EVALUATION OF ACCURACY OF IMPRESSION MATERIALS WITH DIFFERENT MIXING TECHNIQUE

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Abstract

Purpose: To investigate gypsum compatibility and dimensional stability of irreversible hydrocolloid impression materials with three mixing techniques. A comparison between vacuum-mixed, mechanically-mixed and manually-mixed techniques was evaluated for each impression material. **Materials and Methods:** Three irreversible hydrocolloid impression materials Kromopan 100® (Lascod™), Identic® (Dux dental™), and Jeltrate Plus® (Dentsply™) were tested gypsum compatibility in accordance with ANSI/ADA Specification No. 18 for alginate impression materials. The test for linear dimensional stability was tested in accordance with ANSI/ADA Specification No. 19 for elastomeric impression materials. A One-way ANOVA test was used to analyze dimensional stability at a significance levelof ($p < 0.05$). **Conclusion:** The vacuum mixing technique facilitates the mixing of irreversible hydrocolloid impression materials and improves the compatibility with gypsum materialand reproduces a more dimensionally accurate cast than the other mixing techniques.

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1. Introduction

Irreversible hydrocolloid impression material is routinely used for the purpose of reproducing hard and soft intraoral tissues. The gypsum compatibility and the dimensional accuracy of the cast used to fabricate the cast are crucial for diagnostic and treatment planning purposes. In addition, the fabricated casts are valuable for the purposes of evaluating prosthetic space, diagnostic wax patterns for treatment planning and fabrication of resin based prostheses. Recently, several dental manufacturers have introduced electronic rotary devices to facilitate mixing of irreversible hydrocolloid impression materials. With regard to impression making techniques, very few contemporary studies exist.[1] The objectives for these in-vitro studies were to (1) evaluate gypsum compatibility of irreversible hydrocolloid impression materials mixed with mechanical and manual techniques in accordance with specification outlined in ANSI/ADA Specification No. 18, and (2) evaluate dimensional stability of casts produced from different mixing techniques in accordance with specification outlined in ANSI/ADA Specification No. 19.[2,3] The null hypotheses tested were: (1) there is no difference in gypsum compatibility between the impression material and mixing technique, and (2) there is no difference in dimensional stability between the impression material and the mixing techniques.

2. Methodology

The study was carried out at Department of Prosthodontics and Crown & Bridge, Peoples College of Dental Sciences and Research Centre, Bhopal. Three irreversible hydrocolloid impression materials were mixed with three mixing techniques equaling impression-mixing combinations. 10 test samples were madefor each of the 9 impression-mixing combinations to test for gypsum compatibility and dimensional stability. Type III gypsum and Type V gypsum were used to test gypsum compatibility and dimensional stability in accordance with Specification No. 18 for gypsum compatibility and Specification No. 19 for dimensional stability, respectively.

Impression Mixing Techniques

For each of the mixing techniques described below, separate rubber mixing bowls, metal spatulas, and vacuum mixing bowls were used to eliminate cross-contamination of impression materials. The manual-mixing technique utilized a rubber mixing bowl and a metal spatula. Distilled water [(23±1) °C] was measured with a graduated cylinder and dispense into the rubber mixing bowl. The impression powder was measured into a paper cup using an electronic scale. A digital timer was set to monitor the mixing times for each impression mixing technique. Manual-mixing was initiated by incorporating the impression materialto the water in the rubber mixing bowl. The two materials were handled carefully to minimize the formation of dust from the impression powder. The introduction of the twomaterials quickly formed a paste. Using the blade of the metal spatula, the impression material was hand-spatulated against the sides of the rubber mixing bowl until a smooth, powder-free impression mixture was formed.[4,5] The mechanical mixing technique utilized the same rubber bowl and metal spatula from the manual-mixing technique. Distilled water [(23±1) °C] was measured with a graduated cylinder and dispensed into the rubber mixing bowl. Impression powder was measured and dispensed into a paper cup using an electronic scale. A digital timer was also used to monitor and maintain consistent mixing times for each mixing technique. The impression powder was incorporated with distilled water [(23±1) °C], initially with the metal spatula inside the rubber mixing bowl. The rubber mixing bowl was quickly attached to a mechanical, rotary mixing apparatus (Alginator II, Dux dental). At low speed, the rotary mixing apparatus spins the rubber mixing bowl at 265rpm. With the rubber mixing bowl attached to the rotary mixing device, the metal blade of the mixing spatula was firmly pressed against the sides of the rubber mixing bowl for the remainderof the mixing time to produce a smooth, powder free, impression mixture.

