

Original Research Article

A Comparison Study of Dimensional Stability of Primary Impression Techniques: Dual Alginate Impression Techniques

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Abstract: Impression technique is one of the important factors that play a significant role in dimensional accuracy. The aim of this study is to compare dimensional stability of compound, alginate and dual alginate impression techniques. An acrylic resin model of edentulous mandible was prepared and a metal cone was placed (the standard cast) in the regions of first right and left molars and anterior midline point of the arch. Fifteen (15) impressions were made according to compound, alginate and dual alginate impression techniques. Each group of impressions was poured to create stone casts. The length and width of the casts were measured in mm by a digital caliper with an accuracy of 0.01 mm and compared to dimensions of the master model. The data were statistically analyzed utilizing one sample test and SPSS15 software. The results showed that the difference of mean length of experimental and the standard casts were found in compound (0.33 ± 0.04), dual alginate (0.26 ± 0.04) and alginate (0.21 ± 0.03) impression techniques respectively, and the difference of mean width were found in compound (0.46 ± 0.096), alginate (0.21 ± 0.02) and dual alginate (0.15 ± 0.054) impression techniques respectively ($P<0.001$). It can be concluded that the dimensional stability of the suggested dual alginate technique was approximately comparable to conventional alginate technique and had more acceptable dimensional stability than compound technique.

Keywords: Impression technique, dimensional accuracy, edentulous mandible

INTRODUCTION

In fabricating prostheses, dimensional accuracy is very important in providing favorable quality. The impression technique is one of the important factors that play a significant role in dimensional accuracy [1, 2]. To date, several studies have been carried out with the aim of determining the most accurate method for fabricating dentures. Dimensional stability of impression materials is an important indicator for demonstrating an accurate impression. Stability and accuracy of impression material are very critical in providing the desired outcomes associated with the type of the impression, and the resulting cast. Furthermore, several studies have evaluated the dimensional changes of impression materials, in which various impression techniques, materials and evaluation methods have been utilized. Nevertheless, there is no consensus method which provides the most accurate dimensional stability [3, 4]. There are several types of elastomeric impression materials which can be used in dentistry; they are

divided into two large groups of hydrocolloid and elastomeric impression materials. The elastomers, which are often utilized in fixed prosthetic restorations, involve three sets of condensation silicones, addition silicones, and polyethers. Synthetic elastomeric materials include polysulfide's, addition silicones, condensation silicones and polyethers [5]. In this group, silicone impression materials are the most acceptable. The hydrocolloid impression material includes agar and alginate and from these two materials, alginate is the most utilized material. Dentists have no agreement as to which material is superior, but in light of the costs, for more accuracy and easier manipulation, alginate is predominantly preferred [6-8]. A study by Peutzfeldt et al. reported that the dimensional accuracy of alginate and elastomeric impression materials compared with each other and their accuracy values are alike [9]. Craig *et al.*; compared 39 commercially elastomeric impression materials and found that addition silicones had higher dimensional stability when compared with polysulfide, polyether, and condensation silicone in the

first 24 h [10]. In a study by Federic and Caputi, where many elastomeric impression materials were compared with agar, it was found that there is no significant difference between the accuracy of the impressions made by polyether and other materials. These studies have shown that alginate could be the first choice as a favorable impression material [11]. Nevertheless, Lin *et al.*; studied the accuracy of some materials and claimed that polyether had the highest accuracy, followed by silicones, polysulfide, alginate and agar. Since 1947, alginates have been utilized as an impression material, and their dimensional accuracy has been proved since the same year [13]. It has been shown that alginate is one of the most abundant impression materials utilized for fabricating complete dentures [14]. It is inherently unstable and susceptible to dimensional changes. In general, this material should be stored at 100% relative humidity before pouring the cast [15]. Alginate impressions give off liquid to the atmosphere because of evaporation and shrinkage. For maximum accuracy, models material should be poured as soon as possible in alginate impression. One of the most important benefits of alginate is ease of use, but details could not be registered without adequate support. To make a complete denture or partial dentures with long span edentulous, there is need for good primary impression. On the other hand, to make a good special tray, there is need for a good primary impression. Thus, the dual alginate impression technique is a suggestion for making a good and easy primary impression. In order to

