

Comparative Evaluation of Accuracy of Alginate and Alginate Substitute Material Driven Casts Used for Mounting - An In- vitro Study

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Abstract:

Problem: One of the main driving force for use of alginate substitute driven opposing models is the severe mismatch between modern bite registration materials, Vinyl polysiloxane impression material and alginate driven stone models. Therefore the objective of the study is to compare the accuracy of alginate and alginate substitute material driven opposing casts in terms of reproduction of inter arch measurement and number of occlusal contacts in maximum intercuspation. **Approach:** A typodont tooth was scored with a round bur on the labial and buccal side on each maxillary and corresponding mandibular tooth on both the sides for inter arch measurements. Impressions of the typodont were made with alginate and alginate substitute material. Stone models were articulated in maximum intercuspation. Inter arch measurements were recorded using a Vernier digital caliper and number of occlusal contacts were registered using an articulating foil. Sharpico Wilk test was done for testing normality and data was found to be normally distributed. Continuous data was represented as mean and standard deviation. One way analysis of variance was done and p value of < 0.05 was considered as statistically significant. **Findings:** No statistically significant difference was found in terms of reproduction of inter arch measurements and the number of occlusal contacts in both the groups. **Conclusion:** Both alginate and alginate substitute driven opposing casts reproduced inter arch measurements and number of occlusal contacts in maximum intercuspation with comparable accuracy.

Key-words: Accuracy, Alginate , Alginate Substitute ,Occlusal Contacts.

Introduction:

Fabrication of a fixed dental prosthesis (FDP) like single unit crown, or multiple unit bridges inevitably involves a common protocol. A good quality impression material is used to impress the prepared teeth such as polyether or vinyl polysiloxanes (VPS).^[1] Following this bite registration is recorded and an opposing model is prepared from alginate material to allow mounting the casts on the articulator in the laboratory.

Once the prosthesis is fabricated and tried, occlusal discrepancies are a common finding and often the dental technician is blamed for technical errors.^[2] In reality, it is the sequence of procedures and the material selection that leads to clinical errors and valuable time wasted in trying to make the units fit.

Alginate impression material when used as an impression material for preparing opposing casts can contribute significantly to the resulting occlusal errors in FDP. Myriad of properties compromise quality of the alginate impression material. Hydrophilicity of alginate impression material helps to record a good impression in moist environment. This very property forces severe limitations to its use as hydrophilicity can affect dimensional stability.^[3] Therefore, alginate impression should be poured immediately to obtain cast with maximum accuracy because of the imbibition and syneresis property associated with the material. Usually after 10 minutes of storage alginate begins to distort and 1-3 hrs of storage is not recommended to be used for clinical use especially in fixed

prosthodontics.^[4] Powder -liquid ratio of alginate is difficult to control and can affect the flow, accuracy and working time.^[3] Disinfection can also cause distortion of the alginate.

Most commonly untrimmed bite registration material will never fit accurately on the alginate driven stone models no matter how accurate, the bite registration material is. This is due to the inherent mismatch in the accuracy of the two materials, as the occlusal anatomy recorded by VPS bite registration material is not replicated by the alginate, thus not allowing the bite registration to seat accurately on the alginate driven stone model.^[5]

Alginate substitutes are low cost VPS materials which are accurate, dimensionally stable and easy to use. Pouring of VPS can be delayed and also additional pours can be done to fabricate multiple casts^[6] as they are dimensionally stable. Studies have demonstrated that alginate substitutes are superior to alginate in terms of dimensional stability, tear strength and are not affected by disinfection technique.^[7] VPS impression material creates superior surface features of the opposing dentition, and variables of mixing the dental stone are continuously monitored in the laboratory, allowing for a more comprehensive and precise working model.