The vacuum-mixing technique utilized the VPM 2, (Whip-mix corporation) vacuum mixer. The VPM 2 mixer had programmable settings for mixing time and speed.The mixing speed was set at 265 rpm to match the mechanical mixing device, (Alginator II, Dux Dental). The reduced atmospheric pressure was not programmable and remainedat 27.5 in Hg. The mixing times were adjusted to follow manufacturer's recommendations. The vacuum-mixing technique utilized a clear vacuum-mixing bowl with 2 rotary mixing blades. Distilled water [(23±1) °C] was measured and dispensed into the bowl using a 100ml graduated cylinder. Impression powder was measured using an electronic scale and dispensed into a paper cup. The initial mixing of the two materials was manually initiated until the impression powder was incorporated with the distilled water. The vacuum-mix bowl assembly was inserted into the VPM 2 unit and pre-programmed setting for the impression material displayed on the digital monitor and the impression material was mixed. A summary of the armamentarium for each mixing technique is listed in Table 1.

Table 1: List of mixing technique instruments

Mixing technique	Armamentarium
Manual-mixing	Rubber mixing bowl Metal spatula 100ml graduated cylinder
Mechanical-mixing	Alginator II, (Dux Dental)Rubber mixing bowl Metal spatula 100ml graduate cylinder
Vacuum-mixing	VPM 2 vacuum mixing unit, (Whip Mix)Vacuum mixing bowl Metal spatula 100ml graduated cylinder

Table 2: Impression materials

Impression material	**Manufacturer**	**Lot number**
Kromopan 100®	Lascod™	0160291137
Identic®	Dux dental™	011722
Jeltrate Plus®	Dentsply™	100731

Table 3: Water to impression powder ratio

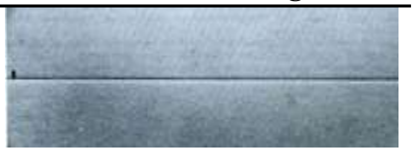
Impression material	Manufacturer	Powder (grams)	Water (ml)
Kromopan 100®	Lascod™	18g	40ml
Identic®	Dux dental™	12g	32ml
Jeltrate Plus®	Dentsply™	14g	38ml

Table 4: Impression material mixing times

Impression material	Manufacturer	Mixing time (seconds)	Working time (seconds)	Setting time (seconds)
Kromopan 100®	Lascod™	45	105	180
Identic®	Dux dental™	30	105	140
Jeltrate Plus®	Dentsply™	60	135	210

