



EFFECT OF DIFFERENT BITE RECORDING MATERIALS ON MOUNTING ACCURACY OF WORKING CAST

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ABSTRACT

Objective: To assess effect of different bite recording materials on accurate mounting of working casts. **Materials and Methods:** A 40 maxillary and mandibular stone casts were obtained from a complete anatomic dentoform using monophasic medium-bodied consistency polyether impression material. Derived stone casts were divided according to bite registration material in to four groups (10 samples each); 1. wax group, 2. polyvinyl siloxane group, 3. polyether group and 4. Bis-crylic resin group. Ten bite records were obtained with poly vinyl siloxane recording material from hand articulated dentoform to serve as control group. The 40 produced mandibular stone casts were mounted on semi adjustable articulators using four bite registrations tested materials (10 for each). Unilateral Polyvinyl siloxane bite registration were made for 40 mounted stone casts to evaluate bite registration accuracy. Then bite records were placed on a light box and a camera set at a fixed distance 8 inches was used to capture the light transmission that was projected through the bite material. The camera transferred the information to an image analysis program (ImageJ) which measure accuracy of registration materials. **Results:** Numerical data were explored for normality by checking the data distribution and using Kolmogorov-Smirnov and Shapiro-Wilk tests. Grey scale data showed parametric distribution while measurement error showed non-parametric distribution. The difference between tested groups and control group was compared using ANOVA test. The results revealed that, the difference between test groups and control was insignificant (P -value = 0.104). **Conclusions:** All tested bite registration materials had comparable results, although Luxabite and polyether showed higher errors than polyvinyl siloxane and wax.

KEYWORDS: Bite recording materials, working casts, polyvinyl siloxane, polyether

INTRODUCTION

To obtain a comfortable prosthesis serves the patient for several years, maintains his TMJ healthy and intraoral components, proper procedures during interocclusal recording should be obtained^(1,2). The more the correct placement of the working cast the less chair time is needing to adjust occlusal irregularities. Mounting of diagnostic and master casts on an articulator is very important step in diagnosis and treatment of partially and complete edentulous patient⁽³⁾.

Interocclusal recording materials should reproduce occlusal detail in addition to preservation of its rigidity and accuracy for reusing more than one time⁽⁴⁾. There are several materials that can be used for inter-occlusal records. These range from hand occluding if there are enough teeth, to the cheap and easy wax bites, to the thin electric sheets or cameras connected to specialized computer software⁽⁵⁻⁸⁾. Elastomeric recording materials have proven to be stable, dimensionally accurate, do not require trays nor special equipment and are easy to

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manipulate^(9,10). There are ideal requirements for bite registration materials which mostly provided in elastomeric materials⁽¹¹⁾. Two basic elastomeric materials used for this purpose, addition silicon and polyether elastomers. Addition silicon has proven to be highly accurate due to no byproducts unlike its predecessor, minimal resistance to closure and simplicity of use. The drawback of these materials elicited as deformation when compressive force applied throughout casts articulation⁽¹²⁾. These elastomers have same composition of elastomeric impression materials in addition to some modifications such as plasticizers^(13,14).

One of known bite recording material is a bis acrylic resin by Zhermack. Although it is not a pure elastomer, the additives in its composition gives it's a rubbery consistency. Together with its glassy filler, it is considered part of the elastomeric recording materials used in the market⁽¹⁵⁾.

To obtain replica of patient bite record and transmit it to mounting working casts, accurate record checking and assessment should conduct. There is no constant rule for evaluation and quantifying inter occlusal contacts in oral cavity. First evaluation method started with Yurkstas et al in 1951⁽¹⁶⁾. Some authors measure maximum contact and non-contact areas between opposing teeth using computer which analyses the photos obtained for light passed through bite registration⁽¹⁷⁾. With the continued development in the digital age Owens et al⁽¹⁸⁾ transferred from illumination to quantification of pixel density where, density below 50μ was considered a contact, $50-350\mu$ was marked as a near contact and 350μ or more was a non-contact area.

MATERIALS AND METHODS

A Dentoform model number 561-562 (Columbia Dentoform Corp, New York, USA) was used to produce forty stone casts to evaluate the accuracy of four different bite registration materials; 1. Wax (Modelling wax ,Cavex), group W;

2. Polyvinyl siloxane (Occlufast, Zermack), group PV; 3. Polyether (Ramitec, 3MESPE), group PE; 4. Bis-acrylic resin (Luxa bite, DMG), group B. To confirm the efficacy of used bite registration methods, control group (10 samples) obtained from hand mounted dentoform using vinyl poly siloxane registration material.

Specimens fabrication:

Maxillary and mandibular stone casts were fabricated by using a custom-made acrylic resin special trays with occlusal stops to produce a 1-2 mm space for a monophasic medium-bodied consistency polyether impression material (3M ESPE Monophasic). The impressions were poured with type IV extra hard stone (KIMBERLIT, Spain). The upper cast was mounted onto a semi-adjustable articulator using a Camper's table with a fixed 15-degree incline, Fig. (1). To allow assembling and reassembling of stone casts without mounting stone fracture, special mounting device (rail plate) was fabricated.