The mismatch of the working model, bite registration material and alginate driven opposing stone models is a cause of concern which necessitates extensive occlusal adjustments on fixed dental prosthesis. Boksman in a study demonstrated severe open bite mounting that can result when using a VPS bite registration material with a poorly detailed alginate driven stone cast.^[5] Hence, using VPS for making the final impression, for the bite registration and fabricating the opposing model eliminates the dimensional mismatch between the materials resulting in more accurate prosthesis and less time for occlusal adjustment.

Therefore, the study aims to compare the accuracy of alginate and alginate substitute driven stone models used as opposing casts for mounting in terms of reproduction of inter arch measurements and the number of occlusal contact in maximum intercuspation .

The null hypothesis tested was that there is no difference in the accuracy between the alginate and alginate substitute impression materials in terms of reproduction of inter arch measurement and number of occlusal contacts.

Subjects and Methods:

This study was initiated after ethics committee clearance from the institutional ethics committee (AJIDSEC/24/2020). Two marketed impression materials were used in the study. The sample size was calculated as 32 and samples were grouped into

Group A: Sixteen stone models fabricated using alginate impression material (Biokalgin, Chromatic Pro Alginate, Brulon group, Gujarat, India).

Group B: Sixteen stone models using alginate substitute impression material (VPS A-silicone, Xantasil, Kulzer, Hanau, Germany).

Maxillary and Mandibular typodont teeth were mounted in maximum intercuspation on a semi adjustable articulator (Hanau Wide Veue, Whipmix, Louisville, USA). The typodont was scored with a round bur on the labial and buccal side on each maxillary tooth and corresponding mandibular tooth on both the sides (maxillary second molar to mandibular second molar, maxillary second premolar to mandibular second premolar, maxillary canine to mandibular canine and maxillary central incisor to mandibular central incisor). Inter arch measurements were done (Fig 2) using a digital Vernier caliper (ANZ, India) and recorded to the nearest 0.1 mm.^[8] Inter arch measurements and static occlusal contacts in maximum intercuspation were recorded by two evaluators who were not involved in the study.

The static occlusal contacts were registered on the typodont using 12 μ m articulating foil (Fig 2) in maximum intercuspation.^[9] Occlusal contacts in terms of number of contact marks in the first premolar, second premolar and first molar were counted.

The values obtained in the typodont were considered as the standard values against which the values obtained by two test materials will be compared.

Impression was made using alginate and alginate substitute impression material for group A and group B respectively and the cast was fabricated from dental stone (TYPE III, Magic stone plaster, Gujarat dental products, Gujarat, India) according to the manufacturer's recommendations in group A. Mandibular working cast was fabricated with Type IV die stone (Prime rock, Next dental products, Gujarat, India) poured into VPS impression material (Photosyl, DPI, Uttarakhand, India) using putty wash impression technique.

The maxillary and mandibular casts were verified for accuracy and any small bubbles were removed from the occlusal surface of the casts using a sharp knife or a large round excavator and the casts were mounted on a semi adjustable articulator using an VPS interocclusal record (3M Espe Imprint, Neuss, Germany). A compressive force^[10] was applied onto the mandibular cast for stabilization and to reduce any vertical or horizontal discrepancies which may be caused by the interocclusal record. Then the weight was removed and the mounting procedure was completed.

Inter arch measurements were done using digital caliper and recorded to the nearest 0.1 mm on the stone models at the scored area and the static occlusal contacts were recorded on the stone models using 12µm articulating foil in maximum intercuspation. Occlusal contacts in terms of number of marks in the first premolar, second premolar and first molar were counted. The data obtained were tabulated.

Statistical analysis:

Data was analysed using SPSS for windows (Statistical System Software, SPSS Inc) version 21.0. Shapiro Wilk test was done for testing normality and data was found to be normally distributed. Continuous data was represented as mean and standard deviation. One way analysis of variance was done and p value of < 0.05 was considered as statistically significant.

Results:

Both the impression materials showed comparable accuracy in terms of interarch measurements and number of occlusal contacts within the experimental setup. The study showed that difference in the inter arch measurements were statistically insignificant in both the test groups compared to typodont which was taken as standard.