The impression material was slightly overfilled. A metal plate was centered over the testing assembly and was slowly placed over the impression material until it seated against the metal support ring. Excess impression material was removed from the assembly and a 1-kg weight was then placed on top of the metal plate. The master die, impression material, metal plate and weight were transferred and returned to the water bath. The impression material was allowed to set three minutes past the manufacturer's recommended setting time in accordance with Specification No. 18. The impression wascarefully separated and each test sample was removed and was inspected to evaluate whether the lines for detailed reproducibility were met. Each specimen was examined under the LABSCO microscope at 10X magnification to visually confirm the reproduction of the 20 micron line. An impression test sample that did not reproduce the 20 micron line was discarded and remade. Only samples which clearly reproduced the entire 20 micron lineof the ADA/ANSI master die were used to fabricate the cast specimens. Two gypsum materials were used in this study for gypsum compatibility. For each impression material and mixing technique test sample that reproduced the 20 micron line, type III and type V gypsum materials were tested. The gypsum materials were mixed using manufacturer's recommendations. Distilled water was measured using a 100ml graduated cylinder and dispensed into a vacuum mixing bowl. Pre-packaged gypsum materials were dispensed into a paper cup and measure electronically. The gypsum material was introduced to the distilled water and was manually mixed to facilitate the incorporation of water to gypsum powder. The gypsum material was vacuum mixed for 30 seconds at 27.5 Hg with the VPM 2 vacuum mixer, (Whip-Mix Corp). The gypsum test sample was separated from the impression material test sample 1hour past the manufacturer's recommended time. The 50 micron line was evaluated for gypsum compatibility using the LABSCO microscope at 10X magnification. The grading criterion for gypsum compatibility described by Owen in 1986 wasutilized to score the gypsum test sample.[6] The score system is listed in Table 5.

Table 5: Scoring scale[14]

Score	Description	Image
1	50 micron line reproduced clearly and sharply over the entire 25mm length. This is the appearance.	

1. Line clear over more than 50% of length, lineappears to be reproduced well over the entirelength, smooth, but not sharp.
2. Line clear over less than 50% of length, or line visible over the entire length but blemished andrough, and/or not sharp.

Line not reproduced over entire length, rough, blemished, pitted. This is the worst appearance.

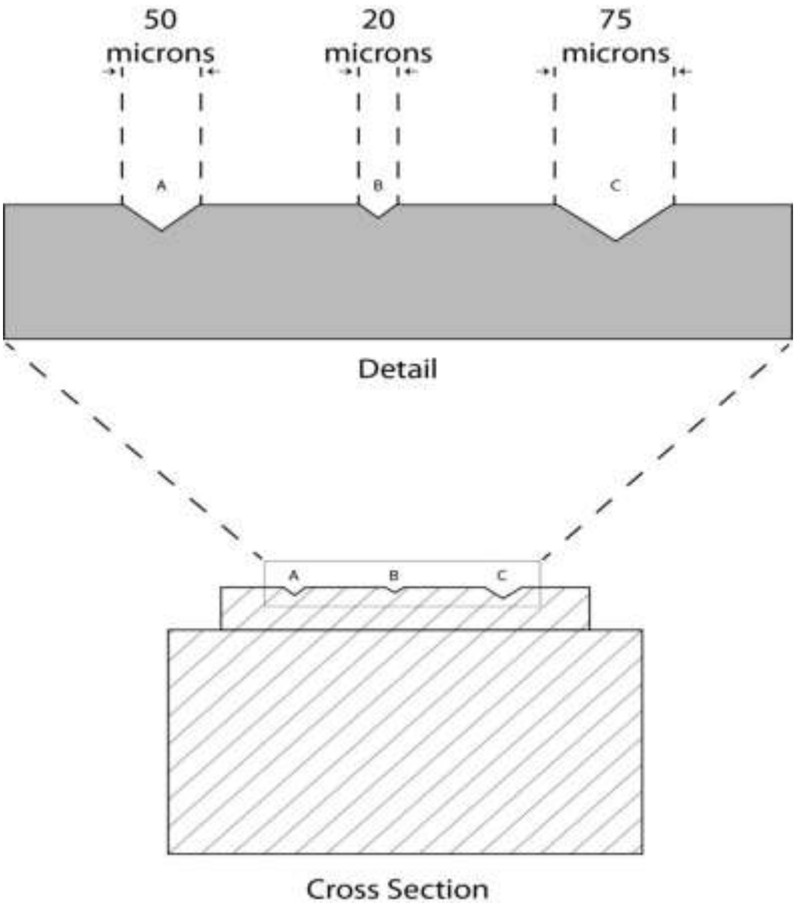


Figure 1: Schematic drawing of the dimensions of the ANSI/ADA Specification No. 18die **surface**

Figure 2: Schematic of the ANSI/ADA Specification No. 18 die surface from a lateralview.

