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ORIGINAL ARTICLE

The influence of different mixing methods on the dimensional stability and surface detail reproduction of two different brands of irreversible hydrocolloids

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ABSTRACT

Purpose: Irreversible hydrocolloid impression materials are some of the most common impression materials in dentistry. Preparation of alginate is critical for dental appliance fabricated upon the cast made directly from the impression. This study compared the effect of two mixing methods i.e. hand mixing or device mixing on the physical properties of two different brands of irreversible hydrocolloid. **Materials and Methods:** Two alginate impression materials: Cavex Tulip (Tulip, Cavex Holland BV, Haarlem, Holland) and Hydrogum Soft (Zhermack, Rovigo, Italy), were mixed according to manufacturers instroductions with two mixing methods. Mixing was performed at room temperature using tap water. The material was allowed to set in a water bath at 35°C (±1°C), simulating intra-oral setting conditions. For each tested material, nine standardized samples were used. The first method was hand mixing; the other method was with a device. Detail reproduction and dimensional changes of impressions were compared. One-way analysis of variance was performed to compare the dimensional differences between the four groups. **Results:** The device mixed speciemens showed better surface detail than hand-mixed samples. Cavex alginate demonstrated better surface detail than Hydrogum. Cavex Tulip alginate showed better dimensional stability than Hydrogum Soft in both hand-mixed and device-mixed samples. Furthermore, all device mixed samples were better than hand-mixed in terms of dimensional stability. A two-way analysis of variance and Fisher's protected least significant difference test at the 0.05 level of significance were used to analyze the data. **Conclusion:** Of the two mixing methods, the vacuum mixer had the best performance overall in reducing the number, percent and volume of porosities in the mixed alginate.

Key words
Dimensional stability, irreversible hydrocolloids, mixing type, surface detail

INTRODUCTION

Irreversible hydrocolloid materials have been widely used in prosthetic dentistry. Alginate impression materials were developed in the 1930s. For obtaining diagnostic and study models of partially or completely edentulous patients, for the impressions of the opposing archs and as the final impression material of certain completely edentolous patients, irreversible hydrocolloids are preferred by many clinicians because it is inexpensive, hydrophilic, reasonably accurate and too easy to manipulate.[1,2]

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Despite being widely accepted and used that alginate is not stable impression material for storage. Because of its limited storage time, dimensional stability of the set alginate is limited.[3] When alginate impressions set, they become three-dimensional semi-permeable gels. Alginate impressions exhibit the two distinct processes of syneresis and imhibition. Free water is gradually extruded on the surface is termed syneresis. Alginates also prone to water absorbsition, termed imbibition.[3]

Despite their lower physical properties compared with elastomeric impression materials, sufficient final impressions could be obtained by following appropriate mixing conditions. Air entrapments or porosities within the impression material may influence the accuracy of an impression and the resulting cast. Using mechanical mixing device can reduce the porosity.[4,5]

Studies by previous writers much interested on the effects of disinfection, there are limited number of studies reporting the effect of the mixing device on the irreversible hydrocolloid impressions. The aim of this study was to compare the effects of mixing methods i.e. hand mixing or device mixing on the various physical properties of different brands of irreversible hydrocolloids.

MATERIALS AND METHODS

A stainless steel test die was constructed according to American Dental Association specification no: 18 for alginate impression material[6,7] [Figure 1]. The impression mould was lubricated with isolater (soft petroleum jelly). The block was cleaned with alcohol and allowed to air dry prior to recording each impression. Two alginate impression materials: Cavex Tulip (Tulip, Cavex Holland BV, Haarlem, Holland) and Hydrogum Soft (Zhermack, Rovigo, Italy), were mixed according to manufacturers introductions with two mixing methods. The first method was manual mixing, the other method was with an automatic mixing machine (Algimax, model DM 21, MonitexXianyang Holy Medical Co., Ltd. PRC) [Figure 2]. The mixed impression material was placed on the center of the molds surface. A glass plate was placed on the molds surface. The assembly was immediately transferred to a water bath at 35 ± 2°C.

