructed to close firmly in the retruded contact position. Enough thicknesses of baseplate wax were cut in the shape of the maxillary arch, to contact the posterior teeth in retruded contact when the jig is in place. The wax was cut in the anterior region to clear the jig when it is in place in the mouth. When the patient closes lightly, the wax prevents the mandibular anterior teeth from touching the jig by approximately 2mm. With the jig seated correctly in the mouth, patient was asked to close the mouth. After the wax was cooled, it was removed from the mouth and carefully perforated on both the sides over the cast in the arches. A small amount of duralay acrylic resin was mixed and placed in the mouth again and the patient was guided to close. After the polymerization, record was removed and it was ready for positioning the mandibular cast in the articulator.[31]

- **Millstein PL *et al* (1994)** 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.[32]

- **Breeding LC *et al* (1994)** 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.[33]

- **Pence BA *et al* (1994)** described the art of utilizing impression plaster for bite registration and suggested certain conditions where its use was indicated. In partially edentulous mouths, however, where some anterior vertical stops remain but where long ridge areas extend distally, impression plaster was 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.[34]

- **Tripodakis *et al* (1997)** 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.[35]

- **McCabe JF *et al* (1998)** examined the rheological properties of elastomeric impression materials, both before and during setting, to assess the clinical significance of certain key characteristics such as viscosity, pseudoplasticity, and the rate of development of elasticity. The loss tangent (tan δ) and the dynamic viscosity (ή) for five impression materials (both unmixed pastes and mixed/setting materials) were measured by means of a controlled-stress rheometer in a cone/plate configuration. For unmixed pastes, tests were performed at various frequencies (0.1 to 10 Hz) and torques (from 1 to 50 x 10^{-4} Nm) while testing on setting materials was performed at constant frequency (1 Hz) and torque (3 x 10^{-3} Nm). Immediately after being mixed, the polyether and polysulfide elastomers showed tan δ markedly higher than those of other mixed materials. The polyvinylsiloxane elastomers showed lower initial tan δ, which rapidly reduced even further with time. This suggests that these materials should be used as soon as possible after being mixed. The polyether elastomer had a comparatively long induction period during which the tan δ remained at a high value. These characteristics were thought to be key factors in controlling clinical efficacy and therefore support the hypothesis, that monitoring tan δ is an appropriate method for evaluating the setting characteristics of elastomers. One limitation was that the controlled-stress rheometer was unable to monitor rheological properties through to completion of setting.[36]

- **Gregory G *et al* (1999)** 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.[37]

- **Campos AA *et al* (1999)** 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.[38]

- **Ockert - Eriksson G *et al* (2000)** 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.[39]

- **Eriksson A *et al* (2002)** 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.[40]

- **Curtis SR (2003)** described the use of a vacuum-formed matrix to make an interocclusal record. After tooth preparation is complete, the matrix is seated onto

the opposing teeth, adjusted so that it is out of occlusion and then autopolymerising acrylic resin is added to record the cusp of a prepared tooth in maximum intercuspation or centric occlusion The advantages of this technique are that the area recorded by the acrylic resin is small, making it relatively easy to ensure an accurate and passive fit onto the master cast. Care must be taken not to damage the master cast. Also, the matrix material is readily available in most laboratories and can be made quickly with little expense.[41]

- **Vergos VK *et al* (2003)** 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.[42]

- **Lu *et al* (2004)** conducted a study to compare the mechanical properties, including elastic recovery, strain in compression, tear energy, and tensile strength of 3 hydrophilic impression materials with low and high consistencies. Two addition silicone impression brands and a polyether brand were studied. Two consistencies of each material (light body and heavy-body) were investigated. They concluded that polyether impression materials tested had significantly higher strain in compression and lower tensile strength compared to new addition silicone materials. Heavy-body materials had significantly higher tear properties and tensile strength than light-body materials. Strain in compression was correlated with elastic recovery, tear energy, and tensile strength. Tear resistance and tensile

strength were not correlated.[43]

- **Michalakis *et al* (2004)** conducted a study to evaluate the linear dimensional change and accompanying weight change of several elastomeric interocclusal recording media. An electronic scale was used for the measurement of the weight change of the specimens and a travelling micrometer microscope was used to measure the linear changes at five time intervals 0, 1 hour, 24, 48, and 72 hours. Of all materials tested, Ramitec(polyether) presented the smallest linear change at all time intervals. Addition reaction silicones presented statistically significant differences in recordings of linear changes among them only at the 1st and the 24th hour. Linear changes did not seem to be associated with weight changes.[44]

- **Michalakis *et al* (2004)** conducted a study to evaluate the resistance to compression after setting of several elastomeric interocclusal recording materials. Testing of the resistance to compression after setting was performed following a modification of the method described in specification No. 19 of the A.D.A, 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. Mixing of the interocclusal registration media was conducted according to manufacturer's instructions, and the materials were injected into the mold. 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 was calculated using a vertical traveling micrometer microscope with an accuracy of 0.001 mm. It was found out that Polyvinylsiloxane Blu Mousse displayed the greatest resistance to compression, when compared to other elastomers, a zinc oxide–eugenol paste, and a wax and the material with the least resistance to compression after setting was zinc oxide-eugenol paste.[45]

- **Michalakis *et al* (2004)** conducted a study to evaluate the consistency prior to the setting of 5 elastomeric interocclusal recording materials in comparison with a wax and a zinc oxide-eugenol paste. Each one of the tested materials was mixed for 20 seconds and was then loaded into a 0.5 mL syringe. The material was syringed onto a 10 x 10 x 0.5 cm glass plate. A second 575 g glass plate was placed on top of the unset interocclusal registration material. The surface area covered by the materials was measured with the help of a scanner and the use of appropriate

computer software. All polyvinylsiloxanes occupied a smaller area than that of the polyether and of the zinc oxide-eugenol paste. Zinc oxide-eugenol paste was the most fluid of all materials tested. Polyvinylsiloxanes displayed less flow properties than polyether.[1]

- **Petridis HP (2004)** 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.[46]

- **Karthikeyan K *et al* (2007)** conducted a study to evaluate and compare the dimensional stability of three types of interocclusal recording materials at various time intervals**.** The materials used in the study were polyvinylsiloxane (Virtual), zinc oxide eugenol paste (Superbite) and Bite registration wax (Alumax). The test was carried out using a mold of the American Dental Association (ADA) specification No. 19. The samples were measured using an optical microscope with a micrometer provision. The measurements were made at time intervals of 1, 24, 48 and 72 hrs. The results obtained were statistically analyzed using a one-way analysis of variance (ANOVA) and Tukey (Honestly Significant Differences) HSD test. Dimensional stability is influenced by both the "material" and "time" factors and is found to decrease as the time factor increased. Polyvinylsiloxane (Virtual, Group A) was dimensionally the most stable followed by zinc oxide eugenol paste (Superbite, Group C) and then Bite registration wax (Alumax, Group B).[47]

- **Dua *et al* (2007)** conducted a study to evaluate the dimensional changes occurring in the interocclusal recording material over a given period of time and the material's resistance to compression during the cast mounting on the articulator. The linear dimensional change and compressive resistance of four commercially available elastomeric interocclusal recording media were tested. Three were addition silicones and the fourth was a polyether material. Cylindrical samples of 10mm diameter of each material were prepared in three different thicknesses of 2, 4 and 6mm. Ten samples each of thickness of 2, 4 and 6mm for all four materials

were prepared (total of 120 samples). The linear dimensional changes of the samples were evaluated after 24 hours of fabrication. The compressive resistance was measured when each of these was subjected to a constant compressive load of 25 N. It was concluded that the compressive resistance of each elastomer 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.[48]

- **Ghazal M *et al* (2008)** described a technique to mount casts using interocclusal records with no significant changes to the recorded maxillomandibular relationships and which was applicable for records made using elastomeric materials. After mounting the maxillary cast using a facebow transfer, seat the interocclusal record on the maxillary cast after which mandibular cast was placed on the interocclusal record and ensure that the 2 casts fit together accurately. A compressive force of 0.5 Kg was applied on to the mandibular cast to stabilize the casts and to reduce any vertical or horizontal discrepancies which may be caused by the interocclusal record. Cast was luted with sticky wax. After which the weight was removed, and the mounting procedure was completed using appropriate dental stone. Alternatively, when not using a facebow, seat both casts in the interocclusal record, stabilize the maxillary cast using the weight, and follow the previously described procedures.[49]

- **Pae *et al* (2008)** conducted a study to compare rheological properties of six dental interocclusal recording materials and to investigate the effect of temperature on the rheological properties during setting. Five polyvinylsiloxane materials and one polyether material were investigated in this study. The storage modulus (G') and the loss factor (tan δ) were measured from 30 sec after mixing during setting using the universal dynamic spectrometer. Viscoelastic properties were evaluated by means of G' and tan δ from 5 repeats at 21°C and 33°C. Individual changes during setting were also evaluated. All data were statistically analyzed using one-way ANOVA and multiple comparison Scheffé test at the significance level of 0.05. The change of loss factor tan δ during setting varied. Within the limitations of this study, dental interocclusal recording materials had different viscoelastic

properties and most of the materials showed different fluidity at 21ºC and 33ºC.[50]

- **Bansal S *et al* (2008)** reviewed the classification of various methods of recording centric relation records and an evaluation of these methods is presented. They have discussed about direct recording techniques, graphic recordings, functional recordings and cephalometrics. The interocclusal check record method is referred to as a physiologic method. The normal functioning of the patient's proprioception and the tactile sense was considered essential in the making of an accurate record. Graphic methods are either intraoral or extraoral, depending upon the placement of the recording devise. The intraoral tracings cannot be observed during the tracing; therefor the method loses some of the value of a visible method. While the extraoral tracings are visible while the tracing is being made. Hence, the patient can be directed and guided more intelligently during the mandibular movements. Functional recording was based on principle that the patient produces a pattern of mandibular movements by moving the mandible to protrusion, retrusion, and right and left lateral. Centric Relation and vertical dimension of occlusion were determined by cephalometric radiographs. This method, however, was somewhat impractical and never gained widespread usage.[4]

- **German *et al* (2008)** studied on the important rheological properties and importance of hydrophilicity for surface detail reproduction and dimensional accuracy for elastomeric impression materials (Flexitime Monophase PVS, Affinis Monophase PVS, Impregum Penta Soft Quick Polyether, Aquasil Ultra Monophase fast set PVS). The study concluded that polyether material have the highest capability of penetrating through the sharp the sharp fins and hence more greater surface reproduction and also produces more accurate impressions when compared to the polyvinlysiloxane material used in the study.[51]

- **Chun *et al* (2009)** conducted a study to 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, one polyether and one dimethacrylate based materials. The polymerization shrinkage values of ten specimens for each material were measured by the bonded-disk method at 1, 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. The representative shrinkage-strain kinetic graphs showed that all specimens shrank immediately, except Luxabite which expanded for the initial few seconds. After that, the shrinkage-strain values increased in the magnitude up to 10 min, but its rate decreased gradually with time. The shrinkage-strain values of O-Bite at 5, 7 and 10 min were significantly lower than the other materials but Luxabite exhibited the highest values. It signified that the interocclusal recording materials investigated presented significantly different polymerization shrinkage-strain kinetics and showed dimensional changes even after the setting time indicated by respective manufacturers.[52]

- **Vivas JL *et al* (2009)** introduced a method of registering an interocclusal record when a tripod contact has been lost due to the crown preparation of the six anterior maxillary teeth. A combination of a Bis-acrylic composite resin for rigid vertical support and a vinyl polysiloxane material to facilitate horizontal positioning of the casts for accurate mounting was presented. To tripod the registration, the prepared abutment teeth closest to the midline was lubricated for the occlusion record registration, including the opposing teeth, with petroleum jelly. The patient was guided into maximum intercuspation and Bis-acrylic composite resin was applied onto the incisal/occlusal thirds of the prepared abutment teeth. After the acrylic resin polymerizes vinyl polysiloxane registration material was injected around the bisacrylic composite resin and all of the remaining teeth. After polymerization, the bis-acrylic composite resin/vinyl polysiloxane interocclusal record was removed. This composite resin/vinyl polysiloxane interocclusal record was used to orient the maxillary and mandibular casts and complete the mounting in the articulator.[53]

- **Rodrigues *et al* (2010)** described a highly efficient technique to obtain articulated casts. Interocclusal recording was carried out using the palate as an area of registration without having to remove or section provisional prostheses while also maintaining the established vertical dimension. A silicone putty elastomer was manipulated and placed over the hard palate and occlusal surfaces of the interim prostheses on the maxillary arch covering the incisal/occlusal third of the teeth and the patient was asked to close his/her mouth into maximum intercuspation.