3. Results

There was no statistical significance among the various combinations of impression materials and mixing techniques evaluated for dimensional stability (*P* >0.05) in this study. For dimensional stability, the mean value for the vacuum-mixing technique (24.929mm) demonstrated better accuracy than the other mixing techniques. With regard to impression materials, Kromopan 100® (24.929mm) had better mean values than Identic or Jeltrate Plus. All combinations of impression materials and mixing techniques failed to meet the 66% requirement to pass the Specification No. 18 requirement for gypsum compatibility. Vacuum-mixed, Kromopan 100® and Die-keen® had the best results of the various mixing combinations with 6 out of 10 samples rated with a score of 1. Based on the results, the null hypothesis was accepted for both gypsum compatibility and dimensional stability.

Figure 3: Gypsum compatibility for impression materials

Score	Description
1	50 micron line reproduced clearly and sharply over the entire 25mm length. This is the best appearance.
2	Line clear over more than 50% of length, line appears to be reproduced well over the entire length, smooth, but not sharp.
3	Line clear over less than 50% of length, or line visible over the entire length but blemished and rough, and/or not sharp.
4	Line not reproduced over entire length, rough, blemished, pitted. This is the worst appearance.

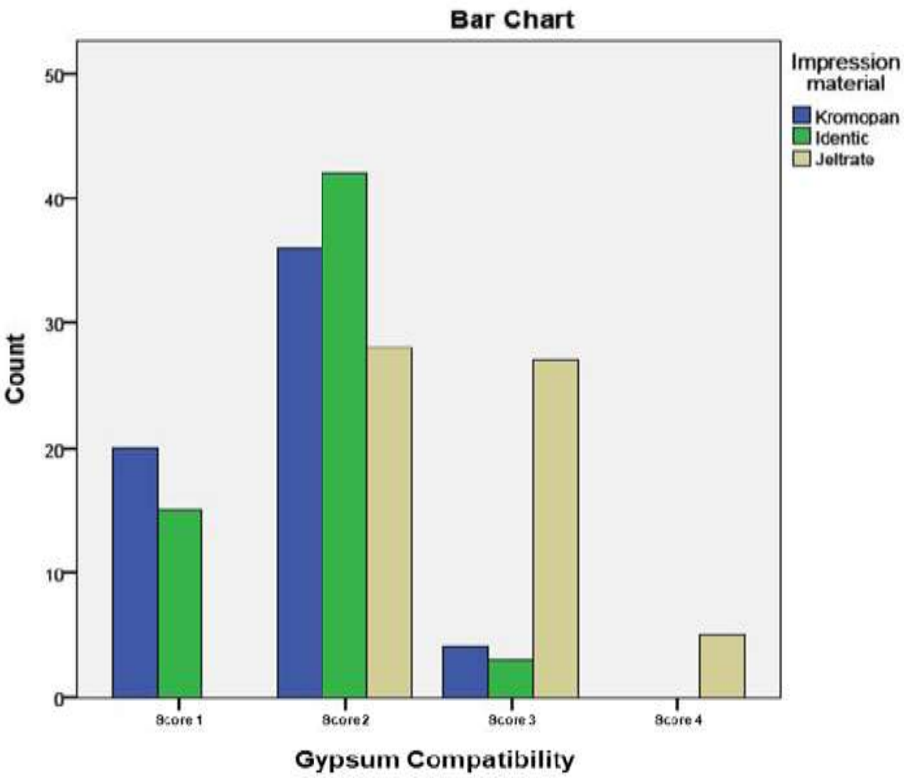


Figure 4: Gypsum compatibility for different mixing technique

Score	Description
1	50 micron line reproduced clearly and sharply over the entire 25mm length. This is the bestappearance.
2	Line clear over more than 50% of length, line appears to be reproduced well over the entirelength, smooth, but not sharp.
3	Line clear over less than 50% of length, or line visible over the entire length but blemishedand rough, and/or not sharp.
4	Line not reproduced over entire length, rough, blemished, pitted. This is the worst appearance.