provide dimensional accuracy with clinical acceptance, impressions made by alginate with low shrinkage property, should not be stored more than 3 h at approximately 100% humidity. Nevertheless, the maximum storage time in such condition is 1 hr [13]. Deformation of alginate impressions increases with elongation of storage time [16]. Our clinical experiences have shown that in the suggested dual alginate technique, periphery borders are recorded better than the one-step method and all problems such as bubble formation and lack of recording of some areas which occurred in the first stage of alginate impression have been resolved by this technique and fairly accurate initial cast is achieved. In the current study, we attempt to determine the dimensional accuracy of a recommended technique for primary impressions; if it has the required accuracy, it can be introduced to clinicians as a practical method.

MATERIALS AND METHODS

An acrylic resin model of edentulous mandible was prepared, where each region of first right and left molars and anterior midline point of the arch, a metal cone was placed (the standard cast) [7]. In each metal cone, a small slot was prepared as the reference point of measurement (Fig 1) [15]. Impressions, in which all the regions and surface details were recorded, were made on the basis of standard cast and in accordance with any impression techniques studied.



Fig 1: An acrylic resin model of edentulous mandible as the standard cast

Compound impression technique

Red compound (Kerr SpA, Italia) was heated to be softened utilizing the compound heater device for 5-6 min in water at 56°C. A perforated plastic tray for mandible with the size fitted to edentulous ridges was chosen and heated simultaneously in water bath so as to stick tray to the compound [17]. The compound was placed in the tray and the impression was made from the master model. After compound hardening, they

were slowly removed from the master model and placed into cold water.

Conventional impression making (alginate)

A perforated plastic tray, which is 5-6 mm wider than buccal and lingual slopes of the model, was chosen and in order to provide at least 2-3 mm height to the metal cylinders, three pieces of wax were placed in three regions and the needed height between the level of the tray and the model was regulated by self-cured

acrylic resin. Thereafter, the waxes were washed away and a measured amount of alginate powder (Bayer, Germany) was poured in a rubber bowl, water was added and mixed for 30 s. The mixed material was put

in the tray, the impression of the model was made, removed, rinsed under water and surface moisture was removed [17, 18]. Excess materials and undercuts were cut away using scalpel blade (Figs 2).



Fig 2: Alginate and red Compound impression making.

Suggested impression technique (dual-alginate)

All the steps were carried out in the same way with conventional impression making, except that it also had alginate spraying step. In this way, surface moisture of the impression was first removed and alginate adhesive was uniformly sprayed on the impression from a distance of 10-13 cm and after 5 min,

a thin layer of alginate was applied into the impression and seated in the same position (Fig 3). In order to maintain the dimensional stability of impression materials, in all three techniques, the steps were carried out in 12 min from the impression making to the cast pouring.



Fig 3: Dual Alginate impression.

Cast Preparation

A measured amount of stone plasters type III (Zhermack SpA, Italia) was gradually added to the water in a container (115 g plaster powder and 30 ml water) and was mixed utilizing a vibrator device for 1 min. The obtained product was slowly poured into the impression. After 45 min, the tray including the impression and plaster was placed into the water bath.

Within 3-5 min later, after compound softening, the impression material was removed from the cast. The conventional alginate impression and also dual alginate were poured with the plaster stone type III (Zhermack SpA, Italia) according to with the manufacturer's instruction (115 g plaster powder and 30 ml water) and was removed from the cast after 45 min (Fig 4).



Fig 4: Cast preparation from Alginate, Dual Alginate and Compound impression.