The maxillary cast was mounted on the articulator with a facebow transfer. After this the interocclusal record was seated over the mandibular cast and verified. The silicone should be in intimate contact with the hard palate in the maxillary cast and with the occlusal and incisal surfaces in the mandibular cast. Mandibular cast was fixed to the platform with stone and lab procedures were carried out. An additional advantage of this technique was that the record of the incisal edge position of the interim prosthesis may function as a guide for the production of the framework of the prosthesis.[54]

- **Anup *et al* (2011)** conducted a study to evaluate and compare the dimensional stability, accuracy and surface hardness of three interocclusal recording materials at various time intervals. Polyvinylsiloxane, Zinc oxide eugenol and Aluwax were taken for this study. A stainless steel die of ADA specification no. 19 was prepared. The samples were measured using a travelling microscope of 10x magnification at 1, 24, 48 and 72 h time intervals. Five readings were taken for each sample, the mean was considered to measure the dimensional change, accuracy and surface hardness. The values obtained were statistically analysed by ANOVA and Tukey HSD-Honestly significant difference. Polyvinylsiloxane was the most dimensionally stable, accurate and had the highest surface hardness among the three inter-occlusal materials.[55]

- **Hatzi *et al* (2012)** conducted a study to investigate the elemental and molecular composition, curing efficiency, setting shrinkage strain and hardness of vinyl-polysiloxane interocclusal recording materials. Curing efficiency was evaluated by micro-ATR FTIR on unset materials and following 3, 5, and 10 min after mixing. Setting shrinkage strain was evaluated by the bonded-disk method as a function of time up to 10 min after mixing and Shore-D hardness measurements were performed at setting time and after 72 hour storage at room temperature. All the interocclusal recording materials tested were particle-reinforced composites with a hydro and vinylpolysiloxane matrix. A fast setting reaction rate was documented in all materials with the highest conversion found in STB (Stone Bite). At setting time, setting shrinkage was highest in OBT (O-Bite). After 10 min, OFR (Occlufast Rock) gave the highest value, with a significant increase found in all materials at 10 min measurements. At setting time, STB was the

hardest product. After 72 h, though, STB and BMC (Blu-Mousse Classic) showed the highest values. The variations found in the properties tested may affect the clinical performance of the materials and highlight the need for further standardization of the products listed in this category.[56]

- **Prasad BR *et al* (2012)** compared various interocclusal records, techniques and reviewed that wax was an unfavorable material for interocclusal registration, it was the most utilized material in the dental practice because of its ease of handling, clinical versatility, ease of corrections and low cost. Combinations of wax with rigid materials like Zinc oxide eugenol paste and acrylic resin has also been used as they incorporate less error. However, these has their own drawbacks. The major problem with Zinc oxide eugenol paste was that it is a brittle material that tends to adhere to the teeth and when used in excess, it might distort. Acrylic resin provided more security to the operator at the time of seating the casts on the registrations. Elastomeric impression materials were amongst the preferred materials as per the various investigations conducted over their accuracy and dimensional stability. However, their major setback was the affordability.[2]

- **Tejo *et al* (2012)** conducted a study to evaluate the time dependent linear dimensional stability of three types of interocclusal recording materials and to find out ideal time for articulation of three types of interocclusal recording materials with accuracy. Polyether bite registration paste (Ramitec), Poly vinyl siloxane bite registration paste (Jetbite) and Zinc oxide eugenol (ZOE) bite registration paste (Super bite) were used in the study. A stainless steel die was made according to modified American dental Associations (ADA) specification no. 19. The distance between two parallel lines was measured at different time intervals i.e. 1 hour, 24, 48 and 72 hours by using travelling microscope (magnus) and compared with standard die measurements made according to ADA specification no.19 to find out the dimensional stability of these interocclusal recording materials. Statistical analysis was performed using analysis of variance (ANOVA) and then Tukey's Honestly Significant Difference (HSD) test for comparison among groups at the 0.05 level of significance. The dimensional stability decreased with increase in time and is influenced by both material factor and time factor. Polyether was found to be more dimensionally stable interocclusal recording material, which was

followed by Silicone and Zinc oxide eugenol (ZOE). The dimensional stability of polyether was good. Zinc oxide eugenol is dimensionally more unstable when compared with polyether and polyvinyl siloxane. They recommend that the polyether interocclusal records must be articulated within 48 hours and Polyvinylsiloxane interocclusal records must be articulated within 24 hours and the ZOE should be articulated within 1 hour to get a correct restoration to have very minimum distortion and maximum satisfaction without failure of prosthesis.[6]

- **Nassar *et al* (2013)** evaluated the dimensional stability of vinyl polyether silicone impression as a function of delayed pouring time for up to two weeks after performing a recommended clinical disinfection procedure. The study concluded that casts produced from a disinfected regular set vinyl polyether silicone demonstrated excellent dimensional stability at different pour times and were comparable to the tested vinylpolysiloxane and polyether impression materials.[57]

- **Al Kheraif AA (2013)** conducted a study to evaluate the effect of chemical disinfection as well as autoclave and microwave sterilization on the surface roughness of elastomeric impression materials. The surface roughness of five commercially available polyvinyl siloxane impression materials were evaluated after subjecting them to chemical disinfection, autoclaving and microwave sterilization using a Talysurf Intra 50 instrument. The differences in the mean surface roughness between the treatment groups were recorded and statistically analyzed. Results showed that there was no statistically significant increase in the surface roughness when the specimens were subjected to chemical disinfection and autoclave sterilization, increase in roughness and discoloration was observed in all the materials when specimens were subjected to microwave sterilization. It was concluded that chemical disinfection did not have a significant effect but since it is less effective, autoclave sterilization can be considered effective and autoclaving did not show any specimen discoloration as in microwave sterilization. Microwave sterilization may be considered when impressions are used to make diagnostic casts. A significant increase in surface roughness may produce rougher casts, resulting in rougher tissue surfaces for denture and cast restorations.[58]

- **Saluja BS *et al* (2013)** reviewed various materials and techniques for recording interocclusal relationship in fixed prosthodontic procedures. They discussed about various materials used for bite registration such as waxes, zinc oxide containing pastes (eugenol containing and non eugenol pastes) and dental plaster, modelling compound, acrylic resin, elastomeric materials and the combination of materials. Also, they described various techniques to record the bite. The most widely used technique was wax bite record as suggested by Dawson. Anterior stop method deprograms the muscles and helps to achieve correct centric relation. The triple tray technique maintained the interocclusal distance accurately but required a special tray for the procedure. In the enamel island (cone) method a conical vertical stop was used as a third point of reference to make a stable occlusal relationship. But if the cone was slender it might result in instability of the vertical stop when it contacts the oblique plane. The wide enamel cone can provide better stability but may result in inaccuracy of the prepared occlusal surface because a large volume of enamel must be removed later.[59]

- **Nassar U *et al* (2014)** conducted an in-vitro study to investigate the surface detail reproduction and dimensional stability of a vinyl polyether silicone (VPES) in comparison to a vinylpolysiloxane (VPS) material as a function of prolonged storage for up to 2 weeks. The results showed that the vinyl polyether siloxane experienced minimal dimensional changes when compared to vinyl polysiloxane, but the surface detail reproduction was not as consistent in vinyl polyether siloxane as compared to vinyl polysiloxane.[60]

- **Katna *et al* (2014)** conducted a study to evaluate the flow property of seven commercially available zinc oxide eugenol impression materials at various time intervals, after mixing 49 samples of 7 groups. The sample were fabricated as equal length of base and accelerator paste of the test materials was taken on the glass slab and mixed with a rigid stainless steel spatula as per manufacturers recommendation till the homogenous mix was obtained. The mix material was loaded in glass syringe and 0.5 ml material was injected on a cellophane sheet placed on marked glass plate. A cellophane sheet and glass plate and 500 g weight was carefully placed on freshly dispensed zinc oxide eugenol impression paste sequentially. The diameter of the mix was noted after 30 sec and 1 min of load

application and also after the final set of material. The diameter gives the flow of material. Flow of zinc oxide eugenol impression paste test samples after 30 s and 1 min of load application and after final set was maximum for P.S.P. and least for PYREX. It was concluded that if a material has the better flow property, it will record the tissue details more accurately and thus will be more dimensionally accurate.[61]

- **Nagrath *et al* (2014)** conducted a study to compare different types of recent interocclusal recording materials and to find the best among them which can resist a constant compressive load and will give the least inaccuracies. Compressive resistance of four interocclusal recording materials i.e. Imprint bite, Vitual refill, Jet bite and Ramitec at various thickness (2, 5, 10 and 20 mm) where subjected to a constant compressive load of 25 N. The thickness of the interocclusal recoding materials were selected to simulate various clinical situations. Results of two-way analysis of variance ($p \leq 0.05$) indicated that there was a significant difference in compressive resistance among the materials of each thickness. The 2 mm thickness specimens showed the least compression and 20 mm thickness specimen showed maximum compression under a constant load of 25 N for all the four materials tested. Virtual Refill bite registration material showed the least compression value than Imprint bite polyvinylsiloxane registration material, Ramitec polyether bite registration material and Jet bite polyvinylsiloxane registration material with negligible error of 0.04 mm found in 2 mm thickness.[62]

- **Chandu *et al* (2015)** conducted a study to compare the compression resistance of various interocclusal recording materials when subjected to a compressive load. Each interocclusal recording material was manipulated according to the manufacturer instruction and placed into a metallic cylinder. Each specimen was placed in the Universal Testing Machine exerting pressure on it, and a force of 100 g/cm^2 was exerted on each sample. Thirty seconds later the reading of the Universal Testing Machine was recorded using a vertical traveling micro meter microscope with an accuracy of ± 0.001 mm. It was shown that there was significant variation between all interocclusal bite registration materials. According to the mean valve of each interocclusal bite registration material, Polyvinylsiloxane Bite Registration Material had better resistance to compression

followed by Polyether interocclusal bite registration material, Aluwax Bite, and Impression Wax, Modelling Wax and at last Zinc Oxide Eugenol Impression Paste.[63]

- **Gurav *et al* (2015)** conducted a study to compare and correlate the accuracy and dimensional stability of commonly used interocclusal recording materials. A stainless steel die, made according to modified ADA specification no. 19, was loaded with different interocclusal recording materials. The distance between two parallel lines was measured at different time intervals to find out the dimensional stability of the material. There was significant difference found between accuracies of different interocclusal recording materials out of which zinc oxide eugenol and polyether were more accurate than silicon and Aluwax. The comparison of dimensional stability showed that zinc oxide eugenol and polyether were more dimensionally stable followed by silicon. Aluwax was least dimensionally stable of all.[3]

- **Kawara *et al* (2015)** conducted a study to compare the viscoelastic rheological properties of elastomeric impression materials for selective pressure impression technique by focusing on tray seating. In this study, eight types of polyvinylsiloxane (PVS), two types of polyether, and two types of alginate impression materials were used. The storage modulus ($G^{\prime}$; degree of stiffness) and loss tangent (tan δ; degree of hardening) were determined as functions of time from 0 to 360 s, commencing immediately after the completion of mixing, using a stress control-type rheometer. Thus, $G^{\prime}$ and tan δ at 0 s and 20 s were compared. It was concluded that Stiffness was found to be widely distributed (4.49–0.26 × 10^4 Pa) among PVS-types, even immediately after mixing the impression material. There was also variation among polyethers (1.55–0.5×10^4 Pa) and among alginates (0.64–0.21 × 10^4 Pa). The hardening of all impression materials progresses beyond 20 s after the completion of mixing. The $G^{\prime}$ values varied with each impression material, even immediately after mixing, and the accurate impression-taking time was determined from the results of tan δ. These results provide unique insight into the selective impression technique.[64]

