

In Vitro Comparative Study of Dimensional Stability of Three Different Polyvinyl Siloxane Interocclusal Recording Materials after Storage for Different Time Intervals of 12Hours, 24Hours, and 48Hours

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Abstract

Background: Interocclusal recording materials are generally used in prosthetic dentistry to register the jaw relationship. These materials have a wide range of viscosity, elasticity, and volumetric changes within various material groups. Newer elastomeric interocclusal materials are chemical modifications of elastomers whose comparative properties relevant to clinicians are yet to be studied.

Aims: To compare the dimensional change between the polyvinylsiloxane bite registration materials manufactured by different brands within the duration of 12hours,24hours, and 48 hours storage.

Methodology: The dimensional changes of the different polyvinylsiloxane bite registration pastes were compared three - dimensionally in different time intervals with the standardised die measurement was 25mm between the vertical lines .

Conclusion: Within the limitations of the study, it was found that all 3 interocclusal recording materials NEOSILK, CADBITE, AND O-BITE showed no significant distortion when stored in-vitro for 12 hours. All Materials showed significant distortion when stored in-vitro for 24 hours and 48 hours. All three materials showed more distortion when stored in 48hours compare to 24 hours. Among polyvinyl siloxane interocclusal recording materials NEOSILK showed better dimensional stability when compared with CADBITE and O-BITE when stored in-vitro 24hours and 48hours. Hence we recommend Neosilk bite material for better dimensional stability when compare with other materials.

Keywords: Dimensional stability, comparison, bite registration pastes

Introduction

The stomatognathic system in humans is a complex that combines the organs, structures and nerves involved in a multitude of functions like speech, mastication and deglutation. Functions of occlusion can influence the overall pattern and the foundation of the stomatognathic system. Long term success of any restoration is dependent on maintenance of harmony between various components of stomatognathic system. The goal of any restorative treatment is to establish posterior occlusal contacts that stabilize the occlusion and to provide anterior guidance which will provide predictable amount of disocclusion during protrusive and lateral

excursions. To achieve proper occlusion in a dentate or edentulous patient, the precise articulation of patient's diagnostic or working casts is a required. Recording and transferring of accurate existing occlusal records is of prime importance for a successful restoration.

Interocclusal recording material should ideally become rigid enough to resist distortion that might result from the weight of the dental casts and exhibit minimal dimensional change after setting before mounting of the casts in the articulator.

The basic principle approach should be that the interocclusal record must be at the correct vertical and

horizontal relation with an accurate, dimensionally stable recording material and recording of eccentric maxillomandibular relations an appropriate method of mandibular guidance.¹ Among the errors in interocclusal recording, only iatrogenic and material based ones are preventable by the operator. Hence, it is essential to know properties of interocclusal recording material.¹

Earlier interocclusal recording materials were impression plaster, bite waxes and zinc oxide eugenol pastes. The newer materials polyvinyl siloxane and polyether are being used commonly due to their elastic properties and dimensional stability. The polyvinylsiloxane bite registration materials have the advantages of less rigidity with easy removal from undercuts compare to polyether materials.

Hence, this study was done to study the dimensional change between the different polyvinylsiloxane interocclusal recording materials commonly used in clinical practice namely CADBITE, NEOSILK AND OBITE at different time intervals.

Materials and Method

The following polyvinylsiloxane interocclusal recording materials were selected for the study: Viz. Virtual CADBITE, NEOSILK, and O-BITE interocclusal recording materials.

Armamentarium used for the study were Stainless steel die (ADA specification – 19), OPUS Nikon profile projector, Auto mixing gun with mixing tips and permanent marker.

