

A Clinical Comparative Study of Four Interocclusal Recording Materials

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Abstract

Objective: The aim of the study was to evaluate the accuracy of four interocclusal recording materials and its effect on the relationship of the casts. **Materials and Methods:** The study was conducted on a group of 25 partially edentulous patients with upper complete natural dentition and lower bilateral free end edentulous areas. Ten pairs of reference points were drawn on the lateral surfaces of the base of each cast pair when the casts were manually articulated in maximum intercuspation position. The vertical distances between each pair of reference points were measured by a scanner and computerized software. Four interocclusal records were made for each patient by four interocclusal recording materials: zinc oxide eugenol paste, polyvinyl siloxane, Aluwax, and Baseplate wax. The casts were fixed on each record, and the vertical separation, anteroposterior, and lateral displacement were measured and calculated. **Results:** Polyvinyl siloxane was significantly more likely to lead to successful articulation than other interocclusal recording materials. Aluwax caused the highest vertical separation whereas Baseplate wax caused the greatest lateral displacement between the casts. **Conclusion:** Polyvinyl siloxane interocclusal recording material was the most accurate whereas Waxes were the least reliable materials.

Keywords: Accuracy, interocclusal recording materials, manual articulation

INTRODUCTION

An accurate transfer of the intraoral maxillomandibular relationship to the articulator is responsible for occlusal quality and essential fabrication of a prosthetic restoration.^[1,2] Many materials have been used for interocclusal records. These materials are basically impression materials but have been modified to give better handling characteristics.^[3] They include dental waxes, metal oxide pastes (such as zinc oxide pastes), acrylic resins, and elastomeric materials, such as polyethers and addition silicones.^[4] These materials should possess attributes as similar as possible to the requirements for ideal bite registration material.^[1,5] An ideal occlusal registration material should provide dimensional stability, resistance to compression force after setting, accurate recording, ease of handling, biocompatibility with the tissues involved in the procedure and ease of verification. The accuracy of an interocclusal record is influenced not only by the material properties, but also

by the recording technique, as well as the reliability of the mandibular position influenced by the occlusal contacts, muscular action, or tissue changes within the joints.^[6] However, apart from the operator's clinical ability and the technique followed, the chosen material can critically affect the accuracy of the interocclusal registration.^[3] The purpose of this study was to evaluate and compare four different interocclusal recording materials used to obtain interocclusal records for bilateral free end edentulous cases.

MATERIALS AND METHODS

The study was conducted on a group of 25 partially edentulous patients (11 males, 14 females—mean age:

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43.2 ± 7.5 years). Selected patients were invited to participate in the study and offered a consent form. All the patients had upper complete natural dentition and bilateral free end edentulous areas with remaining sound anterior teeth up to premolars in the mandible in order to allow manual articulation of the casts in maximum intercuspation position. Preliminary and final impressions were made for each patient. The bases of the master casts were cut the same as in orthodontic casts with modified octagonal shape. The upper and lower casts were manually articulated in maximum intercuspation position and fixed by wooden rods and impression compound [Figure 1].

Ten pairs of reference points were drawn on the lateral surfaces of the base of each cast pair (upper cast U1–U10, lower cast L1–L10). The lateral surfaces of the bases of the attached casts were scanned using a scanner (HP F2180, HP Corporation, Indonesia). During all scanning procedures, the base of the upper cast was fitted to the edge of the scanning screen to provide horizontal position of the base of the upper cast [Figure 2].

The vertical distances between each pair of reference points on the scanned photos were measured by computerized software (Adobe Photoshop CS2) [Figure 3].