- **Aalaei *et al* (2015)** evaluated the dimensional stability of two addition silicone impression material at different time intervals. The results showed that neither of the impression material showed a change in the dimension greater than 0.27% in comparison to standard die and both polyvinylsiloxane materials showed good dimensional stability over the time period of the study.[65]

- **Sweeney *et al* (2015)** conducted a study to evaluate different types of interocclusal record material and to determine which material is optimized for laser scanning and which most accurately articulates digital models. A plastic typodont was modified with reference points for inter arch measurements and articulated in maximum inter cuspal position on a semi adjustable hinge articulator. Twenty-five interocclusal records of each of the 5 experimental materials were made on the mounted typodont and digitized using an Ortho Insight 3D laser surface scanner (Motion View Software). Motion View Software was used to articulate the digital models by matching points from the models to the digitized interocclusal records. The distances between corresponding inter arch markers were measured and compared with the measurements taken on the physical typodont (gold standard). It was concluded that polyvinyl siloxane is a more accurate interocclusal recording material when articulating digital models according to the process described in this study. Using a bite registration to articulate digital models should be considered the first step in the articulation process, with a likely residual need to manipulate the models manually.[66]

- **Vadapalli *et al* (2016)** compared polyvinyl-siloxane (PVS) monophase and polyether (PE) monophase materials under dry and moist conditions for properties such as surface detail reproduction, dimensional stability, and gypsum compatibility. The study concluded as the following, regarding dimensional stability, both impregnum (polyether) and aquasil (polyvinyl siloxane) performed better in dry condition than in moist; impregum (polyether) performed better than aquasil in both the conditions. When tested for surface detail reproduction according to ADA specification, under dry and moist conditions both of them performed almost equally. When tested according to macroscopic evaluation, impregum (polyether) and aquasil (polyvinylsiloxane) performed significantly better in dry condition compared to moist condition. In dry condition, both the

materials performed almost equally. In moist condition, aquasil (polyvinylsiloxane) performed significantly better than impregum (polyether). Regarding gypsum compatibility according to ADA specification, in dry condition both the materials performed almost equally, and in moist condition aquasil (polyvinylsiloxane) performed better than impregum (polyether). When tested by macroscopic evaluation, impregum (polyether) performed better than aquasil (polyvinylsiloxane) in both the conditions.[67]

- **Krahenbuhl *et al* (2016)** conducted a study to evaluate the accuracy and precision of occlusal contacts among stereolithographic casts mounted by digital occlusal registrations. Four complete anatomic dentoforms were arbitrarily mounted on a semi adjustable articulator in maximal intercuspal position and served as the 4 different simulated patients. A total of 60 digital impressions and digital interocclusal registrations were made with a digital intraoral scanner to fabricate 15 sets of mounted stereolithographic definitive casts for each dentoform. After receiving a total of 60 stereolithographic casts, polyvinyl siloxane interocclusal records were made for each set. The occlusal contacts for each set of stereolithographic casts were measured by recording the amount of light transmitted through the interocclusal records. To evaluate the accuracy between the simulated patients and their respective stereolithographic casts, the areas of actual contact and near contact were calculated. It was concluded that for the accuracy evaluation, statistically significant differences were found between the occlusal contacts of all digitally mounted stereolithographic casts groups, with an increase in actual contact values and a decrease in near contact values. For the precision assessment, the values of the actual contact and near contact showed the digitally articulated cast's inability to reproduce the uniform occlusal contacts.[68]

- **Ghazal *et al* (2017)** conducted a study to evaluate the condylar displacement after mounting working casts using different interocclusal recording materials and to analyze the influence of the storage time and the recording technique on the displacement caused by the interocclusal record. Eight interocclusal records were made in each of the following groups: G1: Aluwax (aluminum wax), G2: Beauty Pink wax (hydrocarbon wax compound), G3: Futar D Fast, G4: Futar Scan (G3, G4: vinylpolysiloxane), G5: Ramitec (polyether), G6: LuxaBite (composite resin

based on bis-acryl), G7: LuxaBite corrected with Aluwax. A condylar-positioning indicator measured the condylar displacement in the three planes after storage of the records for two periods of 1 and 48 hours. Two-way ANOVA was used to determine the influences of recording materials and each of the following factors: region (record and non-record side), (2) storage time, and (3) recording technique. Based on the results it was concluded that, the vertical displacement of the condyle caused by the interocclusal records was higher than the lateral or the anteroposterior displacement. Elastomers caused statistically significantly less condylar displacement than waxes or uncorrected composite resin. Corrected LuxaBite records with Aluwax showed significantly less condylar displacement than all other materials.[69]

- **Martins *et al* (2017)** evaluated the dimensional changes of a polyether and addition silicone subjected to disinfection and/or sterilization after a long storage period. The long-term storage of samples subjected to disinfection with 5.25% hypochlorite or autoclave sterilization can be used in a clinical setting as the dimensional changes are below the maximum permitted by the ISO 4823:2000, since there are no clinically significant changes in the dimension of the samples during the storage period.[70]

- **Chandak *et al* (2018)** conducted a study to evaluate the property of flow of various commercially available ZOE impression pastes used as final impression material for complete denture under simulated intraoral conditions. Four commercially available zinc oxide eugenol impression material was used for the study. The testing method used were according to the American Dental Association (ADA) specification no. 16 for ZOE impression pastes. In this study they concluded that at room temperature, maximum flow was seen with Denzomix followed by Dental Product of India (DPI), Neogenate and Cavex in descending order, respectively, at 30 sec, 1 min, and 10 min of load application. At 37°C in saliva, maximum flow was seen with Denzomix followed by Neogenate, DPI and Cavex in descending order, respectively, at 30 sec, 1 min, and 10 min of load application. Of the four ZOE impression pastes, only the flow of Cavex was considerably less than ADA specified value. Results obtained from this study showed that there was considerable variation in the flow values of different

commercially available ZOE impression materials. Change in temperature and presence of saliva had a significant influence on the flow of ZOE impression materials.[8]

- **Rabeeba *et al* (2019)** assessed the quality of vinyl ether polysilicone impressions (VPES) and polyvinylsiloxane (PVS) impressions using one step technique. The study concluded that the new hybrid material vinyl polyether silicone displayed acceptable surface quality and handling properties for clinical use using one step impression technique.[71]

- **Dwivedi A *et al* (2020)** conducted an in vitro study to evaluate and compare the accuracy and the 3-dimensional stability offered by three different types of interocclusal recording materials at storage time intervals of 1 hour and 24 hours. Three commercially available interocclusal recording materials were used: Group I- Polyether bite registration paste (Ramitec), Group II- Polyvinylsiloxane bite registration material (Imprint), Group III- Bite registration wax (Marc). The test was carried out using an epoxy resin model. A total of 30 samples were made with each group consisting of ten samples. Three dimensional measurements were carried out by using 3D-Coordinate measuring machine (CMM) at time intervals of 0-1 hour and 0-24 hours in X, Y and Z- axis. They concluded that polyvinylsiloxane was dimensionally the most stable material followed by polyether and finally bite registration wax. Dimensional accuracy and stability was influenced by both "material" and "time" factors.[72]

- **Ries JM *et al* (2021)** presented an optical 3-dimensional method for analyzing deviations in static occlusion and to compare the accuracy of conventional and digital interocclusal registrations. A Frasaco jaw model was duplicated, articulated, and scanned with a high-precision industrial scanner, and the data were stored in a virtual standard tessellation language (STL) format, which served as the reference model. Fifteen paired mandibular and maxillary models were scanned with a digital intraoral scanner in the completely digital workflow (IOS group). Forty-five paired gypsum casts were poured from polyvinyl siloxane (PVS) impressions and associated with 2 different PVS registration materials. These casts were digitized with a laboratory scanner and grouped as follows (n=15/group): PVS group, conventional Futar D interocclusal record; sPVS group,

conventional Futar Scan interocclusal record; and the AIR group, partially digital antagonist scan of the Futar Scan interocclusal record. The axes (X, Y, Z, and XYZ) of each paired model were aligned to those of the reference model by 3-dimensional superimposition, and deviations were calculated. In comparison with maxillary and mandibular alignment using conventional interocclusal registration materials, digital interocclusal registrations showed greater accuracy in evaluating complete jaw models and can be recommended for clinical use. Additionally, the partially digital workflow with an antagonist scan of the interocclusal record provided acceptable results.[73]

- **Yazigi *et al* (2021)** evaluated the ability of different registration materials (conventional versus scannable) to record maxillary-mandibular relationships and compare the dimensional stability of these records after storage times of 1 hour and 48 hours. Six groups of interocclusal registration materials were tested: 3 conventional (Registrado X-tra, Futar D Fast, and O-Bite) and 3 scannable (Registrado Scan, Futar Cut & Trim Fast, and O-Bite Scan). Eight registrations were made for each group by using a custom-made device with a dial gauge to measure vertical discrepancies. Records were stored at room temperature, and discrepancies measured after 1 hour and 48 hours. The median vertical discrepancies ranged from -2 μm (FS) to 11 μm (O-Bite) after 1 hour and from 3 μm (Futar Cut & Trim Fast) to 13 μm (Registrado X-tra and O-Bite) after 48 hours. A statistically significant difference ($P<.001$) was found between the results after 1 hour and 48 hours for all materials. All scannable interocclusal registration materials showed significantly lower vertical discrepancies than the corresponding conventional materials after 1 hour and 48 hours.[74]

RELEVANCE OF THE STUDY

RELEVANCE OF THE STUDY

Correct interocclusal records give the clinician the opportunity to make only minimal adjustments to the restorations that were delivered from the laboratory and avoid unnecessary use of chairside time, or repetition of some clinical and technical stages. Possible errors in this essential clinical stage may be due to the biological characteristics of the stomatognathic system, faulty techniques of jaw manipulation, or mishandling of the interocclusal recording medium by the clinician.

Jaw relation records, or interocclusal records, have the following functions: (1) They provide the stability or support that the casts of the remaining dentition lack, (2) they reduce chair time for the delivery of the restoration, (3) they reduce the likelihood of making restorations in hyper occlusion or without occlusal contacts, and (4) they reduce the chance of perforation of restorations being inserted with excessive adjustment or having to adjust the opposing dentition inappropriately.

For opposing casts to relate well, there must be a tripod of vertical support and horizontal stability between the two casts. A minimum of three widely spaced tooth-to-tooth contacts should be present during mounting to ensure adequate stability. Casts that rock or wobble due to an insufficient tripod require an interocclusal record to stabilize them before mounting.

Dental plaster, impression compound, wax, zinc oxide eugenol paste, eugenol free zinc oxide eugenol paste, acrylic resin and elastomeric materials1, are routinely used for registration of occlusal relationships. The interocclusal record must be dimensionally stable until articulated, else there may occur vertical and horizontal discrepancies in the interocclusal relationships of the casts. So more of occlusal adjustments will have to be made for the prosthesis, crowns or fixed partial dentures, in the mouth. A tensile force is commonly exerted on the recording material during its removal from the patient’s mouth and during articulation which causes vertical and horizontal inaccuracies during mounting resulting in faulty restorations. So resistance of these recording materials against compressive forces is important. The materials get deformed when compressed under load. The deformation may vary with the thickness and properties of recording materials used. Sometimes, it takes

time to carry interocclusal records to distant laboratories or there may be delay in the articulation of the casts in the laboratory. This time interval also affects the properties of the recording material used. Some materials can be safely stored for long periods while others cannot be.

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. 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.

Hence, the present study was undertaken to evaluate the dimensional stability and resistance to compression of three commercially available elastomeric interocclusal recording materials, which included polyvinyl siloxane and polyether. The null hypothesis states that there is no difference in the compressive deformation and dimensional stability between the three elastomeric interocclusal recording materials.

METHODOLOGY

METHODOLOGY

This in-vitro study was conducted in the Department of Prosthodontics, Crown and Bridge and Implantology, St. Gregorios Dental College, Chelad, Kothamangalam, Kerala. Testing of the samples was carried out in the Bio Medical Technology Wing, Sree Chitra Thirunal Institute of Technology, Trivandrum, Kerala.