Measurement of Casts dimensions

In the current study, in order to reduce measurement errors, an instrument was prepared, applied as a screen marker, or screen parallel caliper or samples. The screen marker includes a fully horizontally flat plane placed on a table or floor and another flat plane placed vertically on the horizontal plane (Fig. 5). In order to determine the positions of the samples, an indicator or reference was placed on the horizontal plane and another indicator or reference on the vertical plane to determine digital caliper position for measuring the width of all samples. In order to measure the length of the samples, an indicator was

placed on the horizontal plane. The samples and digital caliper were positioned at an inclination of 45° to another indicator placed on the horizontal plane [19-21]. In this position, the length of all samples was measured. It seems that this measuring method is the most accurate with the least possible error, considering available resources. In this way, the length and width of the standard cast and other casts were measured three times utilizing a digital caliper (Mitutoyo, England) with an accuracy of 0.01 mm. The means were considered as the dimensions of the casts (Figure 5). Data were statistically analyzed using one sample test and SPSS15 software.



Fig 5: A Screen marker for measuring the length and width of the samples and standard model.

RESULTS

The mean values of length and width of the casts prepared from compound, alginate and dual alginate are presented in Table 1. The mean value length and width differences of the casts prepared from the methods studied compared to the standard cast were statistically significant in all three techniques ($P < 0.001$) (Table 2). The difference of the cast's length to the

standard cast in 100% of alginates and 60% of dual alginates was 0.27 mm or less, but this difference in 100% of compound techniques was more than 0.27 mm. The difference of the cast's width to the standard cast in 100% of alginates and 100% of dual alginates was 0.27 mm or less, but this difference in 100% of compound techniques was more than 0.27 mm (Table 3).

Table 1: The mean values of length and width of the casts prepared from 3 methods of Alginate, Compound and Dual Alginate impression making.

		Number	Minimum (mm)	Maximum (mm)	Mean (mm)	SD (mm)
Compound	Length	15	32.39	39.46	39.37	0.042
	Width	15	51.99	52.32	52.13	0.096
Alginate	Length	15	39.21	39.21	39.25	0.033
	Width	15	51.84	51.91	51.88	0.020
Dual Alginate	Length	15	39.22	39.36	39.30	0.040
	Width	15	51.71	51.93	51.82	0.054

Table 2: The mean length and width differences of the casts prepared from Compound, Alginate and Dual Alginate in comparison with the standard cast

		Mean±SD	Mean±SD	Mean±SD
Compound	Length	39.37±0.42	39.04±0.01	0.33±0.04
	Width	52.13±0.096	51.67±0.023	0.46±0.096
Alginate	Length	39.25±0.033	39.04±0.01	0.21±0.03
	Width	51.88±0.020	51.67±0.023	0.21±0.02
Dual Alginate	Length	39.30±0.040	39.04±0.01	0.26±0.04
	Width	51.82±0.054	51.67±0.023	0.15±0.054

Table 3: Comparison of dimensional differences of the casts prepared from Alginate, Compound and Dual Alginate technique to the Standard cast.

Impression Techniques	Cast Dimension	Difference of 0.27 mm or less compared to the dimensions of the standard cast Number (%)	Difference of more than 0.27 mm compared to the dimensions of the standard cast Number (%)
Alginate Compound Dual Alginate	Length	15 (100)	-
		-	15 (100)
		9 (60)	6 (4)
Alginate Compound Dual Alginate	Width	15 (100)	-
		-	15 (100)
		15 (100)	-

DISCUSSION

Impression making is carried out by various methods and materials. Primary impression must have the required accuracy. In this study, a new technique called dual alginate technique was recommended, where borders would be recorded better than the one-step method and all problems like porous formation and lack of recording of some areas which occur in the first stage of alginate impression, would be resolved and fairly accurate initial cast would be achieved.

One of the methods for determining the accuracy of impression making techniques is the

measurement of dimensional stability [2, 22]. Dimensional stability of impressions is directly provided by measuring the impressions or casts dimensions in comparison with the standard cast. In this study, in order to measure the accuracy of dual alginate technique, which was a suggested method for primary impression with experimentally acceptable results, a comparative method was utilized for the poured casts and standard cast dimensions. This method has been utilized in the study of Taylor, Adabo, Wadhvani, Al-Omari, Thouati, and Johnson [23-27].