After the setting time that the manufacturer recommended mold was removed from test block surface. 18 Cavex alginate samples, 9 of which hand-mixed and 9 of machine-mixed and 18 Hydrogum alginate samples, 9 of which hand-mixed and 9 of which machined-mixed were subjected to investigation. A two-way analysis of variance and Fisher's protected least significant difference test at the 0.05 level of significance were used to analyze the data.

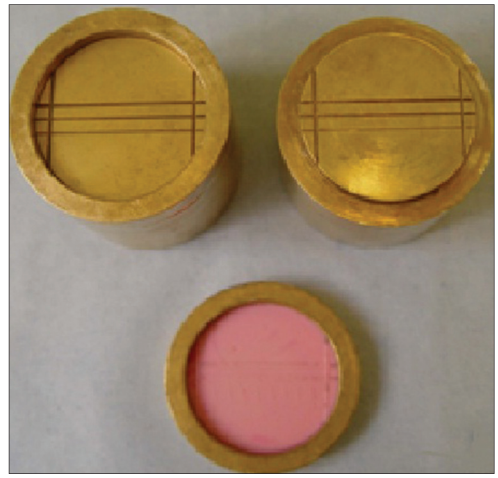

Figure 1: Stainless steel test die constructed according to American dental association specification no: 18 for alginate impression material

Figure 2: Automatic mixing machine Algimax, model DM 21

Detail reproduction of impressions

The impression material was mixed and applied carefully to the test die in order to minimize trapped air. The impressions surface was assessed visually for reproduction of the lines from the test block. The impressions were observed under low – angle illumination without magnification. For better discrimination between specimens, a scanning system with rating values from 1 to 4 was followed

- Rating 1: Well-defined, sharp detail, continuous line [Figure 3].
- Rating 2: Continuous line but with loss of sharpness [Figure 4].
- Rating 3: Poor detail or loss of continuity of the line [Figure 5].
- Rating 4: Marginally or not discernible.

Figure 3: Rating 1: Well-defined, sharp detail, continuous line

Dimensional changes of impressions

The samples were photographed with Nikon Coolpix MDC Lens (Nikon Corp., Tokyo, Japan) combined to microscope and measured with Clemex image analyze program. The impressions were evaluated by measurement of the linear dimension of line X point from X' point. The percentage dimensional change of impressions were calculated by using the formula (A-B/A) ×100, where A is the master model measurement and B is the experimental model measurement. The distance between the crosslines X-X' shown on Figure 6, measured to the nearest 25 μm line on the impression surface using a measuring microscope (Nikon Optihot-100, Tokyo, Japan) [Figure 7]. The microscope was modified with a ring flash fixed at 1.5 inches from the stage to maintain uniform intensity of light. The measurement (X-X') of the metal die was calculated to 24.150 mm [Figure 6]. Figure 8 shows schematic drawing of stainless steel analog indicating the lines measured and reference points. Figure 9 shows microscobic image of alginate samples.

RESULTS

Detail reproduction of impressions

The surface quality of 36 models was fulfilled the relevant specitions in terms of reproduction of the appropriate lines. None of the specimens showed the rates 3 or 4. The detail reproduction of impressions was presented in [Figure 10]. The device mixed specimens showed better surface detail than hand-mixed samples. Cavex alginate demonstrated better surface detail than hydrogum.