Four interocclusal records were made for each patient by four interocclusal recording materials: zinc oxide

eugenol paste (Superbite; Bosworth, USA), polyvinyl siloxane (Virtual CADbite Registration Material; Ivoclar Vivadent, Italy), Aluwax (Aluwax Bite Registration Wax, Aluwax Dental Products, USA), and Baseplate wax (Tena Tex Red [Kemdent]; Associated Dental Products Ltd, Purton, Swindon, Wiltshire, UK). The materials were handled according to the manufacturer's instructions. After completing the recording procedures, the excess material was trimmed using a surgical blade. Each record was interposed between the casts then fixed by wooden rods and impression compound. The lateral surfaces of the bases of the attached casts were scanned, and the photos were analyzed by computerized software. The same procedure of measuring maximum intercuspation position (measurement of upper point to lower) was applied again after the application of interocclusal records. A vertical line was drawn from each upper point perpendicular to the lower points. The line might pass by the lower point or away from it. If the line is not passing the lower point, a new lower point will be formed by drawing a horizontal line intersects the vertical line; the horizontal distance between the two points was measured [Figure 4]. The procedure was repeated for all scanned



Figure 1: The manual articulation of the casts in maximum intercuspation position



Figure 2: Scanning of the lateral surfaces of the bases of the attached casts

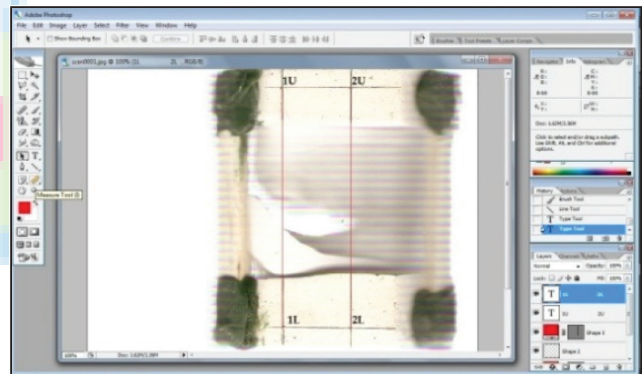


Figure 3: Measurement of the vertical distances between reference points by computerized software

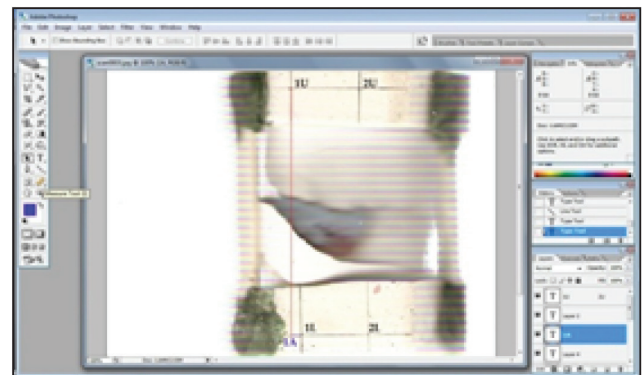


Figure 4: Drawing a horizontal line intersects the vertical line drawn from the upper point to measure the vertical and horizontal distances between the reference points after applying interocclusal records between the casts

photos of the lateral surfaces of the bases of the attached casts on each interocclusal record.

The vertical distance between each pair of upper and lower point (or the new lower point if present) was measured and compared to those made in maximum intercuspation position. These differences referred to the vertical separation values caused by each interocclusal recording material. The horizontal distance between each lower point and the new lower point (if present) was measured. The distances measured on the scanned photos of the right and left lateral sides of the bases of the casts referred to the anteroposterior displacement values caused by each interocclusal recording material [Figure 4]. On the other hand, the distances measured on the scanned photos of the anterior and posterior lateral sides of the bases of the casts referred to the lateral displacement values.

RESULTS

The data were collected and statistically analyzed using one-way analysis of variance (ANOVA) and Bonferroni test ($P \leq 0.05$). One-way ANOVA showed significant differences in vertical separation among the tested interocclusal recording materials [Table 1].