The findings of this study showed the highest accuracy in longitudinal dimension for alginate and subsequently for dual alginate technique. The compound method had the least accuracy. In the width, the highest accuracy was related to dual alginate technique and subsequently for alginate. Moreover, the least accuracy was seen in the compound method.

The mean width difference of the cast prepared from the compound method to the standard cast was 0.46 ± 0.096 mm, alginate method to the standard cast was 0.21 ± 0.02 mm, and dual alginate technique to the standard cast was 0.15 ± 0.054 mm, and in all three methods, the differences were statistically significant (Figs. 6 and 7).

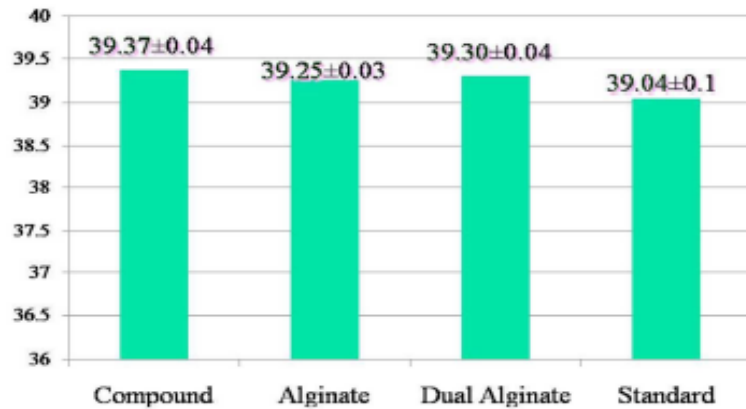


Fig 6: The mean length of the casts prepared from Compound, Alginate and Dual Alginate in comparison with the standard cast.

In the studies of Ciesco, Johnson, Price and Takahashi, dimensional changes of elastomeric impression materials by comparison with master cast were between -0.07 and -0.51 [16, 25, 28, 29]. In the current study, dimensional changes of the impression materials were 0.15 to 0.46 (0.29 to 0.88%). This difference can be as a result of the high accuracy of elastomers compared to alginate and compound. In order to reduce systematic errors, the measurement was

carried out by one practitioner. For each sample, measurement was repeated three times and the means were considered as dimensions of the cast. Furthermore, in order to eliminate practitioner bias, all the casts were encoded and also protuberances and depressions in conventional alginate and compound casts were adjusted and measurement was carried out in blinded manner.

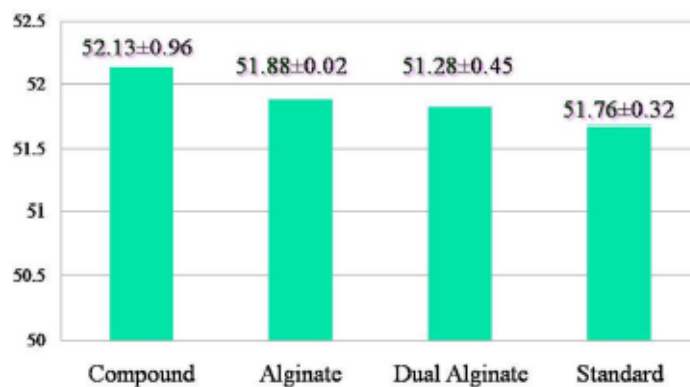


Fig 7: The mean width of the casts prepared from Compound, Alginate and Dual Alginate in comparison with the standard cast

CONCLUSION

The results of this study showed that dimensional stability of suggested dual alginate technique is approximately comparable to conventional alginate technique and had more acceptable dimensional stability than the compound technique. In this method, recording of the periphery borders was

excellent; there was an impression with no porosity and a fairly accurate initial cast.

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