MATERIALS AND METHODS:

Table 1: List of Materials used for the study

Sl No.	Materials used	Brand Name and Company
1	Polyether bite registration Material	Ramitec, 3M ESPE, Germany
2	Polyvinyl siloxane bite registration material	Virtual CADbite REGISTRATION, Ivoclar Vivadent, USA
3	Polyvinyl siloxane bite registration material	EXABITE II NDS, GC America

Table 2: List of Equipments used for the study

Sl No.	Equipments used	Specifications
1	Travelling Microscope	CALTEX HD 60- L12
2	Universal Testing Machine	INSTRON 3345

Table 3: List of Armamentarium used for the study

Sl No.	Armamentarium used	Specifications
1	Stainless steel die	ADA specification no.19
2	Auto mixing gun	3M ESPE
3	Bard Parker handle	No. 12
4	Bard Parker blade	No. 15
5	Glass slab	Vijay Dentals (local supplier)
6	Petroleum jelly	Vaseline
7	1 Kg weight	Local supplier
9	Stainless steel spatula	Manipal Acharya
10	Stop watch	Laboratory timer

SAMPLING

Sample size was was calculated using G*power software 3.1.9.4.

Sample size calculation was done A priori.

α err prob	=	0.05
Power (1-β err prob)	=	0.8
Number of groups	=	6
Sample size per group	=	18

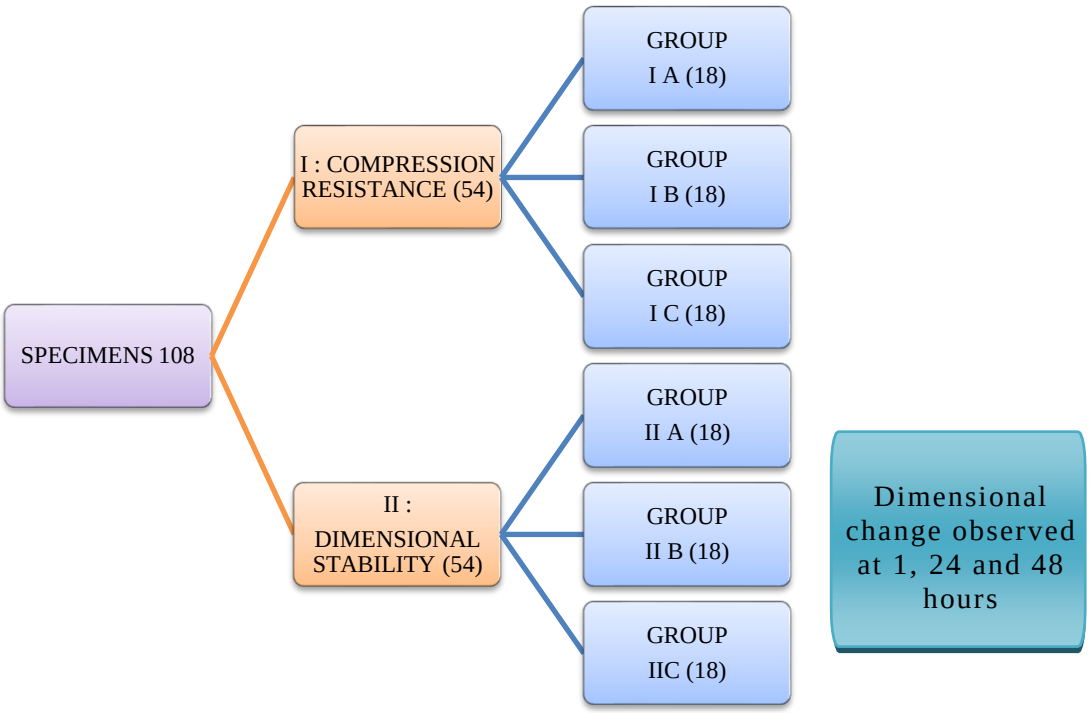
Each groups contains 18 samples and hence, a total of 108 samples

SELECTION AND MANIPULATION OF INTEROCCLUSAL RECORD MATERIALS:

Three commonly used interocclusal record material were selected for this study. All the materials were purchased from local market through regular commercial channels. The materials used for this study were divided into three groups (Group A, Group B, Group C) and six sub groups. These groups and the corresponding specimens used are listed below (Table 4):

Table 4: Description of sample groups

Group	Description
Group A	Polyvinyl siloxane bite registration material (Virtual CADbite REGISTRATION, Ivoclar Vivadent, USA)
Group B	Polyvinyl siloxane bite registration material (EXABITE II NDS, GC America)
Group C	Polyether bite registration material (Ramitec, 3M ESPE, Germany)



Die preparation for evaluating compression resistance (Fig. 03):

A standard cylindrical Stainless Steel die, with ADA Specification No.19, was machine tooled, in the form of hollow cylinders, open at both the ends, having internal diameter of 10 mm and of length 10mm.

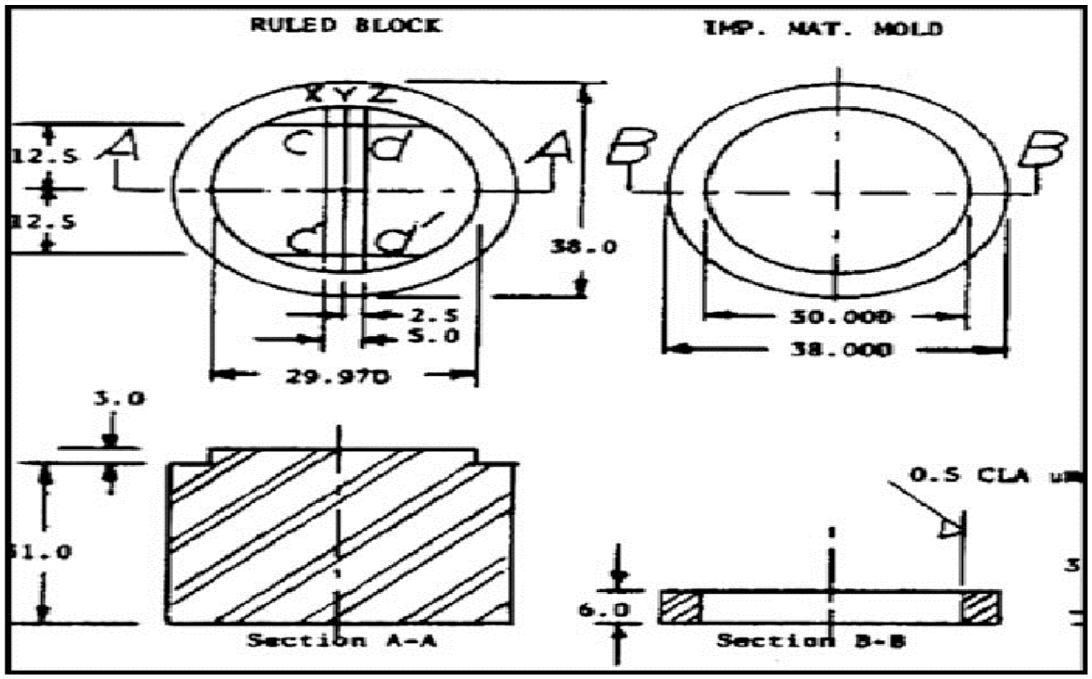
Die preparation for evaluating dimensional stability (Fig. 01, 02):

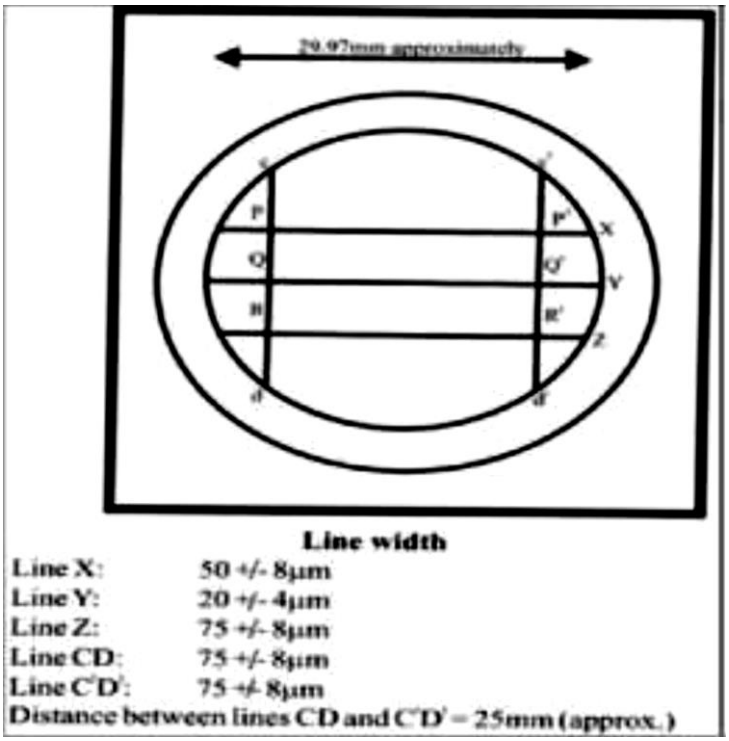
A standard stainless-steel die with ADA Specification No.19 was machine tooled with parts containing a ruled block, outer ring and a riser.

The measurement of the stainless-steel die is as follows –

- A total height of 37mm with a diameter of 38mm
- A ruled block with a diameter of 30mm, thickness of 3mm, ingrained with 3 horizontal lines x, y, z with width of 50±8µm, 20±4µm, 75±8µm respectively, and 2 vertical lines c and d with width of 75±8µm. All lines intersecting at 90º angle.
- An outer ring with an inner diameter of 30mm and outer diameter of 38mm and height of 6mm.
- A riser with a diameter of 30mm and a height of 3mm.

FIG. 01: Schematic Diagram of Stainless- steel die as per ADA Specification No.19





SAMPLE PREPARATION

The polyvinylsiloxane and polyether elastomeric impression materials were manipulated according to the manufacturer's instructions.

Manipulation of polyvinylsiloxane bite registration material:

Polyvinyl siloxane bite registration material (Jet bite) supplied in the form of a cartridge containing base and accelerator paste was used. The cartridge along with mixing tip were attached to an auto mixing dispensing gun. The material which was expelled from the dispensing tip was collected in the stainless steel die, by taking precaution not to incorporate air bubbles.

Manipulation of polyether bite registration material (Fig 08):

Equal lengths of required amount of base paste and catalyst paste were dispensed on the mixing pad provided by the manufacturer. These pastes were mixed together with a stainless steel spatula for 30 seconds to get a homogenous streak free mix. This mix of polyether bite registration material was collected with the mixing spatula and loaded in a disposable plastic syringe provided by the manufacturer.

Loading the stainless steel molds (Fig 09):

- The prepared stainless steel mold was cleaned using ultrasonic cleaner using distilled water to remove any residues of impression materials.
- Care should be taken to protect the surface of the mold to avoid any contamination.
- A light coat of petroleum jelly was applied using gauze to facilitate easy removal of set material from it.
- The manipulated material was injected into pre fabricated stainless steel molds for compression resistance and dimensional stability respectively, such that it flows completely into the mold .
- A flat glass plate was placed over the mold such that pressure was applied over the impression material, firmly against the mold assuring a positive contact between the mold and impression material.
- A weight of 1kg was placed over the glass plate for constant pressure.

- The material was allowed to set according to manufacturer's recommended time.
- The excess material that leached out during compression setting, was removed by using a Bard Parker blade no.15.
- Without disturbing the surface of the sample to be tested, the weight was removed followed by the sample.
- The prepared samples were ready for testing.

EXPERIMENTAL TEST

Evaluation of compression resistance (Fig 13 – Fig 16):

- The compressive resistance was tested using INSTRON 3345 Universal Testing Machine.
- The test was carried out at room temperature at a cross head speed of 1mm/min.
- Each of the test samples was loaded on the Universal Testing Machine and subjected to a constant compressive force of 25 N for a duration of 60 seconds.
- The results so obtained was statistically analysed.