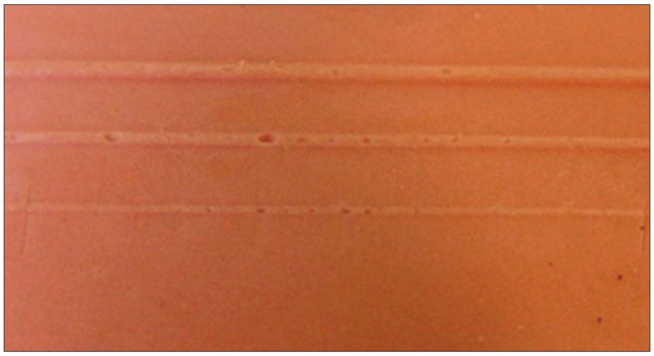

Figure 4: Rating 2: Continuous line but with loss of sharpness

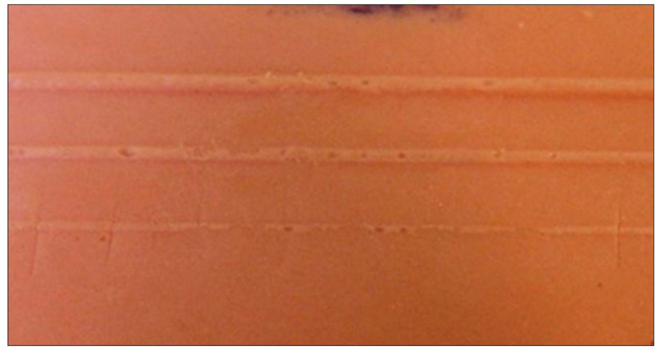

Figure 5: Rating 3: Poor detail or loss of continuity of the line

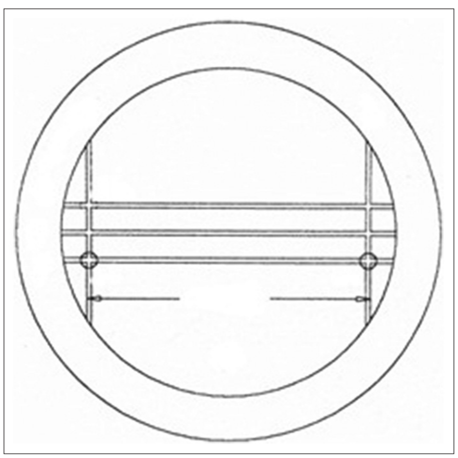

Figure 6: The distance between the crosslines X-X'

Figure 7: Measuring microscope (Nikon Optihot-100, Japan)

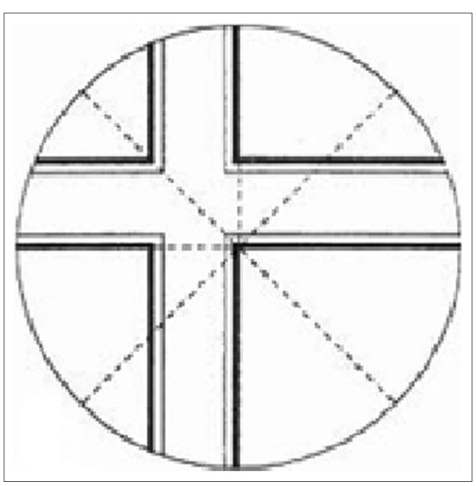

Figure 8: Schematic drawing of stainless steel analog

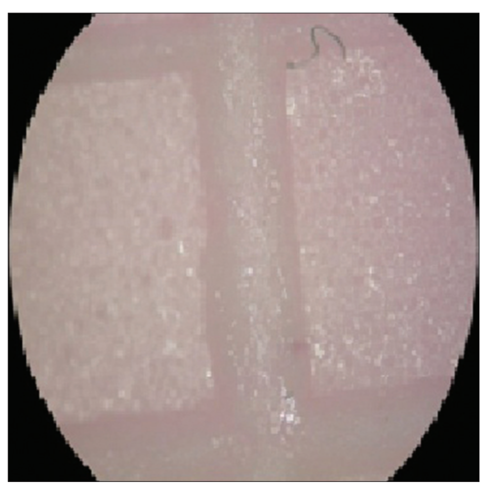

Figure 9: Microscobic image of alginate samples

Dimensional changes of impressions

The percentage dimensional changes of alginate samples from the metal die are presented in [Figure 11 and 12]. For instance, the two-way interaction between type of material and mixing technique implies that the difference between the materials depends on mixing technique. There was significant difference ($P > 0.05$) in overall dimensional accuracy between two brands of impression material used.

For Hydrogum Soft, hand mixed samples; the deviation was found to range from 0.66% to 1.25% and for Hydrogum Soft, device mixed was 0.053-0.894% [Figure 11].

For Cavex Tulip hand mixed samples; the deviation was found to range from 0.517% to 1.432% and for Cavex Tulip, device mixed was 0.03-0.621% [Figure 12].

One way analysis of variance was performed to compare the dimensional differences between the four groups. Cavex Tulip alginate showed better dimensional stability than Hydrogum Soft in both hand-mixed and device-mixed samples. Furthermore, all device mixed samples were better than hand-mixed in terms of dimensional stability and surface detail.