Bonferroni's method showed that polyvinyl siloxane differed significantly at 5% level from both of Baseplate wax and Aluwax. Polyvinyl siloxane showed the least mean value of vertical separation between the casts. On the other hand, Aluwax caused the highest mean value of vertical separation. No statistically significant differences in vertical separation mean value were observed between zinc oxide eugenol paste and the other tested materials [Table 2].

Analysis of values of lateral displacement showed that polyvinyl siloxane differed significantly at 5% level from Baseplate wax; polyvinyl siloxane showed the least mean value of lateral displacement. Baseplate wax caused the highest mean value of lateral displacement. However, no statistically significant differences were observed among the other tested materials [Tables 3 and 4].

The tested materials did not show significant differences in the mean value of anteroposterior displacement [Table 5].

DISCUSSION

Interocclusal record is one of the most important steps in any prosthetic treatment in order to make a successful prosthesis.^[7] It is a registration of the positional relationship of the opposing teeth or arches and has become the most

Table 1: Comparison of vertical separation between four interocclusal recording materials

| Source of variation | | Sum of squares | DF | Mean square | F | Significance |
|--------------------------|----------------|----------------|----|-------------|-------|--------------|
| Vertical separation (mm) | Between groups | 1.42 | 3 | 0.474 | 6.568 | 0.000* |
| | Within groups | 6.93 | 96 | 0.072 | | |

*Significant differences.

Table 2: Bonferroni test: Comparison of vertical separation between the groups

| Variation | Employment category (I) | Employment category (J) | Mean differences (I-J) | Standard error | Significance | |
|--------------------------|-------------------------|-------------------------|------------------------|----------------|--------------|----------------------------|
| Vertical Separation (mm) | Superbite | Virtual | 0.145 | 0.08 | 0.355 | No significant differences |
| | | Tena Tex Red | -0.131 | 0.08 | 0.525 | No significant differences |
| | | Aluwax | -0.153 | 0.08 | 0.28 | No significant differences |
| | Virtual | Tena Tex Red | -0.276 | 0.08 | 0.003 | Significant differences |
| | | Aluwax | -0.298 | 0.08 | 0.001 | Significant differences |
| | Tena Tex Red | Aluwax | -0.022 | 0.08 | 1 | No significant differences |

Table 3: Comparison of lateral displacement between four interocclusal recording materials

| Source of variation | | Sum of squares | DF | Mean square | F | Significance |
|---------------------------|----------------|----------------|----|-------------|-------|--------------|
| Lateral displacement (mm) | Between groups | 0.69 | 3 | 0.23 | 3.351 | 0.022* |
| | Within groups | 6.57 | 96 | 0.07 | | |

*Significant differences.

Table 4: Bonferroni test: Comparison of lateral displacement between the groups

| Variation | Employment category (I) | Employment category (J) | Mean differences (I–J) | Standard error | Significance | |
|---------------------------|-------------------------|-------------------------|------------------------|----------------|--------------|----------------------------|
| Lateral displacement (mm) | Superbite | Virtual | 0.07 | 0.07 | 1 | No significant differences |
| | | Tena Tex Red | -0.16 | 0.07 | 0.245 | No significant differences |
| | | Aluwax | -0.04 | 0.07 | 1 | No significant differences |
| | Virtual | Tena Tex Red | -0.23 | 0.07 | 0.015 | Significant differences |
| | | Aluwax | -0.11 | 0.07 | 0.786 | No significant differences |
| | | Tena Tex Red | 0.12 | 0.07 | 0.696 | No significant differences |

Table 5: Comparison of anteroposterior displacement between four interocclusal recording materials

| Source of variation | | Sum of squares | DF | Mean square | F | Sig. |
|-----------------------------------|----------------|----------------|----|-------------|-------|--------|
| Anteroposterior displacement (mm) | Between groups | 0.24 | 3 | 0.08 | 1.303 | 0.278* |
| | Within groups | 5.88 | 96 | 0.06 | | |

*No significant differences.