FIG (1) Cast articulated using Camper's table.

Using the original mounted dentoform model, 10 unilateral occlusal records were made in maximum intercuspation for each tested bite registration material. For standardization during bite registrations a 500gm weight applied. The least mounting gypsum was used to decrease deformity during articulation. To simplifying assembling and

re assembling mounted casts split of magnetic was used. The articulator closed until the pin reached the incisal table. For wax bite materials, a 2 mm thick pink wax plate was warmed in water, folded once and applied on the teeth then articulator closed. Ten unilateral registrations were done and then placed in cold water to regain maximum hardness. The records were used immediately after fabrication to articulate ten upper and lower derived casts together.

The polyvinyl siloxane bite material was supplied in a cartilage form so was directly expelled using a gun onto the occlusal surface. The Polyether bite material was supplied in a two-tube system which had to be hand mixed on a paper pad, uploaded into a syringe then injected. The Luxa bite material was supplied in a two-component tube with a mixing tip which was also just applied to the occlusal surface, Fig. (2). For each group the material was left to set for 4 minutes before removing. Any excess material was trimmed for easy repositioning and accuracy measurements. Bite registrations were utilized through twenty-four hours for articulation.



FIG (2) Registration with Bis-crylic resin (Luxa bite).

Bite registration accuracy evaluation:

A 40-vinyl poly siloxane occlusal records were obtained from articulated stone casts and dentoform then adjusted to rest flat on the light source during measuring accuracy.

Specimens were placed on a light box, and a camera set at a fixed distance 8 inches to capture the light transmission that was projected through the bite material. The camera transferred the information to an image analysis program (ImageJ). This system allowed the different amounts of light projected through perforations/near perforations occlusal contact areas in the impression to be translated into a gray scale value (GSV), which was assigned a thickness value, in millimeters, ie. optical density analysis of the transmitted light. All impression record scans were placed on the light source in the same position and at the same angle to minimize placement error.

RESULTS

Numerical data were explored for normality by checking the data distribution and using Kolmogorov-Smirnov and Shapiro-Wilk tests. Grey scale data showed parametric distribution while measurement error showed non-parametric distribution.

Repeated measures ANOVA was used to compare between the different techniques and control group. Friedman's test was used to compare between measurement errors of the different techniques. Wilcoxon signed-rank test with Bonferoni's adjustment was used for pair-wise comparisons between the techniques when Friedman's test is significant. The significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM SPSS (SPSS, Inc., an IBM Company) Statistics Version 20 for Windows.

Comparison between the different techniques and control group:

There was no statistically significant difference between the different techniques and control group (P -value = 0.104), Tab. (1) and Fig. (3).

TABLE (1) Descriptive statistics and results of repeated measures ANOVA for the comparisons between measurements of the different techniques and control group

Group	Mean	SD	Median	Minimum	Maximum	95% CI		P-value
						Lower bound	Upper bound	
Control	122.28	4.54	123.98	111.68	126.26	119.04	125.53	0.104
Luxe bite	115.68	6.38	115.55	101.75	124.28	111.12	120.25	
Polyether	116.51	3.06	116.50	111.86	120.31	114.32	118.70	
Polyvinyl Siloxane	122.91	4.08	122.52	118.68	132.10	119.99	125.83	
Wax	124.50	17.38	122.20	109.26	171.76	112.07	136.94	

*: Significant at $P \leq 0.05$

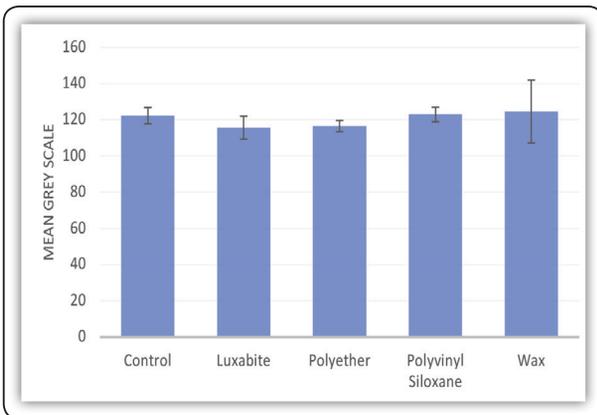


FIG (3) Mean and standard deviation values of grey scale for different tested techniques and control group.

Comparison between measurement errors with different techniques:

Measurement error was calculated as:

$$\text{Error} = \text{Control measurement} - \text{Technique measurement}$$

There was a statistically significant difference between measurement errors of the different techniques ($P\text{-value} = 0.033$). Pair-wise comparisons between the techniques revealed that there was no statistically significant difference between Luxabite and Polyether techniques; both showed a decrease in grey scale value compared to control. There was no statistically significant difference between Polyvinyl Siloxane and wax techniques; both showed an increase in grey scale value compared to control. Luxabite and Polyether techniques were statistically significantly different from Polyvinyl Siloxane and wax techniques, Tab. (2) and Fig. (4).

Regardless of increase or decrease - Luxabite and Polyether had higher error 'less accuracy' than Polyvinyl Siloxane and Wax.