Evaluation of linear dimensional stability (Fig 17 – Fig 19):

- After the samples were prepared, a toolmaker microscope, 30x magnification was used to assess whether the 3 lines has been reproduced in the samples or not.
- Those samples in which the 3 lines has been reproduced perfectly without any discontinuity was selected for assessing the linear dimensional stability.
- The samples were stored on table top in room temperature.
- The distance between the lines, CD and C´D´, reproduced on the samples, was measured at three different points PP´, QQ´ and RR´ (i.e. at the intersections of these lines with the lines XYZ) by using Toolmaker microscope (30x magnification) , at time intervals of 1 hour, 24 hours and 48 hours.
- Three readings was obtained for each sample and the average of these three values was tabularized for statistical analysis.

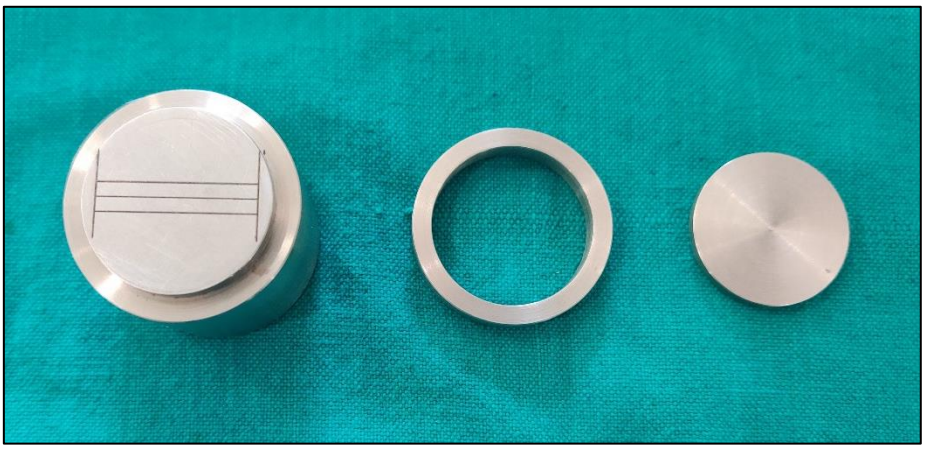


FIG. O2: STAINLESS STEEL DIE FOR EVALUATION OF LINEAR DIMENSIONAL STABILITY (ACCORDING TO ADA SPECIFICATION NO. 19)