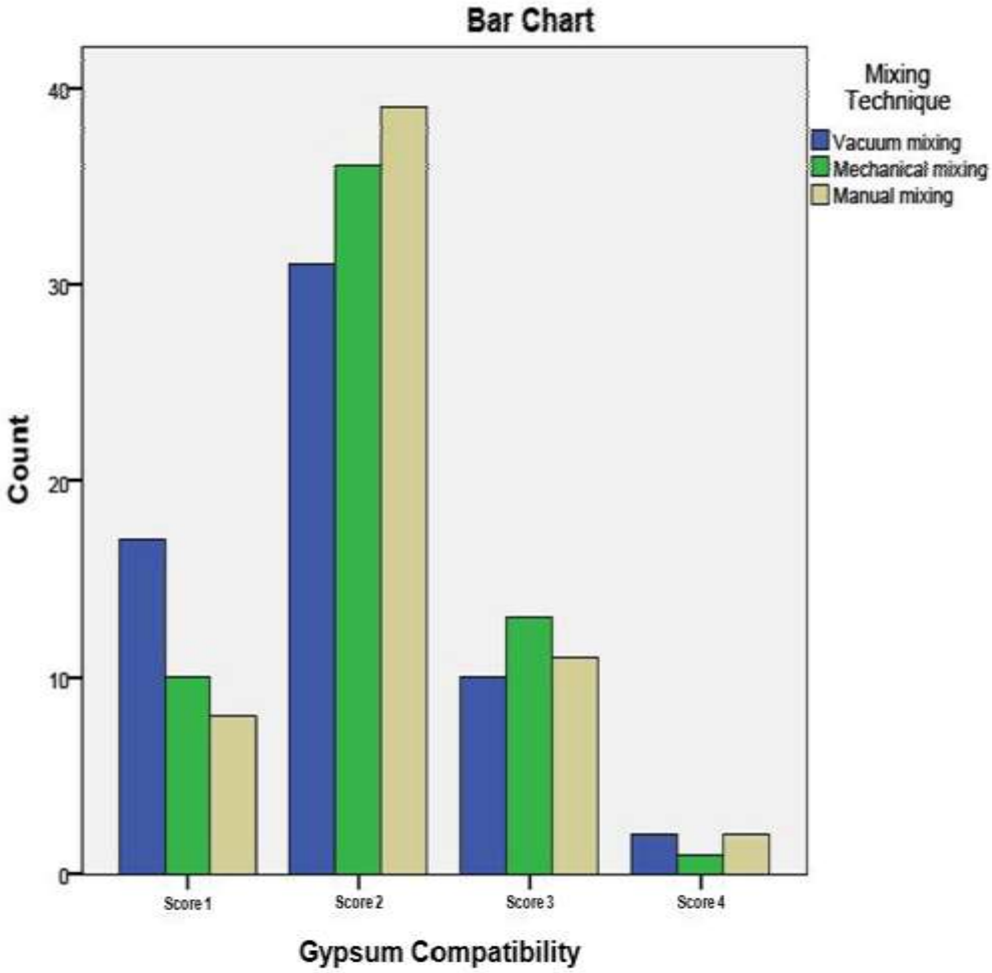
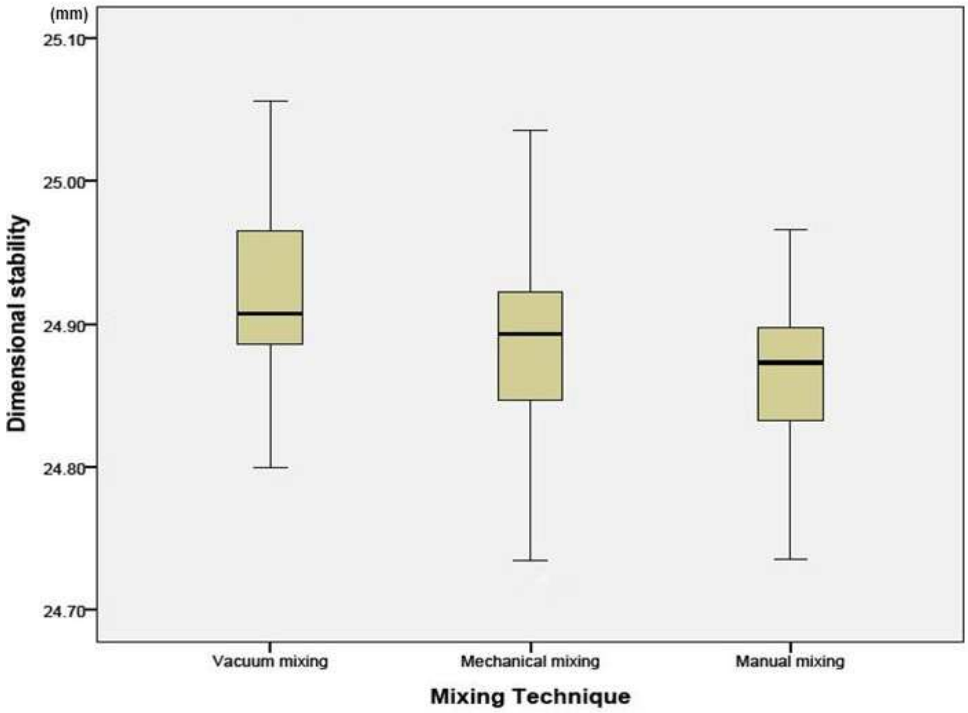