popular method of transferring maxillomandibular relations from the mouth to the articulator.^[8-10] Due to introduction of different interocclusal recording materials, dentists encounter difficulties in the selection of optimum material for the registration and transfer of occlusal records to the articulator.^[5] However, the clinician needs to decide the most suitable material–technique combination according to the existing intraoral conditions.^[10] This study was planned to evaluate four interocclusal recording materials commonly used in bilateral free end edentulous patients. In all cases included in this study, the presence of the lower anterior teeth up to premolars provided tripod of vertical support with satisfactory horizontal stability between the casts, which allowed their manual articulation in maximum intercuspation.^[11-13]

Waxes are the most commonly used interocclusal recording materials because of their ease of manipulation and cost-effectiveness.^[14] Aluwax consists of low-viscosity wax with impregnated aluminum particles to evenly disperse the heat and to avoid excessive cooling contraction.^[15,16] In this study, Aluwax caused the highest mean value of vertical separation, and Baseplate wax showed the highest mean value of lateral displacement and the second highest mean value of vertical separation with statistically significant differences from polyvinyl siloxane. There is general agreement that waxes, in any of the numerous forms available (Baseplate, beauty hard wax, metallized, or metallized with an aluminum laminate) are the least accurate materials.^[17] Waxes have low ability to reproduce the occlusal surfaces accurately.^[18] They can be distorted upon removal and have a dimensional change by release

of internal stresses. Furthermore, wax records may cause mandibular deflection and resistance to closure.^[12] These results were in accordance with previous studies that showed wax was the most variable and least reliable of all interocclusal recording materials.^[14,15,19] Pagnano *et al.*^[13] also found that wax provided the highest range of vertical variation. On the other hand, these results disagreed with the finding of another study by Pagnano *et al.*,^[20] which showed that wax caused the lowest vertical separation. This may be attributed to the difference in sample size and evaluation technique.

Zinc oxide eugenol is a traditional bite registration paste that is being used for a long time and has gained wide acceptance as impression as well as bite registration material because of its ease of manipulation and economy.^[21,22] It is shown to reproduce accurate surface details mainly because of its low initial viscosity coupled with its pseudo elastic nature, which allows fine detail reproduction.^[23] In addition, zinc oxide eugenol offers no resistance to closure of mandible, thus allowing a more accurate interocclusal relationship record to be formed. Nevertheless, it dehydrates, cracks, and sticks to the teeth, and vital portions of the record can be lost through breakage.^[19] In this study, Zinc oxide eugenol showed acceptable results without statistically significant differences from other tested materials. Currently, polyether and polyvinyl siloxane bite recording materials are increasing in popularity due to their handling characteristics, accuracy, and dimensional stability. These materials are very similar to dental impression materials, but their properties have been modified by addition

of plasticizers and catalysts.^[8,24] Polyvinyl siloxane bite registration material is characterized by short working time, setting time, high stiffness, low-percent strain in compression, and low flow.^[25] The results of this study revealed that polyvinyl siloxane was found to be the most accurate of all the tested materials. It showed the least mean value of vertical separation and lateral displacement. This may be attributed to its high stiffness and low permanent deformation at the time of removal.^[22] In addition, polyvinyl siloxane found to be the more accurate interocclusal recording material when articulating digital models.^[26]

CONCLUSION

On the basis of the findings of this study, the following conclusions were drawn:

- (1) Polyvinyl siloxane interocclusal recording material was the most accurate material among the four tested materials and waxes were the least reliable interocclusal recording materials.
- (2) It caused the least vertical separation between the casts followed by zinc oxide eugenol paste, Baseplate wax, and Aluwax.
- (3) Polyvinyl siloxane caused the least lateral displacement followed by zinc oxide eugenol paste, Aluwax, and Baseplate wax.
- (4) No statistically significant differences were observed among the tested materials in the anteroposterior displacement mean value.

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Conflicts of interest

There are no conflicts of interest.

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