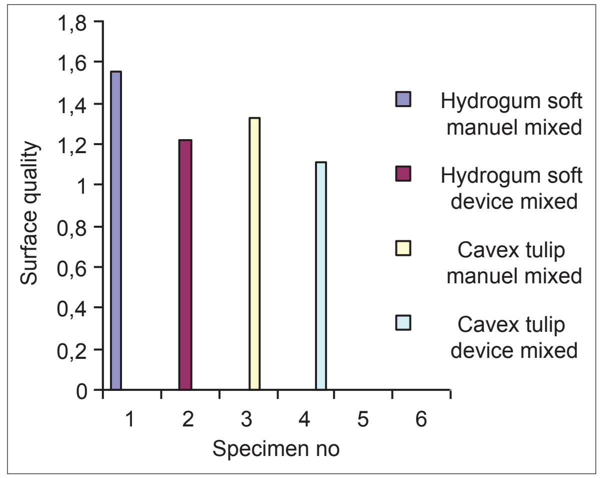

Figure 10: Detail reproduction of impressions

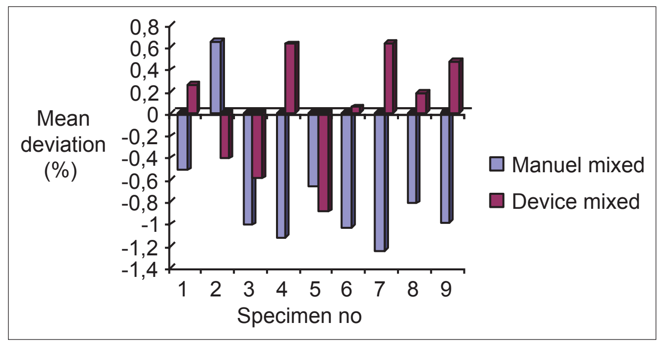

Figure 11: The percentage dimensional changes of Hydrogum soft alginate samples from the metal die

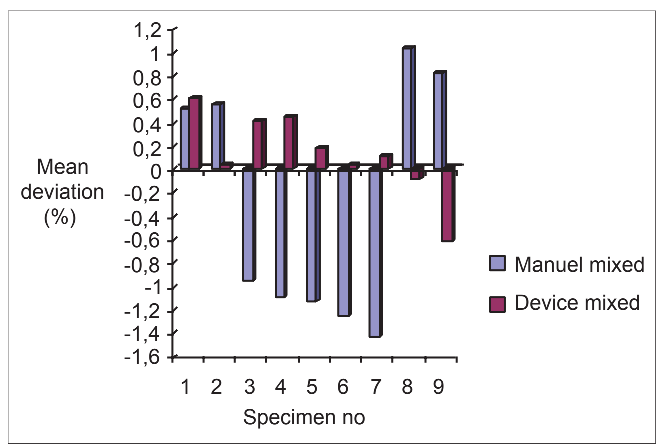

Figure 12: The percentage dimensional changes of Cavex tulip alginate samples from the metal die

DISCUSSION

Koski compared mixing techniques and devices with different alginate brands and showed that alginate mixed with the vacuum mixer produced fewer surface defects and had better detail reproduction with cast gypsum than either hand or centrifugal mixing.[8] Furthermore some other studies have shown that handmixing of elastomeric impression materials produced more porosities than automated-mixing.[9,10] Inoue *et al*. reported that the high-speed rotary mixing instruments, such as the automatic instrument, greatly reduced the number of air bubbles with the paste.[11] Furthermore it has been reported that there is no major difference in physical properties of alginates using either hand or mechanical mixing.[12] The largest deviation in measurement between the test die and impressions was 1.432% at hand mixed impression. This level of deviation would have greater significance if the impressions were to be used construct fixed prostheses.

It was observed in this study that mechanical mixing improve the consistency of the alginate after mixing, the ease in which the material was incorporated into the mix, the bubble-free texture and the ease of use, when compared with hand mixing. The quality of impressions producted from. Cavex Tulip alginate, mixed with device was of a higher standard in terms of surface reproduction.

Within the limitations of this *in vitro* study. The differences between the materials and between the mixing methods are found to be significant. The preference for device mixing is not only to standardize the alginate mixing procedure but also to facilitate the mixing, to reduce the amount of air bubbles, to obtain a homogenous mixture.[13]

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