FIG. O3: STAINLESS STEEL DIE FOR EVALUATION COMPRESSION RESISTANCE

FIG. O4: GROUP A SPECIMEN- IVOCLAR CADBITE POLYVINYL SILOXANE MATERIAL

FIG. O5: GROUP B SPECIMEN- GC EXABITE POLYVINYL SILOXANE MATERIAL

FIG. O6: GROUP C SPECIMEN- 3M ESPE RAMITEC POLYETHER

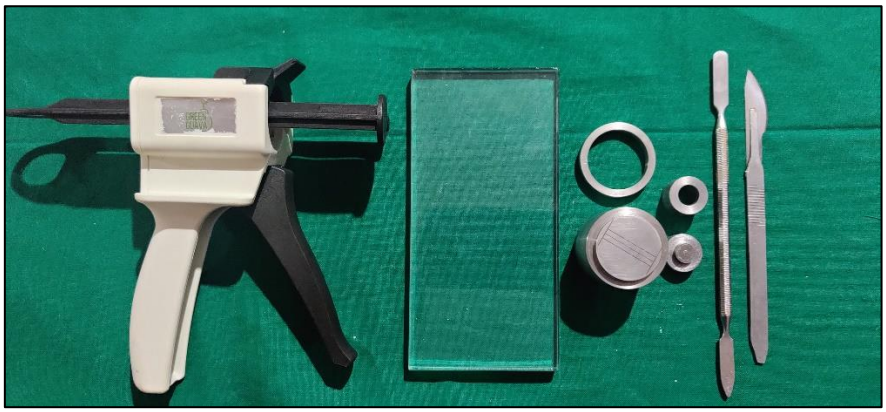


FIG. 07: ARMAMENTARIUM USED FOR THE STUDY

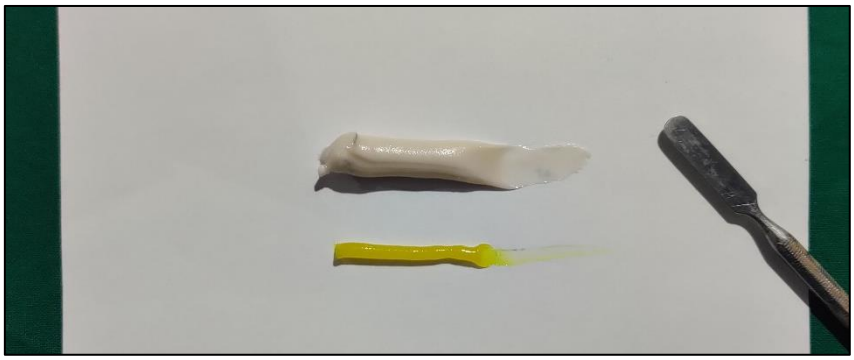


FIG. 08: MANIPULATION OF RAMITEC POLYETHER MATERIAL

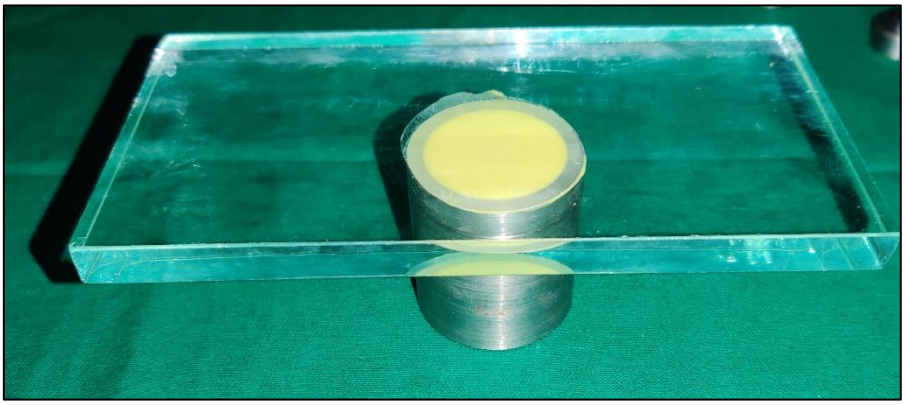


FIG. 09: LOADING THE STAINLESS STEEL DIE

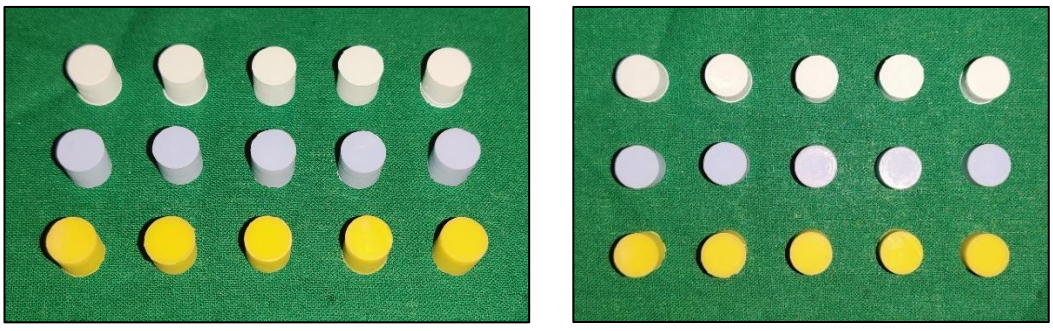


FIG. 10: VARIOUS SAMPLES PREPARED FOR EVALUATION OF COMPRESSION RESISTANCE

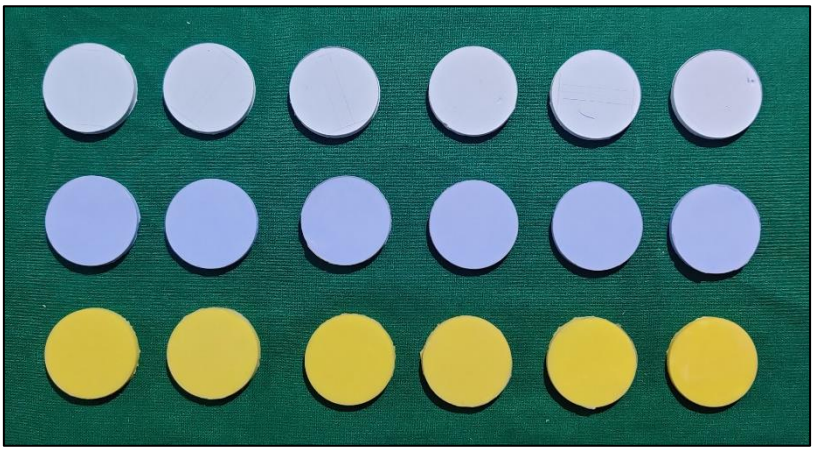


FIG. 11: VARIOUS SAMPLES PREPARED FOR EVALUATION OF LINEAR DIMENSIONAL STABILITY

FIG. 12: DEMARKATION OF THE LINES ON SAMPLE PREPARED FOR EVALUATION OF LINEAR DIMENSIONAL STABILITY

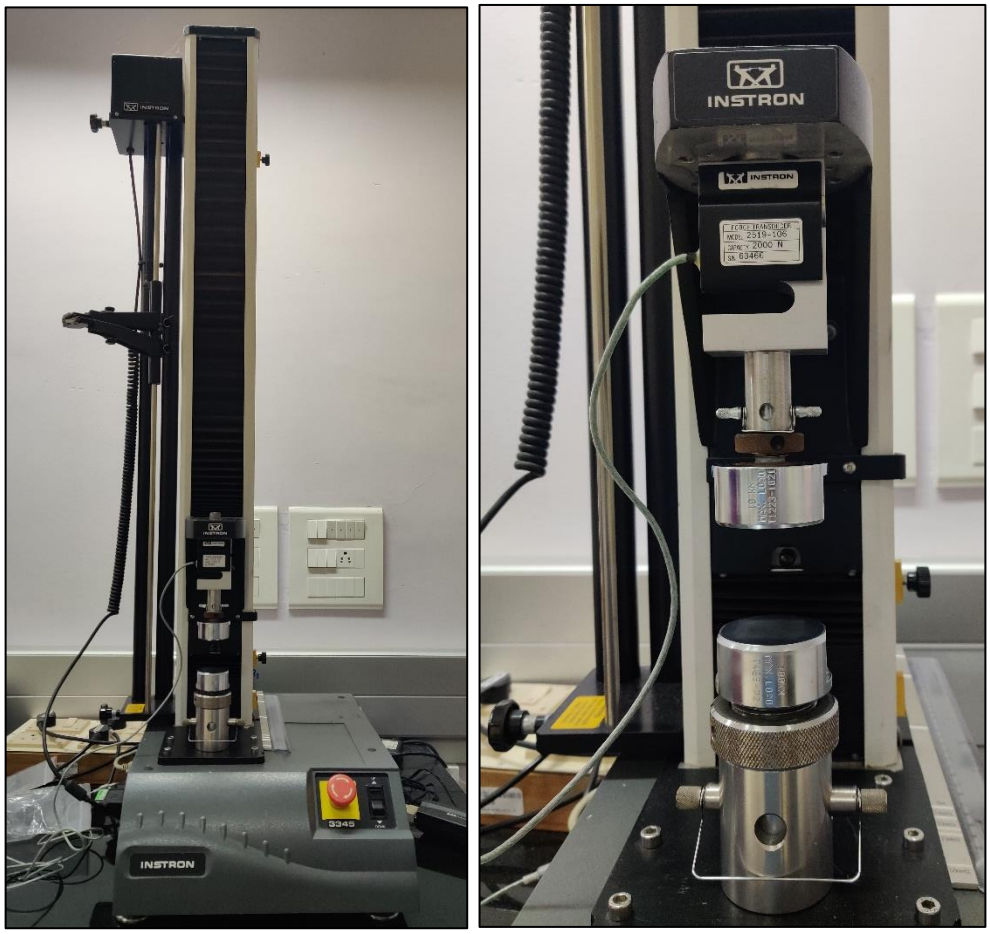


FIG. 13: UNIVERSAL TESTING MACHINE

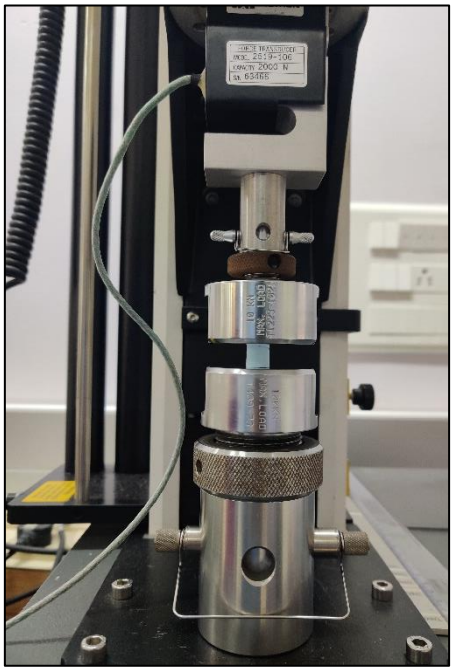


FIG. 14: TESTING OF GROUP I A SAMPLES

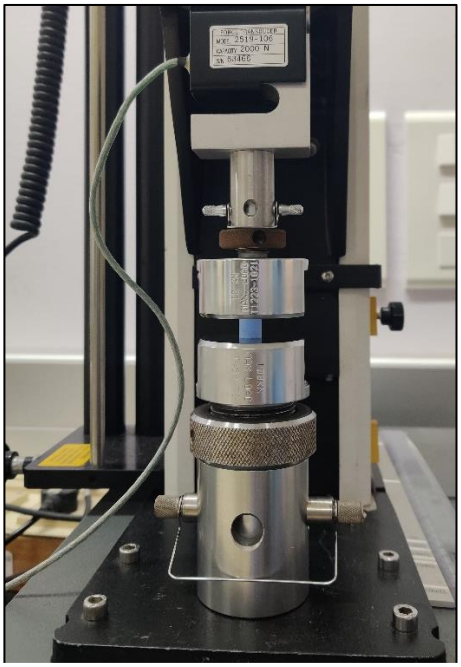


FIG. 15: TESTING OF GROUP I B SAMPLES

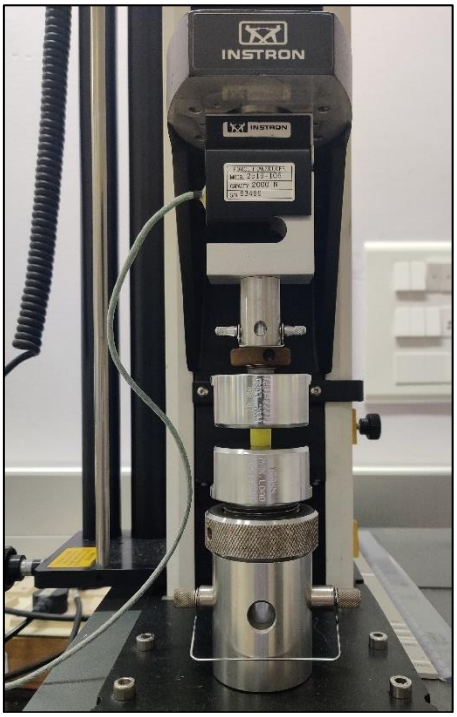


FIG. 16: TESTING OF GROUP I C SAMPLES

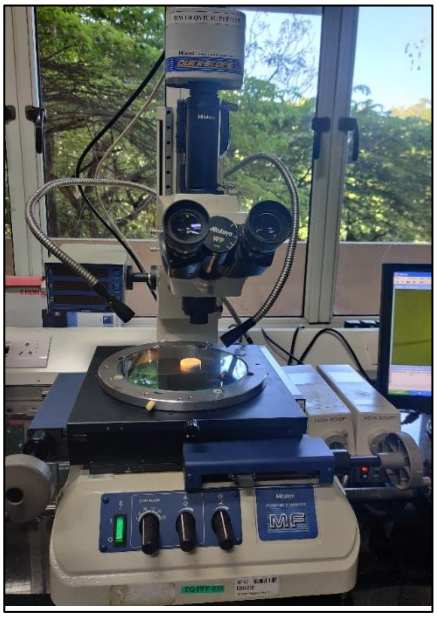


FIG. 17: TOOLMAKERS MICROSCOPE

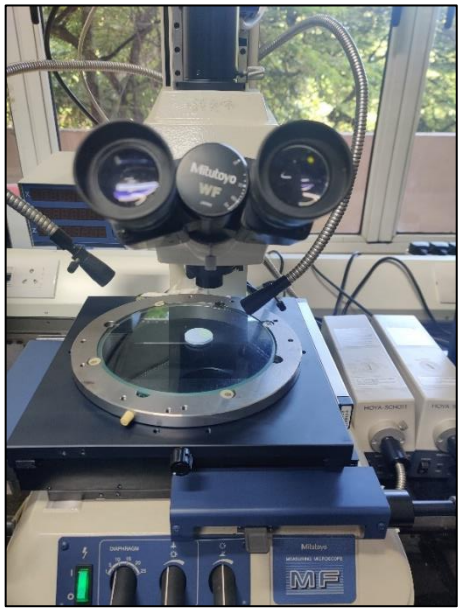


FIG. 18: TESTING OF GROUP II SAMPLES

FIG. 19: TESTING OF GROUP II SAMPLES (ENLARGED VIEW)

RESULTS

RESULTS

The compression distance of three groups were evaluated and the calculated values were listed in Table 5.

TABLE 5: VALUES OF COMPRESSION DISTANCE FOR DIFFERENT ELASTOMERIC INTER OCCLUSAL RECORDING MATERIALS (mm)

SL.NO	GROUP I A	GROUP I B	GROUP I C
1	0.27	0.32	0.39
2	0.29	0.34	0.47
3	0.21	0.27	0.46
4	0.32	0.36	0.5
5	0.27	0.3	0.38
6	0.36	0.29	0.39
7	0.25	0.32	0.41
8	0.29	0.33	0.52
9	0.31	0.26	0.42
10	0.27	0.35	0.53
11	0.26	0.33	0.49
12	0.28	0.28	0.51
13	0.33	0.31	0.43
14	0.29	0.3	0.37
15	0.24	0.32	0.46
16	0.25	0.3	0.47
17	0.26	0.29	0.5
18	0.29	0.34	0.48

The dimensional stability of three different groups at various time intervals were evaluated and calculated values were listed in Table 6 (6a, 6b, 6c).

TABLE 6 a: VALUES FOR DIMENSIONAL STABILITY OF CADBITE POLYVINYL SILOXANE (GROUP II A) INTER OCCLUSAL RECORDING MATERIAL (mm) AT VARIOUS TIME INTERVALS

SL.NO	1 HOUR	24 HOURS	48 HOURS
1	24.73	24.71	24.69
2	24.8	24.79	24.75
3	24.88	24.86	24.8
4	24.77	24.73	24.7
5	24.87	24.85	24.8
6	24.76	24.72	24.68
7	24.8	24.75	24.71
8	24.85	24.83	24.76
9	24.75	24.71	24.64
10	24.82	24.77	24.7
11	24.87	24.82	24.79
12	24.73	24.7	24.65
13	24.85	24.81	24.76
14	24.71	24.7	24.64
15	24.83	24.79	24.72
16	24.78	24.74	24.7
17	24.81	24.76	24.68
18	24.79	24.74	24.67

TABLE 6 b: VALUES FOR DIMENSIONAL STABILITY OF EXABITE POLYVINYL SILOXANE (GROUP II B) INTER OCCLUSAL RECORDING MATERIAL (mm) AT VARIOUS TIME INTERVALS

SL.NO	1 HOUR	24 HOURS	48 HOURS
1	24.74	24.73	24.69
2	24.75	24.73	24.7
3	24.87	24.85	24.83
4	24.79	24.77	24.73
5	24.74	24.72	24.69
6	24.84	24.82	24.8
7	24.83	24.8	24.77
8	24.81	24.8	24.76
9	24.77	24.75	24.69
10	24.89	24.87	24.82
11	24.8	24.78	24.72
12	24.76	24.75	24.71
13	24.75	24.72	24.7
14	24.82	24.81	24.76
15	24.8	24.79	24.77
16	24.79	24.77	24.74
17	24.77	24.75	24.73
18	24.81	24.8	24.78

TABLE 6 c: VALUES FOR DIMENSIONAL STABILITY OF RAMITEC POLYETHER (GROUP II C) INTER OCCLUSAL RECORDING MATERIAL (mm) AT VARIOUS TIME INTERVALS

SL.NO	1 HOUR	24 HOURS	48 HOURS
1	24.79	24.77	24.75
2	24.78	24.78	24.76
3	24.88	24.87	24.86
4	24.89	24.89	24.88
5	24.79	24.79	24.75
6	24.82	24.8	24.78
7	24.86	24.85	24.81
8	24.8	24.78	24.74
9	24.88	24.85	24.82
10	24.78	24.77	24.74
11	24.81	24.79	24.76
12	24.87	24.85	24.83
13	24.79	24.77	24.74
14	24.84	24.83	24.8
15	24.8	24.79	24.77
16	24.81	24.8	24.78
17	24.83	24.81	24.79
18	24.79	24.77	24.76

STATISTICAL ANALYSIS

The obtained results of all the samples were subjected to the following statistical test for analysis: one way ANOVA (Analysis of Variance) and TUKEY'S POST HOC TEST.

The compression distance of all the groups were compared and the mean and standard deviation of each group were evaluated.

Table 7: Mean values of compression distance of different elastomeric inter occlusal recording materials (mm)

GROUP	N	Minimum	Maximum	Mean	Std. Deviation
I A	18	.21	.36	.2800	.03531
I B	18	.26	.36	.3117	.02771
I C	18	.37	.53	.4544	.05113
Valid N (listwise)	18				

The compression distance of Cadbite polyvinyl siloxane (Group I A) ranges from 0.21 mm to 0.36 mm, with a mean value of 0.28 mm. The compression distance of Exabite polyvinyl siloxane (Group I B) has a lower limit of 0.26 mm and an upper limit of 0.36 mm, with an average displacement of 0.3117 mm. The values of compression distance of Ramitec polyether (Group I C) ranges from a minimum of 0.37 mm to a maximum of 0.53 mm, and a mean displacement of 0.4544 mm.

Table 8: Mean values of dimensional stability of different elastomeric inter occlusal recording materials at various time intervals (mm)

GROUP	Time intervals	N	Mean	Std. Deviation
GROUP II A	1 hour	18	24.8000	.05202
	24 hours	18	24.7655	.05223
	48 hours	18	24.7133	.05236
GROUP II B	1 hour	18	24.7961	.04313
	24 hours	18	24.7783	.04328
	48 hours	18	24.7439	.04487
GROUP II C	1 hour	18	24.8228	.03786
	24 hours	18	24.8089	.03818
	48 hours	18	24.7844	.04162
Valid N (listwise)		18		

For GROUP II A the mean values of linear dimensional stability ranges from 24.8 to 24.7655 to 24.7133 at time intervals of 1 hour, 24 hours and 48 hours respectively.

Similarly, for GROUP II B the mean values of linear dimensional stability ranges from 24.7961 to 24.7783 to 24.7439 at time intervals of 1 hour, 24 hours and 48 hours respectively.

And, for GROUP II C the mean values of linear dimensional stability ranges from 24.8228 to 24.8089 to 24.7844 at time intervals of 1 hour, 24 hours and 48 hours respectively.

ONEWAY ANOVA:

One way ANNOVA was used to determine statistical differences among compression distance and dimensional stability of three groups. Data were analysed by SPSS software and results were obtained.

Table 9: Results of Oneway ANOVA for compression resistance of different elastomeric inter occlusal recording materials

	Sum of Squares	Df	Mean Square	F	P-value Sig.
Between Groups	.311	2	.155	100.748	.000
Within Groups	.079	51	.002		
Total	.390	53			

The Ramitec polyether group (group I C) showed higher values than Cadbite polyvinyl siloxane (group I A) and Exabite polyvinyl siloxane samples (group I B). The Cadbite polyvinyl siloxane (group I A) showed least compression distance .

