Alginate Substitutes: Rationale for Their Use

The irreversible hydrocolloid that we commonly refer to as alginate is extensively used for study casts, master casts and working models for the fabrication of intraoral appliances.1 Alginate is the most common impression material used for creating the opposing model for crown & bridge, but it has many shortcomings as an ideal impression material. The ideal impression material should reproduce oral detail accurately, have high tear strength, have reasonable working and setting time, be biocompatible, be dimensionally stable, allow multiple pours, and not be affected in its accuracy by disinfection.2

Background on Alginates

Due to its hydrophilic nature, alginate takes a good impression in a moist environment.3 However, this very feature — which is so important to clinicians — creates one of the most severe limitations for its use. This property creates an impression that is not dimensionally stable due to environmental humidity and temperature.4−7 This feature of hydrophilicity also affects the stability of polyethers, which can change dimensionally (larger by 30 to 240 μm, or smaller by 20 to 120 μm) depending on humidity.8 Polyether impressions and alginate impressions wrapped in moist towels should never be shipped to the laboratory in the same polybag because the polyether impression can absorb water from the alginate impression or its wet wrap. Alginate impressions should immediately be poured in dental stone for maximum accuracy because of the material’s ability to imbibe or lose moisture. After 10 minutes of storage time, alginate begins to distort. After one to three hours, it cannot be used for many clinical purposes, especially fixed prosthodontics (Fig. 1).9

The stability of alginates is also affected by the reaction of syneresis, in which fibril cross-linking continues, creating a contraction with time and an exudation of water. This reaction, therefore, necessitates immediate pour-up of the alginate. Irreversible hydrocolloids such as alginate can be poured up only once because of hydrophilicity.

Hydrophilicity also creates a monumental problem with disinfection of irreversible hydrocolloid, with hundreds of research articles looking at types of disinfectants in various combinations with a multitude of alginates. These investigations show that disinfection can create severe effects on dimensional accuracy, with immersion creating the greatest inaccuracy, as well as an effect on the surface quality of the casts produced.10−14 Alginate has a low tear strength and snags easily, especially in deep undercuts and pontic areas. It has a tendency to stick to teeth, with possible alginate tears on removal of the alginate. Polishing or prophylaxis of the teeth exacerbates the problem, preventing the alginate material from wetting the teeth and reproducing detail.15 If the teeth are dried from taking one impression, retaking a good detailed second impression of the same arch is impossible.2
If one adds the clinical variability of the inaccuracy of the amount of powder used in the mix (Fig. 2), the amount and temperature of the water (both which affect thixotropy and working time) (Fig. 3), the effects of mixing methods on the mechanical properties of alginates, the effect of type and design of tray on clinical accuracy, the effects of using adhesives (Fig. 4) and the exposure to hazardous dust, it is not surprising that alginate substitutes are becoming more popular (Table 1, Fig. 5).

**Alginate Substitutes**

Alginate substitutes are low-cost polyvinylsiloxanes (PVS) that have the same characteristics of higher-priced PVS materials used for final impressions in fixed prosthodontics. Christensen describes these alginate substitutes as accurate, clean to use (no bowl to clean, no dust), flavorless (flavor increases salivation, which is not favorable), odorless and as having the ability to delay pouring or to make additional pours of the same impression (Fig. 6). Multiple studies have demonstrated that PVS is the most dimensionally stable impression material and has a higher tear strength than alginate. Unlike alginates, they are not affected by disinfection techniques.

The ability to pour these alginate substitutes at any time provides a whole new window of opportunity and now allows the clinician to send these opposing impressions along with the final crown & bridge impression to the laboratory, eliminating the need to pour, separate and trim the model in the dental office. Not only does this save the office a tremendous amount of time and money, but now this process is a billable procedure as part of the laboratory fee for the crown & bridge case. Currently, most dentists absorb the cost of fabricating the opposing model and do not bill it as a separate procedure. Because the PVS has better surface replication of the opposing dentition, and because the variables around mixing the dental stone are more closely monitored in the laboratory, the opposing model will be much more detailed and accurate.

![Figure 1: Dehydration of the flanges of this alginate impression is noticeable 2 minutes after taking the impression.](image)

![Figure 2: The amount of powder in the measuring cup can be highly variable.](image)

![Figure 3: Each and every mix of traditional alginate will have different thixotropy and working/setting time due to variables in water/powder ratio and temperature of the water.](image)

![Figure 4: Model derived from alginate impression without the use of an adhesive. Note that the lower left quadrant has pulled away from the tray.](image)

**Alginate Substitutes Currently Available**

<table>
<thead>
<tr>
<th>Alginate Substitute</th>
<th>Manufacturer</th>
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<tbody>
<tr>
<td>COUNTER-FIT™</td>
<td>Clinician’s Choice</td>
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<tr>
<td>Position™ Penta™ Quick</td>
<td>3M ESPE</td>
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<tr>
<td>AlgiNot™</td>
<td>Sybron Dental Specialties/Kerr</td>
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<tr>
<td>Silgimix™</td>
<td>Sultan Healthcare</td>
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<tr>
<td>StatusBlue</td>
<td>Zenith Dental/DMG</td>
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<tr>
<td>Frealign</td>
<td>Zhermack</td>
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<td>Algin•X™</td>
<td>Dentsply Caulk</td>
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*Table 1*
Figure 5: Alginate substitute (COUNTER-FIT) is injected into a Border-Lock® (Clinician’s Choice) tray lined with a PVS (Affinity™ Tray Adhesive [Clinician’s Choice]) adhesive.

Figure 6: Internal detail of a COUNTER-FIT impression that has been repoured four times. (An alginate should never be poured a second time.)

Figure 7: Alginate-derived stone models on PVS bite registration material show an obvious open-bite relationship.

Figure 8: Alginate-driven stone models on Affinity™ Quick Bite PVS bite registration material show inaccurate fit.

Figure 9: Mounted case from Fig. 8 shows mismounted open bite.

Figure 10: COUNTER-FIT–driven stone model on Quick Bite PVS shows good interdigitation of the three components.

Figure 11: Precise mounting of the opposing casts is obvious when using matching accuracies in the impression and bite registration materials. This creates clinical predictability.
One of the main driving forces of a change in direction from opposing models produced from alginates to opposing models derived from alginate substitutes in fixed prosthodontics is the severe mismatch of accuracy between modern bite registration materials and alginate-driven stone models. Boksman looked at PVS bite registration materials and the need for extensive occlusal adjustments on crown & bridge prostheses, showing the severe open-bite mounting that can result when using a highly accurate PVS bite registration with a poorly detailed alginate-driven stone model (Fig. 7). Using PVS for the final impression, for the bite registration and for the opposing models eliminates the dimensional mismatch between materials, resulting in more accurate mounting of the case and less clinical necessity for occlusal adjustments (Fig. 8-11).

The surface replication of the casts is also much smoother than models derived from alginate impressions. Even though the cost of the PVS alginate substitutes is higher than the irreversible hydrocolloid alginate materials, the impression is easier to take due to the thixotropic nature of these materials, the time and cost of pouring up the opposing model can be eliminated, the impression can be repoured if the model is broken or chipped, there is increased office efficiency, the opposing model is more accurate, the bite registration actually fits, and the time and frustration of adjusting the final prosthesis is minimized. These many benefits more than compensate for the extra cost. In addition, the clinician can now (in some cases) bill this as part of the laboratory procedure. CM

References