The mean inter arch measurement obtained in the typodont, alginate and alginate driven stone casts is presented in Table I. The mean inter arch measurement obtained in alginate and alginate driven stone casts were less than the typodont in all the measured region. This however, was not statistically significant ($p < 0.05$). Intergroup comparison of mean interarch measurement obtained in alginate and alginate substitute driven stone models is presented in Table 2.

Mean number of occlusal contacts obtained in typodont, alginate and alginate substitute driven stone casts in maximum intercuspation is presented in Table 3. There was no statistically significant difference found in the test groups compared to typodont in first premolar and first molar region ($p < 0.05$) except second premolar region which showed statistically significant ($p < 0.028$) differences. However, when individual number of contacts were considered in the premolar region the results were not clinically significant.

Inter group comparison of mean number of occlusal contacts in alginate and alginate driven stone casts in maximum intercuspation is presented in Table 4. However, there was no statistically significant between test groups in terms of reproduction of occlusal contacts in second premolar and first molar region ($p < 0.05$) except first premolar which showed statistically significant difference ($p < 0.020$). However, when individual number of contacts were considered in the premolar region the results are clinically significant.

Discussion:

The results of the present study indicate that there was no statistically significant difference between the alginate and alginate substitute driven stone casts when used as opposing models for mounting in terms of accuracy of reproduction of inter arch measurements and the number of occlusal contacts. Thus, null hypothesis was accepted.

When mean inter arch measurements obtained in the central incisor, canine, second premolar and second molar region were compared for both the test materials to that of typodont (standard value) there was no statistically significant difference. Inter group comparison between the alginate and alginate substitute impression material also did not reveal any statistically significant difference in terms of inter arch measurement.

In the present study, the percentage difference was calculated for variations in inter arch measurements from the standard value for both the test materials and it varied from a low of 3.59% (Alginate group maxillary second molar to mandibular second molar) to high of 6.36% (Alginate group maxillary canine to mandibular canine) in the maxillary second molar to mandibular second molar region. With a typodont inter arch measurement of 3.75 mm, a 3.59% difference would represent a discrepancy of 0.13mm. For maxillary canine to mandibular canine inter arch

measurement of 7.10mm, 6.36% difference would represent a 0.45mm discrepancy. However, because of smaller difference from the typodont group the results were not considered clinically insignificant.

A comparison in terms of reproduction of occlusal contacts compared to the contacts obtained in the typodont, did not reveal a significant difference in the first premolar and first molar region except for second premolar region for both the test materials. The inter group comparison between the two test materials did not reveal a significant difference in the second premolar and first molar region except first premolar region.

Among the studied test materials, alginate is the most popular in dental clinics because of low cost and ease of use. Similar results were obtained by studies that compared alginate and elastomeric impression material.^[11-13] In the present study alginate presented an accuracy comparable to that of VPS impression material in terms of reproducing inter arch measurement and number of occlusal contacts suggesting that alginate can be used to produce opposing casts with comparable accuracy as that of alginate substitute .

The inherent drawbacks of alginate like dimensional instability and surface roughness has limited its use only for diagnostic casts. Nevertheless, a comparable accuracy was observed with alginate, as long as the manufacturer's instructions were followed. The manipulation instructions with temperature of mixing water, environment and water powder ratio plays a key role in minimizing the distortion.^[14] The reaction of syneresis, also necessitates immediate pour up of the alginate. Irreversible hydrocolloids can only be poured up once because of hydrophilic property of the material. Alginate substitute materials are superior alternatives to traditional alginates due to superior detail reproduction and tear strength of alginate substitute materials.^[15]

According to Cohen et.al^[16] irreversible hydrocolloid impressions stored at 100% humidity for 24 hours resulted in casts that matched the definitive cast in terms of dimensional accuracy. The accuracy of the casts is directly related to the amount of water gained or lost during the various storage processes. Syneresis can occur when the impression material is stored and water evaporates. The distance between the measured reference points could increase as a result of this shrinkage. The points of measurement would be closer together if water were gained because it would cause the material to swell (imbibition). The delicate balance between these two conditions means that an ideal impression material would have the tendency to make up for these physical characteristics.