TUKEY'S HSD POST HOC TEST(PAIRWISE COMPARISON):

Table 10: Results of multiple comparisons with post HOC tukey test for compression resistance of different elastomeric inter occlusal recording materials

Dependent Variable: group Tukey HSD						
GROUPS	Variables	Mean Difference (I-J)	Std. Error	P value Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
I A	I B	-.03167*	.01309	.049	-.0633	-.0001
	I C	-.17444*	.01309	.000	-.2061	-.1428
I B	I A	.03167*	.01309	.049	.0001	.0633
	I C	-.14278*	.01309	.000	-.1744	-.1112
I C	I A	.17444*	.01309	.000	.1428	.2061
	I B	.14278*	.01309	.000	.1112	.1744
*. The mean difference is significant at the 0.05 level.						

Tukey's HSD POST HOC test was used to compare between two groups.

When group I A was compared with all other groups, there was a statistically significant difference between group I A and group I B with a p value of 0.49, and between group I A and group I C with a p value of 0.00.

When group I B was compared with all other groups, there was a statistically significant difference between group I B and group I A with a p value of 0.49, and between group I B and group I C with a p value of 0.00.

Table 11: Results of the Post hoc pairwise comparison for dimensional stability of CADBITE Polyvinyl siloxane (group II A)

(I) time	(J) time	Mean Difference (I-J)	Std. Error	P-value Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1 Hour	24 Hours	.03856	.017	.080	-.0036	.0808
	48 Hours	.09078*	.017	.000	.0486	.1330
24 Hours	1 Hour	-.03856	.017	.080	-.0808	.0036
	48 Hours	.05222*	.017	.011	.0106	.0938
48 Hours	1 Hour	-.09078*	.017	.000	-.1330	-.0486
	24 Hours	-.05222*	.017	.011	-.0938	-.0106
Based on estimated marginal means						
*. The mean difference is significant at the .05 level.						
b. Adjustment for multiple comparisons: Bonferroni.						

Table 12: Results of the Post hoc Bonferroni pairwise comparison for dimensional stability of EXABITE Polyvinyl siloxane (Group II B)

(I) time	(J) time	Mean Difference (I-J)	Std. Error	P-value Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1 Hour	24 Hours	.018*	.002	.000	.014	.022
	48 Hours	.052*	.003	.000	.043	.061
24 Hours	1 Hour	-.018*	.002	.000	-.022	-.014
	48 Hours	.034*	.003	.000	.026	.043
48 Hours	1 Hour	-.052*	.003	.000	-.061	-.043
	24 Hours	-.034*	.003	.000	-.043	-.026
Based on estimated marginal means						
*. The mean difference is significant at the .05 level.						
b. Adjustment for multiple comparisons: Bonferroni.						

Table 13: Results of the Post hoc Bonferroni pairwise comparison for dimensional stability of RAMITEC Ployether (Group II C)

(I) time	(J) time	Mean Difference (I-J)	Std. Error	P-value Sig.[b]	95% Confidence Interval for Difference[b]	
					Lower Bound	Upper Bound
1 Hour	24 Hours	.014*	.002	.000	.009	.019
	48 Hours	.038*	.003	.000	.030	.047
24 Hours	1 Hour	-.014*	.002	.000	-.019	-.009
	48 Hours	.024*	.002	.000	.018	.031
48 Hours	1 Hour	-.038*	.003	.000	-.047	-.030
	24 Hours	-.024*	.002	.000	-.031	-.018
Based on estimated marginal means						
*. The mean difference is significant at the .05 level.						
b. Adjustment for multiple comparisons: Bonferroni.						

The least variations of linear dimensions was given by group II C (Ramitec polyether) at one hour with a mean value of 24.8228 mm. The values of the same group was decreased to a mean of 24.8089mm at the 24th hour 24.7844 mm at the 48th hour respectively.

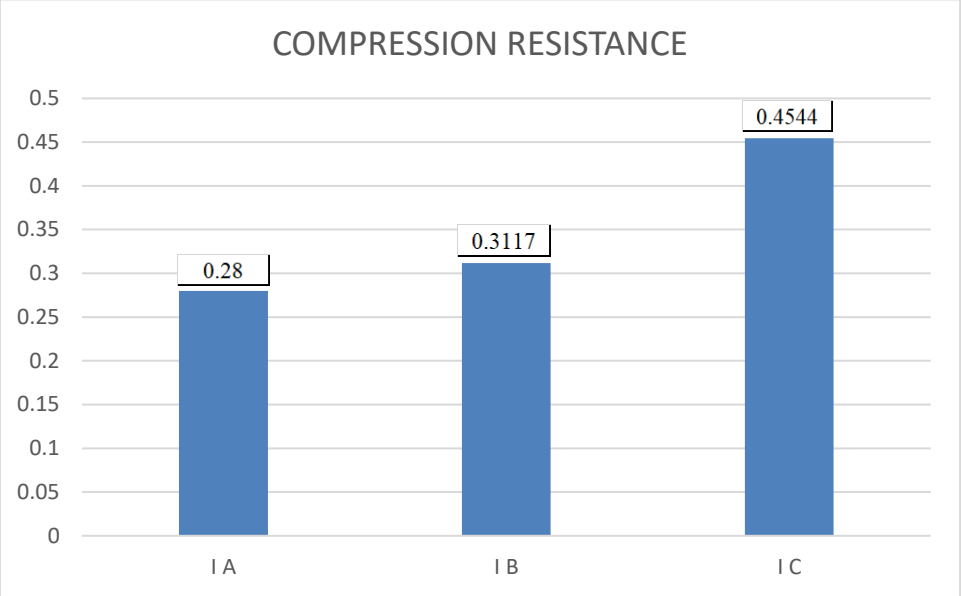
The second dimensionally stable group was of GC EXABITE (Group II B) polyvinyl siloxane with the mean value of 24.7961 mm at one hour and reduced to 24.7783 mm and 24.7439 mm during 24 and 48 hours respectively.

CADBITE polyvinyl siloxane was least dimensionally stable with the mean value of 24.8000 mm at one hour and 24.7133 mm by 48 hours of storage period.

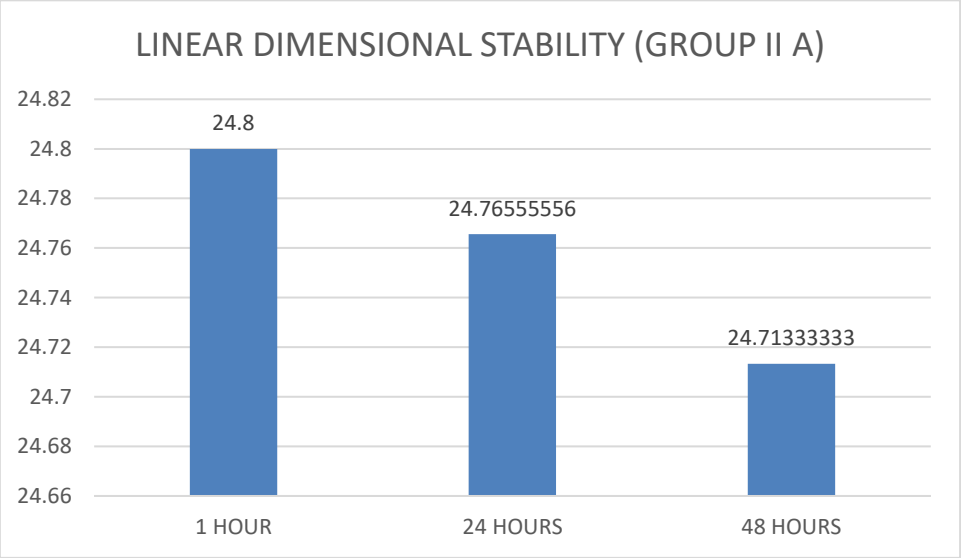
Table 14: Comparing the linear dimensional stability of three groups at various time intervals (Tukey HSD)

Dependent Variable	(I) groups	(J) groups	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
1 HOUR	II A	II B	.00389	.01491	.963	-.0321	.0399
		II C	-.02278	.01491	.286	-.0588	.0132
	II B	II A	-.00389	.01491	.963	-.0399	.0321
		II C	-.02667	.01491	.183	-.0627	.0093
	II C	II A	.02278	.01491	.286	-.0132	.0588
		II B	.02667	.01491	.183	-.0093	.0627
24 HOURS	II A	II B	-.01278	.01496	.671	-.0489	.0233
		II C	-.04333*	.01496	.015	-.0794	-.0072
	II B	II A	.01278	.01496	.671	-.0233	.0489
		II C	-.03056	.01496	.112	-.0667	.0055
	II C	II A	.04333*	.01496	.015	.0072	.0794
		II B	.03056	.01496	.112	-.0055	.0667
48 HOURS	II A	II B	-.03056	.01550	.130	-.0680	.0069
		II C	-.07111*	.01550	.000	-.1085	-.0337
	II B	II A	.03056	.01550	.130	-.0069	.0680
		II C	-.04056*	.01550	.031	-.0780	-.0031
	II C	II A	.07111*	.01550	.000	.0337	.1085
		II B	.04056*	.01550	.031	.0031	.0780

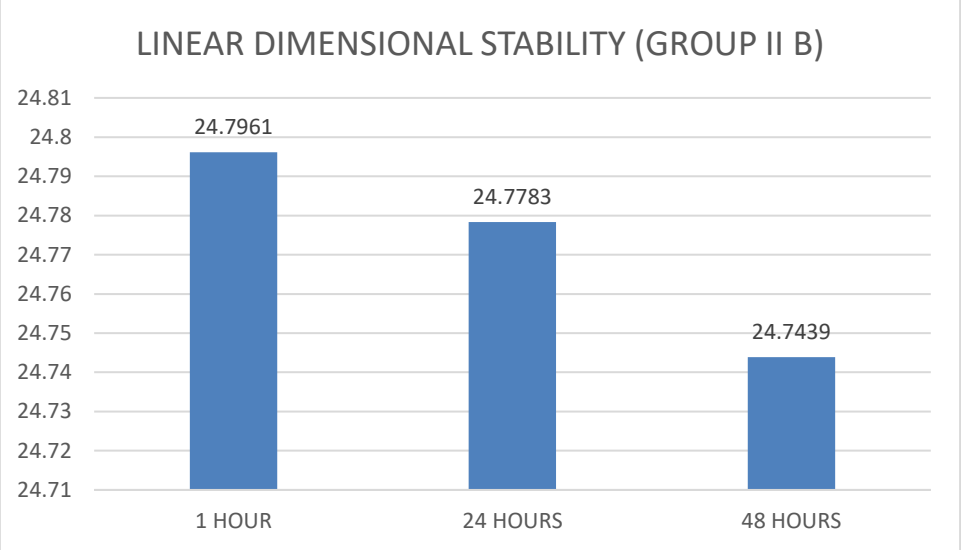
*. The mean difference is significant at the 0.05 level.