1. Preparation of stainless steel die:

For the present study 2 stainless steel dies were prepared according to ADA specification No.19 for preparation of test specimens with different polyvinyl siloxane bite registration materials. According to ADA specification 19 each die consisted of a cylindrical stainless block of 38mm diameter, with 30mm diameter step on its superior surface. The die was scored with 3 horizontal lines and 2 vertical lines on the top of impression surface. The horizontal lines were marked as X, Y, Z and vertical lines were marked as CD and C'D' for ease in making measurements. The distance between two horizontal lines was 25mm and between two vertical lines was 25mm. The die was subjected to Nd-YAG Laser treatment and 3 horizontal and 2 vertical line were scribed, with the width of 0.016mm on top of

30mm diameter surface. According to above-mentioned specifications a total 2 dies were prepared.

Each die had a highly polished surface and also contained a ring that surrounds the periphery of it, which serves as a tray or as a container for the interocclusal recording material.

2. Manipulation of Materials:

polyvinyl siloxane materials were supplied in the form of cartridge containing base and accelerator paste. Manufacturer's instructions were meticulously followed for manipulation and the material which extruded from gun was uniformly spread over the surface of the die. Glass plate covered with polyethylene sheet was placed on the die over with a weight of 500g was kept and allowed to set for 4-5mins.

3. Specimen fabrication:

Each material was manipulated as mentioned above and total force of 5.55N was applied. The whole assembly was then submerged into a water bath for the setting time suggested by manufacturer plus 3mins to ensure polymerization. After removal from water bath the material was separated from the die by using brass disk or Riser to remove the excess flash trimmed using scalpel. Thus prepared specimens were measuring 30mm in diameter 3mm in thickness and had lines X,Y,Z,CD,C'D' lines on it. Similarly all the 40 bite registration record samples were obtained.

In between the days of observation, the samples were stored in moisture free polyethylene bags at room temperature of 28 ± 2 °C.

4. Testing of specimens:

The distance between the lines, CD and C'D' reproduced on the sample, was measured at three different points PP', QQ' and RR' (i.e. intersections of these lines with the lines XYZ) by using Nikon Profile Projector V-12 with 10X magnification. Readings were obtained for each sample, and the mean of these three values were noted. Likewise, readings were made at different time intervals, viz. immediately after removal of the material from die, 12hours, 24hours and 48hours, respectively for each of the samples. All the readings thus obtained were tabulated and subjected to statistical analysis for the comparison and correlation of dimensional stability.

Statistical Analysis

The descriptive statistics was given by mean and standard deviation. The dimensional change over time was analysed by Friedman’s repeated measures (ANOVA). For significant values, post hoc test was done

using Wilcoxon Signed Rank test (Paired). At every time interval, the groups were analysed by Kruskal Wallis test with post hoc Dunn test, where values were significant. P < 0.05 was considered significant. Analyses were performed with IBM-S

Result

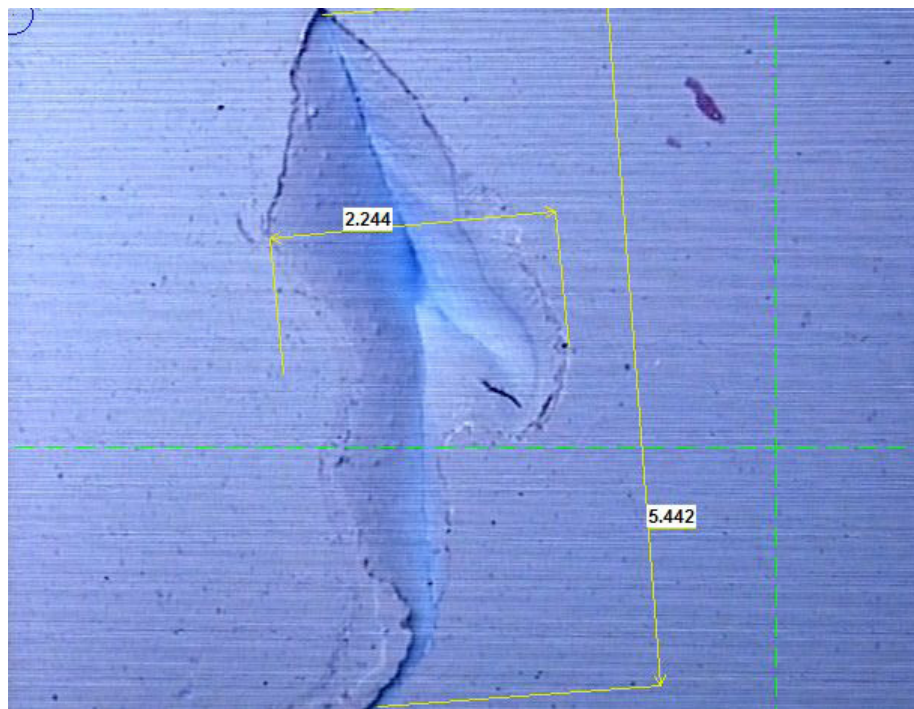
Table 1 – Dimensional Stability of the Bite Registration Pastes

