

# Wax Lining in an Impression Tray and Accuracy in Gypsum Cast Fabrication

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## Abstract

**Purpose:** Controversy exists as to whether lining a metal-perforated impression tray with wax will yield a distorted irreversible hydrocolloid impression. Two current textbooks have completely different recommendations, but there is no evidence to support either theory. This project evaluates distortion in gypsum casts that have been prepared from wax-lined and unlined metal impression trays. The purpose of this study was to assess the influence of wax on the border and in the palate of metal-perforated impression trays on the dimensional stability of the resulting irreversible hydrocolloid impression.

**Materials and Methods:** A dentaform was prepared with marks on the cusp tips of teeth 6 and 11 and distobuccal cusps of teeth 2 and 15. Using a standard maxillary rim lock impression tray, alginate impressions were made using a dentaform with no wax lining, wax lining the border of the tray, and wax lining the border and the palate ( $n = 10$ ). Casts were randomized. Six measurements were taken using a stereographic measuring microscope, from tooth #6 to #11, #11 to #15, #15 to #2, #2 to #6, #6 to #15, and #2 to #11. An acrylic template was used to position the cast in a reproducible position on the microscope.

**Results:** Trays lined with wax on the border and the palate yielded casts with significantly different dimensions when compared to those poured from unlined or border-lined trays ( $p < 0.05$ ). Casts produced from unlined and border-lined trays were not significantly different in dimension from the dentaform ( $p > 0.05$ ).

**Conclusion:** There is no difference between the metal tray with no wax, the metal tray with a wax around the border, and the dentaform. The clinician can make irreversible hydrocolloid impressions using wax on the periphery or without wax on the periphery and feel confident that the impression has not been compromised in its ability to accurately reproduce the maxillary arch when used. Caution should be exercised when adding wax to the palate of the impression tray.

Irreversible hydrocolloids are used to make impressions for diagnostic casts and the fabrication of appliances that do not require high detail.<sup>1</sup> A high degree of accuracy with these impressions is needed to allow the clinician the ability to diagnose and treat. Inaccuracies can lead to a prosthesis that does not fit well and an inaccurate diagnosis from mounted casts.<sup>2</sup>

Lining the borders of impression trays is a commonly used technique to make alginate impressions. Carr<sup>3</sup> recommends the use of wax to ensure the even distribution of the impression material and to prevent the material from slumping away from the palatal surface. Carr also feels that the wax lined impression

tray will help orient the impression tray in the mouth during the making of the impression.<sup>3</sup> According to Carr, the mandibular tray should be lined to prevent the tissue of the floor of the mouth from rising up inside the impression tray.<sup>3</sup> Zarb and Bolender also recommend the use of wax to line the periphery of the impression tray.<sup>4</sup>

Jones and Garcia<sup>5</sup> state that alginate will not stick to wax and recommend that it not be used to line the metal impression trays. Rudd et al state that the clinician should never use wax to cover the border of the impression tray because the alginate always pulls loose from the wax border.<sup>6-8</sup> Rudd and

Rudd state that the use of wax to build up the internal surfaces and the border of the tray is error #22 of 243 possible errors in the fabrication of a removable partial denture framework.<sup>6</sup> They state that the wax will soften when used with a tray adhesive and will allow the irreversible hydrocolloid to separate from the tray.<sup>6</sup> There were no evidence-based studies to verify the statements of Rudd and Rudd. Phoenix et al recommend the use of modeling compound to line the impression tray, then the use of an adhesive to ensure there is no loosening of the irreversible hydrocolloid from the impression tray.<sup>9</sup>

Irreversible hydrocolloid accuracy is subject to many variables. If the alginate impression is stored for an extended time, significant dimensional changes can occur.<sup>10-12</sup> Proper handling and technique by the operator can also affect dimensional properties of the irreversible hydrocolloid impression.<sup>13</sup> Disinfection of alginate with disinfectants can also alter dimensional stability of the impression.<sup>14</sup> Ensuring that the alginate and the gypsum used to pour the cast is also important for a predictable outcome.<sup>15</sup>

Despite statements of possible error and statements of how to make the best irreversible hydrocolloid impression, there is no evidence to support either theory. The purpose of this study is to evaluate the use of wax on the periphery of the impression tray, and the use of wax as suggested by Carr to line the palate of the tray against the impression tray that has no wax liner. The null hypothesis is that there will be no difference between the irreversible hydrocolloid impressions with or without a wax liner, and that there will be no difference between the impressions and a dentaform, which serves as a replica of the mouth.