Figure 5: Box-plot values by dimensional stability



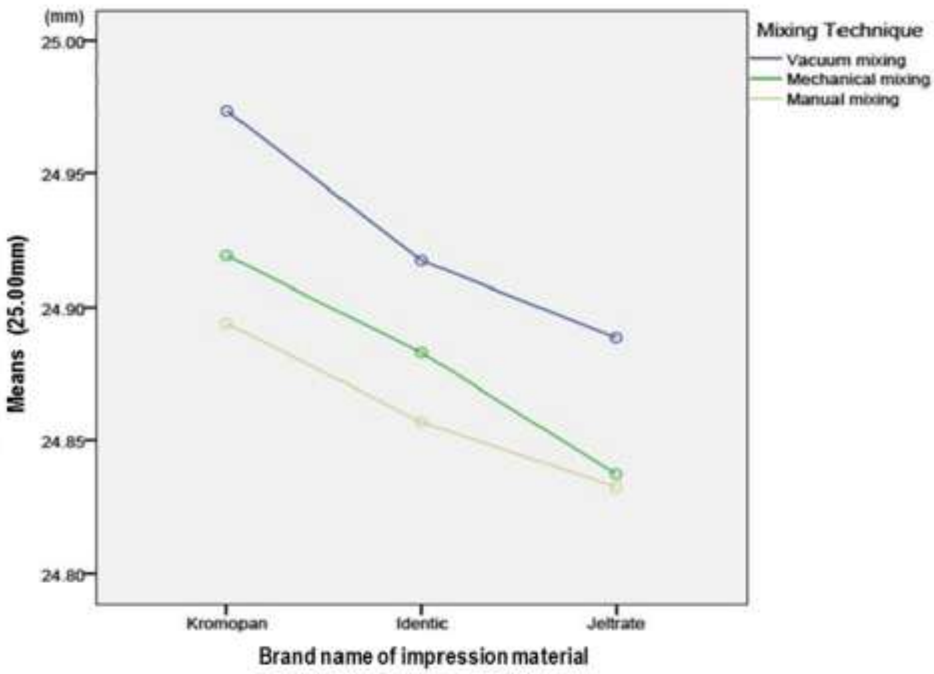


Figure 6: Dimensional stability values by impression material and mixing techniques