Brand	12HRS	24HRS	48HRS	P Value
CAD-BITE	24.72 ± 0.0424	24.70 ± 0.0759	24.66 ± 0.0884	0.1224*
NEO SILK	24.73 ± 0.0297	24.72 ± 0.0272	24.71 ± 0.0352	0.2019*
O-BITE	24.73 ± 0.0282	24.62 ± 0.1325	24.51 ± 0.2161	0.0055*\$
P Value	0.8866**	0.4682**	0.1636**	----
P value (PostHoc)	NA	0.05876 [#]	0.01242^{#S}	----

*-Friedman’s Repeated Measures ANOVA; **-Kruskal Wallis Test; [#]-Wilcoxon Signed Rank Test (Post Hoc); \$-Statistically Significant.



Figure – 1: Metallic master die with riser



Figure–2. View of the sample seen through Opus Nikon Profile projector (Representative photograph)

Discussion

The properties of the dental materials vary with the temperature and humidity. Most of the materials used in prosthodontic procedures should be stored in the ambient temperatures to maintain their shelf life. The operator skill in the manipulation of the material is very important apart from the storage conditions of the material.

The dimensional changes in the recording materials will not transfer the true maxilla-mandibular relation from the mouth to the articulator and the prosthesis fabricated will have occlusal contacts in the mouth different from the one fabricated in the articulator. The time elapsed between the interocclusal record, and the mounting in the articulator extends up to three days as the work is sent to distant laboratory. The casts and the interocclusal record are sent to laboratory in different conditions as separately with the casts, casts tied with the rubber bands or mounted immediately. The dimensional changes in the interocclusal recording materials can be expected when the material is removed from the mouth due to the variation in the temperature between the oral cavity and the dental office and the plastic deformation when the material is removed from the mouth. This distortion is possible even when the casts are mounted immediately.

The distortion of the material is expected when the upper and the lower casts are tied using the rubber bands with the interocclusal material interposed and transferred to the laboratory. This distortion is due to the constant pressure till the casts are mounted in the articulator by the laboratory technician.

The time elapsed between the interocclusal recording and the casts mounted in the articulator will cause distortion due to the prolonged setting or polymerisation and the variation of the temperature between the dental office and the laboratory. The average time for mounting of the casts using the interocclusal record varies from few hours when the laboratory is situated locally to two days when sent to distant place.

The current study was done to assess the distortion of the interocclusal record at the intervals of 12 hours, 24 hours and 48 hours similar to the normal clinical situations. The study was done with the interocclusal record without any pressure application to check distortion at different time intervals.

Poly vinyl silicone and poly ether materials, when used as interocclusal materials solved most of the problems associated with the earlier materials. These materials are elastic with moderate stiffness (elastic modulus) so that they can be removed from the mouth and mounted in the articulator without breakage.

These materials are supposed to high dimensional stability, as they do not release any by-product during polymerisation. Polyvinyl siloxane materials have lower stiffness with the comfortable removal from the mouth and mounting with articulator than the polyether so that poly vinyl siloxane interocclusal materials are commonly used as interocclusal record.