## Materials and methods

Materials used were regular set alginate (Cavex Impression Materials, Haarlem, Netherlands), graduated cylinders for measuring distilled water, vacu-mix bowls and spatulator (Whip Mix Corp, Louisville, KY), a maxillary dentoform (Columbia Dentoform Co., Long Island City, NY), and finally a standard perforated rim lock maxillary impression tray (Coe impression tray, stainless steel; GC America Inc., Alsip, IL). In preparing the impression trays for the study, group one (1) had no modification of the impression trays, group two (2) had wax lining the periphery of the tray, and in group three (3) the trays were modified following the method taken directly from *McCracken's Removable Partial Prosthodontics* (ed 12) textbook,<sup>3</sup> which included the addition of wax in the palate of the impression tray and the periphery. Each perforated, rim-lock impression tray was chosen to be large enough to provide 4 to 5 mm thickness of the alginate material between the dentaform teeth and tissue, and the impression tray. This was a #1 impression tray.

For tray preparation of group one, the perforated impression tray was not modified (Fig 1). For group two, the border of the impression tray was modified using rope wax to cover the rim of the impression tray (Fig 2). For group three, the palatal portion of the maxillary impression tray was covered with wax to ensure even distribution of the impression material and to prevent irreversible hydrocolloid from slumping away from



**Figure 1** Perforated metal impression tray without alteration.



**Figure 2** Perforated metal impression tray altered by the addition of wax to the periphery.



**Figure 3** Perforated metal impression tray altered by the addition of wax to the periphery and to the palate.

the palatal surface. The dimensions of the wax coverage were 50 mm wide and 54 mm anterior-posteriorly (Fig 3).

The dentaform was prepared by flattening the cusp tips of the cuspids and the distobuccal cusp tips of the second molars using a smooth carbide bur (no more than 1 mm reduction) to provide an easy-to-read and easy-to-prepare standard model. A quarter round bur and a guiding arm were used to place one small dimple on each newly flattened cusp tip. A designated location on the outside border of each dimple was used as the reference point for measurement. The dentaform is shown in Figure 4 after modification; one of the dimples is shown in Figure 5 on a maxillary molar after the cusp has been flattened.

Irreversible hydrocolloid impressions were made using the manufacturer's recommended powder-to-liquid ratio. Distilled water was used to mix the irreversible hydrocolloid powder at



**Figure 4** Dentoform with dimples placed on teeth 2, 6, 11, and 15.

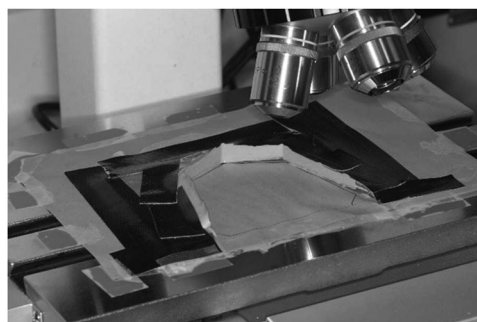


**Figure 5** Dimple placed on a flattened cusp tip for a posterior second molar. The dimple is easily seen, and a location on the outside border was designated for measuring distances between teeth.

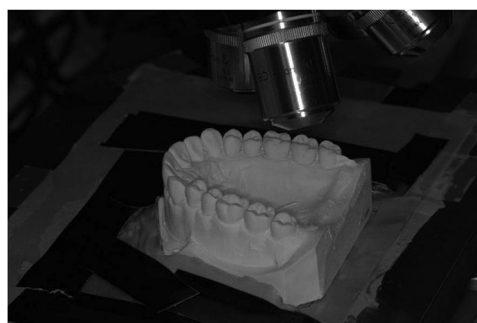
a ratio of 7 g of powder to 15 ml of water. The irreversible hydrocolloid was measured by weight to ensure a consistent mix. All materials were used at ambient laboratory conditions ( $23 \pm 1^\circ\text{C}$ ,  $50 \pm 10\%$  RH). One operator dispensed and mixed all the powder (30 seconds). Alginate was hand mixed.