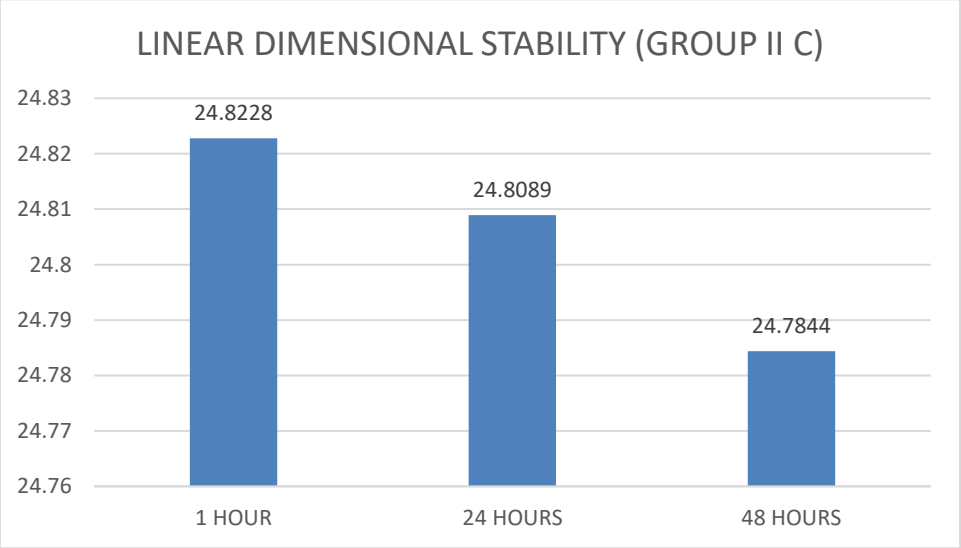
GRAPH 1: COMPARISON OF RESISTANCE TO COMPRESSION OF GROUP A, GROUP B AND GROUP C



GRAPH 2: COMPARISON OF LINEAR DIMENSIONAL STABILITY OF CADBITE POLYVINYL SILOXANE (GROUP II A)



GRAPH 3: COMPARISON OF LINEAR DIMENSIONAL STABILITY OF EXABITE POLYVINYL SILOXANE (GROUP II B)



GRAPH 4: COMPARISON OF LINEAR DIMENSIONAL STABILITY OF RAMITEC POLYETHER (GROUP II C)

DISCUSSION

DISCUSSION

Recording maxillomandibular relationships is an important step in oral rehabilitation. This relationship is transferred to the articulator, so that the laboratory procedures done on the casts will correspond with the patient's mouth. There are various methods of recording maxillomandibular relationships namely, graphic, functional, cephalometric and direct interocclusal.[35]

Direct interocclusal records are most commonly used to record maxillomandibular relationships because of their simplicity. The arches are brought into a relationship with or without tooth contact, and a space is created between the teeth. The recording material, which is initially soft, fills the spaces between teeth, hardens, and records the specific relationship of the arches. The hardened material is then transferred onto casts to be mounted on an articulator.[42] According to Millstein and Hsu, "The interocclusal record should be an accurate and dimensionally stable representation of an interocclusal space that is subsequently transferred to an articulator".[31]

The first interocclusal registration was made in 1756 by Philip Pfaff.1 Plaster, wax, modelling compound, zinc oxide - eugenol paste, auto polymerizing acrylic resin, condensation type silicones, polyether and polyvinylsiloxane are the commonly used materials for recording maxillomandibular relationship.[42]

The ideal properties of the interocclusal registration medium are

i) Limited initial resistance to closure (in order to avoid the displacement of mobile teeth or of the mandible during record making).
ii) Dimensional stability after setting.
iii) Resistance to compression after polymerization.
iv) Ease of manipulation.
v) Absence of any adverse effects on the tissues involved in the recording procedures.
vi) Accurate recording of the incisal or occlusal surfaces of the teeth and
vii) Ease of verification.[1]

The importance of accurate, reliable recordings of jaw relations cannot be overemphasized. The function of indirectly made crowns and fixed partial dentures is directly related to this critical step.[75] Correct interocclusal records give clinician the opportunity to make only minimal adjustments to the restorations that were delivered from the laboratory and avoid unnecessary use of chair time, or repetition of some clinical and technical stages.[1]

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 semi adjustable 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.[76]

Commonly used interocclusal record materials are:-

a) 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 *et al* 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.[24]

b) 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.[25]

c) 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.

d) 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 the 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.[19]

Lassila and McCabe found that polyether interocclusal records expanded considerably when stored in water 1.4% of expansion was observed after 72 hours.[20]

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 by products during setting.[16]

e) 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.[38] 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.

One of the most desirable characteristics of the interocclusal registration materials is resistance to compression after polymerization. The material should be rigid enough to resist the distortion that might be caused from the weight of the dental casts, the components of the articulator, or other means used to stabilize the casts during the mounting procedure.[45] The ability of an interocclusal registration material to resist compressive forces is very important because any discrepancy between the intraoral relationships of the teeth and the position of the teeth on the mounted working casts will result in restorative errors.[29]

Breeding L C, Dixon D L *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, so this value was selected in the investigation.[29]

The thickness of the interocclusal recording materials were selected to simulate clinical situations. A limited thickness of recording material is usually indicated between prepared teeth on one arch opposing an unprepared dental arch compared with a thickness of material between two opposing edentulous arches. The specimens were stored at room temperature for 12 hours to simulate the time between clinical and laboratory phases (registration and mounting).[29]

In the above context, the present in vitro study was conducted with the aim of evaluating and comparing the resistance to compression and dimensional stability of three types of commercially available elastomeric interocclusal recording materials (polyvinyl siloxane and polyether) at time intervals of 1, 24, and 48 hours.

The Universal Testing Machine measures the compression distance or the deformation in the test samples. The compression distance of Cadbite polyvinyl siloxane (Group I A) ranges from 0.21 mm to 0.36 mm, with a mean value of 0.28 mm. The compression distance of Exabite polyvinyl siloxane (Group I B) has a lower limit of 0.26 mm and an upper limit of 0.36 mm, with an average displacement of 0.3117 mm. The values of compression distance of Ramitec polyether (Group I C) ranges from a minimum of 0.37 mm to a maximum of 0.53 mm, and a mean displacement of 0.4544 mm.

Tukey's HSD POST HOC test compared between two groups and significant p values were obtained. When group I A was compared with all other groups, there was a statistically significant difference between group I A and group I B with a p value of 0.49, and between group I A and group I C with a p value of 0.00.

When group I B was compared with all other groups, there was a statistically significant difference between group I B and group I A with a p value of 0.49, and between group I B and group I C with a p value of 0.00.

The samples with least amount of deformation will have maximum compression resistance. Hence, the Cadbite polyvinyl siloxane (Group I A) exhibited maximum compression resistance. The polyvinyl siloxane groups had less compression deformation and hence, better compression resistance compared to the polyether interocclusal record material. Ramitec polyether (Group I C) showed maximum values of deformation on compression and hence, has least compression resistance.

Then, the values obtained for linear dimensional stability was assessed. The least variations of linear dimensions was given by group II C (Ramitec polyether) at one hour with a mean value of 24.8228 mm.The values of the same group was decreased to a mean of 24.8089mm at the 24th hour 24.7844 mm at the 48th hour respectively.

The second dimensionally stable group was of GC EXABITE (Group II B) polyvinyl siloxane with the mean value of 24.7961 mm at one hour and reduced to 24.7783 mm and 24.7439 mm during 24 and 48 hours respectively.

CADBITE polyvinyl siloxane (Group II A) was least dimensionally stable with the mean value of 24.8 mm at one hour, 24.7655 at 24 hours and 24.7133 mm at 48 hours of storage period.

The results of post hoc tests gave significant differences and p values between the three groups. When group II A was compared with all other groups, there was a statistically significant difference between group II A and group II B with a p value of 0.00, and between group II A and group II C with a p value of 0.00.

When group II B was compared with all other groups, there was a statistically significant difference between group II B and group II A with a p value of 0.00, and between group II B and group II C with a p value of 0.00.

The values dimensional stability of all the three groups was found to be decreasing from time period one hour to 24 hours to 48 hours. As the storage time increases the dimensional stability of the samples decreases and hence, the less stable polyvinyl siloxane interocclusal recording materials should not be stored for more than an hour. Working castes with the interocclusal records must be articulated within an hour for better results.

The limitation of the present study was that it was carried out in vitro and not in oral environment. There could be oral fluids like saliva and blood in the oral cavity which would alter the properties of the materials used. Thus, further in- vivo studies may be required to confirm the in-vitro findings.

CONCLUSION

CONCLUSION

Within the limitations of the study, the following conclusions are drawn:

1. Among all the groups, the maximum compression resistance was exhibited by Cadbite polyvinyl siloxane interocclusal recording material followed by Exabite polyvinyl siloxane.

2. The Ramitec polyether interocclusal recording material had the least compression resistance.

3. The linear dimensional stability of Cadbite polyvinyl siloxane, Exabite polyvinyl siloxane and Ramitec polyether were inversely affected as the storage time increased from 1 hour to 24 hours to 48 hours.

4. Ramitec polyether interocclusal recording material was found to be the most dimensionally stable elastomeric inter occlusal recording material.

5. The linear dimensional stability of polyether was followed by Exabite polyvinyl siloxane and Cadbite polyvinyl siloxane interocclusal recording material being the least stable.

To summarize, the study compared and evaluated the compression resistance and linear dimensional stability of different elastomeric interocclusal recording materials. Three commonly used interocclusal recording materials were used for this study: Ivoclar Virtual Cadbite Registration polyvinyl siloxane (Group A), GC Exabite II polyvinyl siloxane (Group B), and 3M Ramitec polyether bite registration paste (Group C). A total of 108 specimens were fabricated and divided into 6 sub groups with 18 samples each.

Standard cylindrical stainless steel die, with internal diameter and length of 10mm was loaded with 18 samples each, from the three groups, for evaluating compression resistance. Each of the test samples was loaded on the Universal Testing Machine and subjected to a constant compressive force of 25 N for a duration of 60 seconds. The deformation of each specimen was measured after 60 seconds of loading to obtain compression distance values. Also, 18 samples each from the three groups were loaded in the standard stainless-steel die with ADA Specification No.19, for evaluating linear

dimensional stability. The distance between the lines, reproduced on the samples, was measured at three different points by using Toolmaker microscope, at time intervals of 1 hour, 24 hours and 48 hours. The results obtained was statistically analysed. As ANOVA showed a significant overall difference between the groups, Post Hoc test was performed to check the level of difference at individual level.

Within the limitations of the study, the following conclusions were made: Among all the groups, the maximum compression resistance was exhibited by Cadbite polyvinyl siloxane interocclusal recording materal, followed by Exabite polyvinyl siloxane and Ramitec polyether interocclusal recording material. The linear dimensional stability was maximum for Ramitec polyether material followed by Exabite and Cadbite polyvinyl siloxane bite registration materials, at time intervals of 1 hour, 24 hours, and 48 hours.

Further researches can be carried out in- vivo to confirm the in-vitro findings obtained.

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ANNEXURES

ST. GREGORIOS DENTAL COLLEGE

UNDER THE MANAGEMENT OF MJSCE TRUST, PUTHENCRUZ

CHELAD , KOTHAMANGALAM, ERNAKULAM DIST, KERALA - 686681

SGDC/152/2019/3733

15/11/2019

ETHICAL CLEARANCE CERTIFICATE

To,

Dr.Raisa Mariam Jacob
St.Gregorios Dental College
Chelad, Kothamangalam

Dear Dr.Raisa Mariam Jacob

Subject: Ethics Committee Clearance – reg.

Protocol: A comparative evaluation of the compression resistance and dimensional stability between three elastomeric interocclusal recording materials: An in-vitro study.

At the Institutional Ethics Committee (IEC) held on 15th of November 2019, this study was examined and discussed. After consideration, the committee has decided to approve and grant clearance for the aforementioned study.

The members who attended the meeting at which the protocol was discussed were:

1) Dr.C.K.K Nair - Former BARC Scientist.
2) Dr.Cinu Thomas A - Scientist, Senior lecturer, Department of Pharmaceutical Sciences Centre for Professional and Advanced Studies.
3) Dr.Lissy Jose - Former member Women's Welfare Association.
4) Adv.Jose Aranjani - Advocate.
5) Dr.Sauganth Paul - Reader, Department of Biochemistry, St. Gregorios Dental College.
6) Dr.Eapen Cherian - Secretary.
7) Dr.Jain Mathew - Principal and Head of the Department, Department of Conservative Dentistry and Endodontics.
8) Dr.George Francis - Head of the Department, Department of Prosthodontics and Crown & Bridge.
9) Dr.Binoy Kurian- Head of the Department, Department of Orthodontics &Dentofacial Orthopaedics.

Dr. C.K.K Nair
Chairman Institutional Ethics Committee
St.Gregorios Dental College, Chelad

St.Gregorios Dental College Chelad - 686 681

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LIST OF ABBREVIATIONS USED

ADA	American Dental Association
wt %	Weight percentage
%	Percentage
mm	Millimeter
µm	Micrometer
cm	Centimeter
gm	Gram
N	Newton
Pa	Pascal
s	Seconds
min	Minute
SD	Standard deviation
Fig	Figure
P value	Probability value
hr	Hour