Direct interocclusal record is the most commonly used technique to record maxilla-mandibular relationship. The recording material is soft initially, and it fills the space between the teeth, hardens, and records the specific relationship of the arch. The set material is transferred to cast and mounted on the articulator.³

Nisan et al. observed that addition type polyvinylsiloxane was the most accurate and stable interocclusal recording material. Previous studies have also demonstrated that handling PVS bite materials remain dimensionally stable up to 7 days.⁴ Many authors have evaluated the dimensional change of bite registration materials by means of stone casts and different devices such as three dimensional Zeiss meter, digital caliper, microscope, and stereomicroscopes and Profile Projectors.^{4,5,6} In the current study Nikon Profile Projector was used for the evaluation of dimensional stability due to its higher precision combined with ease of use.

The stainless steel die used in the present study was similar to the standard die given by ADA specification No 19.⁷ The surface of this die is smooth and shiny; therefore, it is easier to evaluate dimensional changes compared to tooth surface with cusps and fossa. In the standard ADA dies, the diameter and angles of the flutes are important for evaluation of the accuracy of impression materials.⁸ This study evaluated the distance between the vertical lines at different time intervals with different interocclusal recording materials. The test die has 25mm distance between the vertical lines.

The distance between vertical lines for Cadbite poly vinyl siloxane interocclusal material in the present study was 24.71 mm for 12 hours, 24.72 mm for 24 hours and 24.62 mm for 48 hours. In Neosilk poly vinyl siloxane interocclusal material the measured values between the vertical lines was 24.74 mm for 12 hours, 24.71 mm for 24 hours and 24.68 mm for 48 hours. In O-Bite material it was 24.72 mm for 12 hours, 24.30 mm for 24 hours and 24.31 mm for 48 hours.

Balthazar-Hart et al, (1981) had done a study with polyether and zinc oxide eugenol paste and concluded that Polyether shows the least distortion, and zinc oxide eugenol paste presents higher distortion.⁹ Lassila et al, in 1986 had done a study with acrylic resin, zinc oxide eugenol pastes and elastomeric materials and concluded that elastomeric materials have good dimensional stability when compared with acrylic resin and zinc oxide eugenol paste.¹⁰ Karthikeyan et al, in 2007 has done a study with polyvinylsiloxane bite material, zinc oxide eugenol pastes, and bite registration wax (aluwax) and concluded that Polyvinylsiloxane (Virtual, Group A) was dimensionally more stable followed by zinc oxide eugenol paste (Superbite, Group C) and then Bite registration wax(Alumax, Group B).¹¹

According to the results obtained in a study done by Sampath Kumar Tejo et al in 2012, Polyether was found to be more dimensionally stable than polyvinylsiloxane followed by zinc oxide eugenol.¹² They recommended the use of polyvinylsiloxane recording material should be articulated within 24 hrs. They also recommended that polyether should be articulated within 48 hrs and Zinc oxide eugenol within 1 hr to prevent distortion. Polyvinylsiloxane bite registration material is popular contemporary bite registration material along with polyether material.

The newer polyvinyl siloxane bite registration materials used in this study Cadbite, Neosilk and O-bite have a major composition of vinyl polysiloxane, methyl hydrogen siloxane, silicone dioxide. They polymerize by addition polymerization and do not form any by-product in the reaction. They have longer polymerization period resulting in sustained contraction period. These are the reasons for these materials being more dimensionally stable than earlier materials.

Conclusion

Within the limitations of the study following conclusions were drawn. Polyvinyl siloxane interocclusal recording materials NEOSILK, CADBITE, and O-BITE showed no significant distortion when stored in-vitro for 12 or 24 hours, but showed significant distortion when stored in-vitro for 24 hours and 48 hours. Among polyvinyl siloxane interocclusal recording materials NEOSILK showed marginally better dimensional stability when compared with CADBITE and O-BITE when stored upto 48 hours.

Conflict of Interest: No conflict of interest

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Ethical Clearance: Taken

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