The alginate substitute used in the present study was a medium-viscosity, VPS impression material (Xantasil) intended to serve as an alternative for alginate. Because of its long-term dimensional stability, multiple pours are possible and the impression can be stored for a few weeks. Improved rheological properties of the material allows better surface detail reproduction compared to traditional irreversible hydrocolloids. However, it has also been observed that they can undergo dimensional changes following polymerization and due to permanent deformation after removal from the mouth.

Since they are much more expensive than irreversible hydrocolloid materials and in certain clinical situations like mobility of teeth or if there are significant soft-tissue undercuts,^[17] alginate may serve as a better material for making the impressions.

A variety of factors, including polymerization shrinkage, loss of by-products, thermal contraction from oral to room temperature, syneresis, imbibition, disinfectants, or a high humidity, and permanent deformation can affect the dimensional stability of the impression.^[18,19]

Therefore, from the above findings it can be inferred that alginate can produce accurate opposing casts for mounting comparable to VPS impression material in the construction of fixed dental prosthesis where a single cast from an impression is required and can be poured immediately. The alginate substitute might be the best option, if multiple casts are required or if the impression cannot be poured immediately.

Although VPS produces more accurate opposing modes, if the occlusion must still be refined regardless of which impression material is used, it may be economical to use a less expensive material and spend more time manually refining the occlusion. Marking ribbons and films are likely to produce false positive marks. Jaw flexure and tooth movement could not be considered during quantitative assessment of occlusal contacts which could affect the quality of the results. Clinically, when interocclusal records are made teeth experience occlusal forces. Therefore, calculating contacts directly from the interocclusal record is the preferred.^[20]

This study has several limitations. The test impression material might behave differently in vivo, which is a moist environment. Oral fluids like blood and saliva may also influence the behaviour of the materials. Further, impression materials were not subjected to disinfection which might also have an effect on the results. The clinical environment

provides challenges not experienced in the laboratory. Sample size used in the study is small and future studies with larger sample size in a clinical scenario are warranted.

Conclusion:

Within the limitations of the study following conclusions were drawn,

- There was no statistically significant difference between alginate and alginate substitute driven opposing casts used for mounting in terms of reproduction of interarch measurements
- There was no statistically significant difference between alginate and alginate substitute driven opposing casts used for mounting in terms of number of occlusal contacts in all the measured area except for the second premolar region.

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Table 1: Inter group comparison of mean inter arch measurements obtained in alginate and VPS driven stone models

	Groups	N	Mean	SD	P Value
Central Incisor	Alginate	16	5.59	0.51	P = 0.101
	VPS	16	5.36	0.22	NS
Canine	Alginate	16	6.36	0.53	P = 0.37
	VPS	16	6.22	0.34	NS
Second Premolar	Alginate	16	5.23	0.52	P = 0.29
	VPS	16	5.39	0.3	NS
Second Molar	Alginate	16	3.59	0.28	P = 0.48
	VPS	16	3.65	0.14	NS

Level of significance at $p < 0.05$, N-Number, SD- Standard Deviation , NS-Not Significant

Table 2: Inter group comparison of mean number of occlusal contacts in alginate and VPS Driven stone models

	GROUPS	MEAN	SD	P value
First Premolar	Alginate	1.75	0.447	0.020 S
	VPS	2.00	0.365	
Second Premolar	Alginate	2.12	0.500	0.158 NS
	VPS	1.62	0.500	
First molar	Alginate	3.38	0.719	0.171 NS
	VPS	3.25	0.577	

Level of significance at $p < 0.05$, N-Number, SD- Standard Deviation , NS-Not Significant S- Significant

Figure legends

Fig 1: Interarch measurement on the mounted cast



Fig 2: Occlusal contact registration on the mounted casts