4. Discussion

In this study, irreversible hydrocolloid impression materials were subjected to different mixing techniques to demonstrate improvement over conventional manual-mixing techniques. The utilization of a mechanical or an automated mixing device has produced impression materials that have less porosity and improved mechanical strength[4, 5,]. The smooth surface texture of impression materials created by electronically operated devices produces a mixture that is easy to work with, better surface texture, improvement in rheological properties and produces accurate casts over the manual-mixed techniques[5, 7,8] Three brand name irreversible hydrocolloid impression materials were mixed withthree different mixing techniques. Two gypsum materials were used to then fabricate test samples to compare and evaluate for gypsum compatibility of impression materials mixing with the different mixing techniques. In order to evaluate the effectiveness of different impression mixing techniques, gypsum compatibility and dimensional stability of gypsum casts reproduced from the impression materials were used to carry out this investigation. Among the impression materials used in this study, Kromopan 100®, demonstrated better compatibility with both types of gypsum materials than the other impression materials. Although the impression/mixing technique combinations did not show statistical significance for gypsum compatibility, there was a positive trend for gypsum compatibility with Kromopan® 100 than the other impression materials. During the fabrication of the impression test specimens, there were a higher number of Jeltrate Plus® impression samples that were not able to duplicate the 20 micron line. Comparatively, a larger number of remakes were made of Jeltrate Plus® than the other impression materials. Vacuum-mixed and mechanically-mixed Kromopan 100 and Identic did not have any remakes. However, three samples each were remade forKromopan 100 and Identic due to an air bubble superimposed over the 20 micron line. Ofthe 30 samples of Jeltrate Plus® impression material, 17 samples were remade. The manually-mixed technique had the highest number of remakes with 9 specimens. The inability of the impression material to reproduce the 20 micron line further supported the poor overall performance of Jeltrate Plus® impression material.

Among the two gypsum materials, in general, test specimens fabricated with Die-keen®, resulted in higher compatibility scores than Microstone®. These results are in agreement with previous studies.[9] The test for dimensional stability was evaluated by using the formula:

$\Delta l = 100(x_1 - x_2) / x_1$

x_1, measure distance on the ADA/ANSI master die

x_2, measure distance on the gypsum cast

Based on the results from this investigation, Kromopan 100®, Identic, and Jeltrate Plus exhibited a percentage decrease of 0.28%, 0.45% and 0.59%. These values are within theacceptable value of 1.0% for dimension change under ANSI/ADA Specification No. 19.[10]

One of the goals for this study was to demonstrate if there is a significant difference between manual-mixing and electronically-mixed impression materials. However, due to the number of variables being studied, there was no statistical evidenceto arrive at a conclusion that one mixing technique produced better impression materialsfor improved gypsum compatibility and dimensional stability than the other. The vacuum-mixing technique does produce a smooth, uniformly mixed, bubble-free impression[5, 8]. But the statistics was not able to distinguish which combination of impression material/mixing technique produced the gypsum compatibility and dimensional stability.

5. Conclusion

Gypsum compatibility and dimensional stability were evaluated for three brand name irreversible hydrocolloid impression materials, (Kromopan 100, Identic, Jeltrate Plus) mixed manually with a rubber mixing bowl and a spatula, mechanically with a rotary mixing device and under vacuum with a vacuum-mixing bowl. 10 samples of 9 different impression material/mixing technique combinations were evaluated with twogypsum materials. In total, 90 Die-keen and 90 Microstone casts were fabricated to evaluate gypsum compatibility and dimensional stability. Within the limitation of thisinvestigation, the following conclusions can be drawn:

1. For evaluation of gypsum compatibility and dimensional stability, Kromopan 100®was the most accurate compared to the other tested impression materials.
2. Impression materials mixed under vacuum produced better compatibility for gypsum and less dimensional change.
3. Die-keen gypsum material produced the more accurate casts for all alginate materialsstudied.

6. References

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