TABLE (2): Descriptive statistics and results of Friedman’s test and Wilcoxon signed-rank test for the comparisons between measurement errors of the different techniques

Group	Mean	SD	Median	Minimum	Maximum	95% CI		P-value
						Lower bound	Upper bound	
Luxabite	-6.60 ^B	7.61	-5.40	-24.00	2.78	-12.05	-1.15	0.033*
Polyether	-5.77 ^B	4.34	-5.19	-12.78	1.23	-8.88	-2.67	
Polyvinyl Siloxane	0.63 ^A	7.07	-1.32	-6.75	14.38	-4.43	5.69	
Wax	2.22 ^A	15.93	-1.46	-14.05	45.50	-9.18	13.62	

*: Significant at $P \leq 0.05$, Different superscripts are statistically significantly different

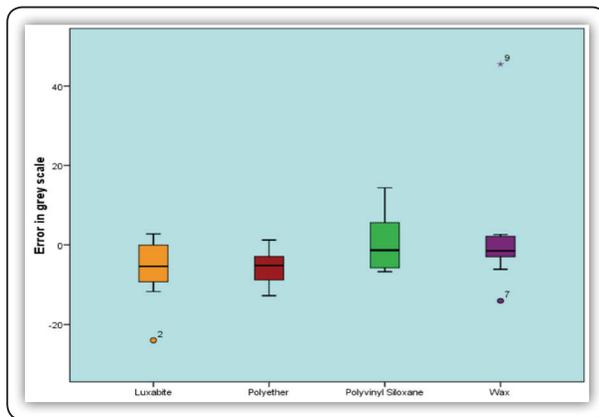


FIG (4) Median and Quartile values of measurement errors in grey scale of the different techniques (Circle and star represent extreme values).

DISCUSSION

This study was directed to evaluate if there was an effect of using bite recording materials on accuracy of produced casts during mounting on semi-adjustable articulator.

Several steps are required for transmission of intraoral details to dental technician. These procedures involving impression, bite registration, cast construction and articulation of obtained casts.

Standardization protocol and manufacture instructions were followed to minimize errors during bite recording and stone casts articulation. Patient variables were also eliminated by a dentoform model was used to remove oral cavity variables and allowing focus on the recording materials.

Bite registration between maxillary and mandibular arches is simple yet complex procedure. It seems easy due to finished in minimum time in contrast it appears complicated as related to the posture may be devious, hard to registered and not easy to transmit to an articulator.

For all types of prosthetic reconstruction, it is mandatory to reproduce accurate inter occlusal relation from patient mouth to mounting articulator⁽¹⁹⁾. Selection of the most suitable material and proper technique for taking inter occlusal record, provides

a prosthesis without need for any occlusal adjustments⁽²⁰⁾.

One of the most used materials for bite registration is modeling wax as it handles easily and is low priced but shows some dimensional inaccuracy⁽²¹⁾. Elastomers were most accurate bite recording materials as it produces least error⁽²²⁾. Also, these materials easy handling and have less or no impedance during occlusion, easy to remove excess without deformation and confirmedly produce fine detailed occlusal surfaces.

Addition silicones presented the least amount of distortion. This 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 elements occur in polymerization reaction. High accuracy, minimal resistance to closure and easy manipulation are the main advantages of addition silicones as interocclusal registration material. This in agreement with Deepthi et al⁽²²⁾.

The spring action found in these materials caused the articulated stone cast to open in centric relation position. Hence, the records should be trimmed, and adequate seated over the occlusal surface to minimize the negative spring action⁽²³⁾.

Polyether interocclusal recording material consists of the basic impression material augmented by plasticizers and fillers to improve its properties. The advantages of this material as an interocclusal registration material of high accuracy, excellent stability after polymerization and during storage, fluidity, minimal resistance to jaw closure and can be used without a carrier⁽²⁴⁾. Craig and Peyton⁽²⁵⁾ stated that there was a 0.3 % contraction in polyether at the end of 24 hours, so in this study all specimens were used within 24 hours to remove this variable. Polyether showed a negative reading on the grey scale measurement. A possible explanation is that although the specimens were used within 24 hours a small percentage of contraction still existed.

Acrylic resin is accurate and rigid after setting. Disadvantages of acrylic resin as an interocclusal recording material includes dimensional instability due to continued polymerization reaction resulting in shrinkage, the rigidity of the material can damage plaster cast and dies during mounting procedures on the articulator⁽²²⁾. These many disadvantages were apparent in our study, as it showed the highest measurement errors of all the groups.

Wax bite recording technique is known to the least accurate, studies stated that bite wax not suitable as bite recording material as it shows additional linear changes, which happened also in 1st 24 hours^(26,27). This in contrast with this study, this may have attributed to using of a fixation weight in our study.

Authors found that polyether showing more dimensional stability as compared to polyvinyl siloxane bite recording materials, but the two materials should use for mounting of working casts without significant change^(13,28). Our study found that all the materials used, wither elastomeric, acrylic or wax can produce an acceptable bite registration record.

CONCLUSIONS

Within the limitations of this study all tested bite registration materials had comparable results, although Luxabite and polyether showed higher errors than polyvinyl siloxane and wax.

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