To make the impression with the wax-free and wax-lined impression trays (one with the wax in the palate and one without wax in the palate), a 60 ml syringe was filled with irreversible hydrocolloid (Monoject; Coviden, Mansfield, MA). The irreversible hydrocolloid was placed onto the four marked cusp tips using the syringe to ensure they were captured in the impression, and also in the apex of the palate. The impression tray was loaded with irreversible hydrocolloid, and the tray seated on the maxillary dentoform. Enough impression material was used to completely surround the anterior edges of the dentoform. If any show-through was detected in an impression, the impression was discarded. Each impression was allowed to set for 3 minutes prior to pouring with gypsum, the manufacturer's recommended set time.

Gypsum casts were poured up using premeasured packages of Type IV stone (Silky Rock, Whip Mix Corp. Louisville, KY), and distilled water. The stone was mixed in a vacuum mixing machine using water/powder ratios recommended by the manufacturer. The dental stone was measured by weight to ensure a consistent mix. The stone was mixed in a vacuum-mixed bowl using the premeasured packet weight and 16 ml water for 30 seconds (Whip Mix Corp). Each packet of Silky Rock was



**Figure 6** The jig to position the cast under the microscope to measure the distance between dimples on the dentoform.



**Figure 7** Completed maxillary cast mounted under the measuring microscope to ensure all measurements are similar.

reweighed to ensure accuracy; if there was a discrepancy, stone was added or removed to ensure each mix was identical. The impressions were poured immediately after complete set of the irreversible hydrocolloid. Type IV stone was used because it is the most commonly used gypsum product for both fixed and removable prosthodontics at our institution.

Each gypsum cast was removed from the impression after 30 minutes as recommended by the manufacturer, and excess gypsum was trimmed from the sides in order for the cast to fit into a positioning template created for the measuring microscope (Nikon Measurescope MM-11; Nikon Corp., Tokyo, Japan). The template was created to conform to the dimensions of the edges of the dentoform (Fig 6). The template was secured into position onto the moving stage of the measuring microscope to allow the same position to be maintained for each cast to be measured. The casts were positioned by sliding into the template; if the cast did not fit into the template exactly, the cast was discarded. Figure 7 shows the cast properly positioned for recording distances between dimples. Preliminary trials indicated that a cast could be removed and repositioned within the template and distance measured within a measurement error range of 0.004 to 0.025 mm. The detection limit of the microscope was 0.0005 mm.

Once properly positioned, distance measurements were made at 50x magnification between the following tooth pairs: 6 to 11, 11 to 15, 15 to 2, 2 to 6, 6 to 15, and 11 to 2. Casts were randomly assigned a number 1 to 30, and a recorder was kept blind to the cast being measured. The dentoform was also measured, resulting in a standard for comparison for cast measurements.

**Table 1** Distances between prepared teeth (in mm, mean  $\pm$  SD)\*

	6-11	11-15	15-2	2-6	6-15	11-2
Dentoform	36.62 $\pm$ 0.014 <sup>a</sup>	37.41 $\pm$ 0.023 <sup>ab</sup>	57.31 $\pm$ 0.004 <sup>a</sup>	37.9 $\pm$ 0.005 <sup>bc</sup>	59.44 $\pm$ 0.009 <sup>ab</sup>	59.18 $\pm$ 0.009 <sup>a</sup>
No wax	36.66 $\pm$ 0.251 <sup>a</sup>	37.32 $\pm$ 0.290 <sup>ab</sup>	57.35 $\pm$ 0.065 <sup>a</sup>	37.72 $\pm$ 0.252 <sup>ab</sup>	59.19 $\pm$ 0.250 <sup>a</sup>	59.12 $\pm$ 0.269 <sup>a</sup>
Border with wax	36.65 $\pm$ 0.081 <sup>a</sup>	37.22 $\pm$ 0.293 <sup>a</sup>	57.38 $\pm$ 0.088 <sup>a</sup>	37.64 $\pm$ 0.170 <sup>a</sup>	59.25 $\pm$ 0.166 <sup>a</sup>	59.14 $\pm$ 0.117 <sup>a</sup>
Border wax + Palate wax	37.14 $\pm$ 0.511 <sup>b</sup>	37.56 $\pm$ 0.202 <sup>b</sup>	57.87 $\pm$ 0.217 <sup>b</sup>	38.01 $\pm$ 0.136 <sup>c</sup>	59.79 $\pm$ 0.256 <sup>c</sup>	59.72 $\pm$ 0.337 <sup>b</sup>

\*Groups with different superscript letters are significantly different at the 0.05 confidence level. Comparisons are vertical only.

For determining distances between teeth, x and y coordinates were recorded for each tooth dimple position, and distances were calculated by the vector equation

$$\text{Distance} = [(x_1 - x_2)^2 + (y_1 - y_2)^2]^{1/2}$$

where  $x_1$ ,  $y_1$  were the x, y coordinates for the first tooth, and  $x_2$ ,  $y_2$  were the x, y coordinate for the second tooth. Ten casts were constructed for each group. Therefore, ten distances were recorded for each tooth pair per group. For the dentoform group, ten repeated measurements were made for each tooth pair. Means and standard deviations were calculated for each tooth pair in each group. Homogeneity of variances was assessed with the Shapiro-Wilk W test,<sup>16</sup> and normality was evaluated with the Kolmogorov-Smirnov goodness-of-fit test.<sup>17</sup> The null hypothesis was tested with a one-way ANOVA,<sup>11</sup> where the independent variable was the type of tray technique or dentoform, and the dependent variables were the six tooth pair distances. Significant differences were detected by the ANOVA ( $p < 0.05$ ), which prompted pairwise comparisons with the Tukey-Kramer post hoc test ( $p < 0.05$ ).<sup>17</sup>

## Results

All groups passed tests for normality and homogeneity of variance (not shown). Results presented in Table 1 demonstrate that for all distances, except for the distance between teeth numbers two and six, the group with wax added to the borders and palate was significantly different from the remaining groups ( $p < 0.05$ ). With one exception, the unlined, border-lined, and dentoform groups were not significantly different from each other for any tooth pair distance ( $p > 0.05$ ). The one exception occurred for the two to six tooth pair, where the distance between the teeth was significantly lower for the group with wax added to borders, as compared to the dentoform.

## Discussion

Making irreversible hydrocolloid impressions is one of the most common clinical procedures done in a dental office as part of treatment planning and fabrication of appliances. Accuracy is an important part of the evaluation needed for treatment planning and for the fit of any prosthesis made from the impressions. Often it is convenient to line the impression tray with wax either to extend the border of the impression tray slightly to help capture a specific anatomical part, or to prevent impingement of delicate intraoral structures.

This study tested the hypothesis that three impression tray techniques would yield impressions of similar dimensional accuracy and would not be different from a dentoform, which served as a replica of the mouth. The research design included distance measurements between pairs of teeth in a manner that permitted evaluation of potential distortion occurring within the same quadrant and across the palate of a maxillary impression. The results demonstrated that covering the palatal portion of a maxillary impression tray with wax leads to distortion both within a quadrant and across the arch. Although the reason for this occurrence was not tested in this study, it can be postulated that the underlying palatal wax either deformed during tray removal from the dentoform (due to low proportional limit of wax), or it pulled away from the tray during removal, or the alginate pulled away from the wax.

For the clinician it is important to rely on evidence-based information, rather than long-held beliefs passed down from generations of hard-working clinicians. From the data evaluated, the clinician can feel confident in making irreversible hydrocolloid impressions either with or without wax on the periphery. The clinician should be concerned about accuracy of the resulting cast if wax is used to fill the palatal area of the impression tray.

## Conclusions

Within the limitations of this study, the following conclusions can be drawn:

1. If wax is used to line the periphery of an impression tray, the clinician can be assured that the resulting cast will be accurate.
2. If wax is used to cover the palatal portion of the tray, some distortion can be possible.

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