

## **Dimensional changes in alginate impression during immersion in a disinfectant solution**

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### **Abstract**

**Objective:** To determine the effect of a commercially available disinfectant solution (Perform ID) on the dimensional stability of two different commercially available alginate impression materials.

**Methods:** Linear changes in standardized impression samples (1.5 mm & 3.0 mm thickness) made in two commercial alginates were recorded at 5 minute intervals, over a period of an hour after immersion in a disinfectant. The alginate impression samples were prepared placing the alginate mixes into a wax mould. After the material had set, each of the samples was removed from the mould. It was then placed in a Polytetrafluoroethylene (PTFE) trough before measuring the dimensional changes using a Chesterman travelling microscope.

**Results:** 3mm Blueprint Cremix showed greater shrinkage than 3mm Hydrogum. While, 1.5mm Hydrogum appeared to have uniformly greater shrinkage as compared to 1.5mm Blueprint Cremix. There was significant difference between 1.5 and 3mm thicknesses of both Hydrogum and Blueprint Cremix (PAIRED SAMPLE t test  $p < 0.05$ ). The 1.5mm samples showed much higher shrinkage than 3mm samples.

**Conclusion:** Immersion of the alginates in the same disinfectant showed variable linear shrinkage indicating that slight changes in composition could lead to variable results. In addition, there were significant differences in the linear shrinkage between the two thicknesses of the same alginate material; this indicates the possibility of distortion in actual impressions where the geometry is complex.

**Keywords:** Alginate impression, Dental prosthesis, Cross infection, Blueprint cremix, Hydrogum (JPMA 61:756; 2011).

### **Introduction**

When providing dental prostheses to patients, there is a need for an impression to be made so as to have a cast of the patients' jaw on which to fabricate the prosthesis. The impression must be accurate so that the cast can accurately represent the oral tissues. The elastic recovery of impression material from deformations is important, on removal of material from the mouth. In addition to that, the material should be dimensionally stable during storage as it normally takes some time before the impression is poured for the cast.<sup>1</sup> Therefore, it is essential that the dimensional changes in the impression material are limited to a permitted range of 0-0.15%.<sup>2</sup> However, most alginates do not fulfill this criteria.

Another important point is to control cross-infection by dis-infecting the impressions.<sup>3</sup> Micro-organisms present in the blood and saliva tend to embed in the impressions.<sup>4</sup> The time period and mode of application of disinfectant depends on the ability of the impression material to withstand the process of dis-infection without any adverse effect on dimensional stability of the material.<sup>5</sup>

The dimensional stability of alginate impression

materials is affected by exposure to air, placement in aqueous solution and disinfectants.<sup>6</sup> It is mandatory to disinfect the impressions before they are delivered to the laboratory.<sup>7</sup> None of the commercially available disinfectants are universally acceptable. It is due to the fact that all the disinfectants have some disadvantages. This situation is further aggravated by the fact that the present market offers a wide range of impression materials. Although the ingredients of alginate impression materials are similar, their detailed composition differs and is not disclosed by the manufacturer. Therefore different combinations of disinfectants and impression materials could produce varying results as related to dimensional change of the alginate impression material.

None of the previous research works have measured the dimensional changes of alginate impression materials directly. The changes in dimension have been made after the cast had been fabricated from the disinfected impressions. One more aspect that the researchers have previously not looked into is the effect of different thicknesses on the dimensional changes of the material. This factor is important due to the fact that impressions of the oral

cavity are not uniform in thickness.

The objective of this study was to determine the linear shrinkage occurring in impression samples of different thicknesses made in two different alginate impression materials (Hydrogum and Blueprint Cremix) after immersion in a commercially available disinfectant solution namely Perform ID. Linear shrinkage that could occur in the samples of two alginates was measured at 5 minute intervals, over a period of an hour.

## Material and Methods

In this study two different commercially available alginates were used. These were Blue Print Cremix (Dentsply, USA) and Hydrogum (Ivoclar-Vivadent, Liechtenstein). The disinfectant solution used was Perform I.D. (Schulke and Mayr, Germany). Perform ID was supplied by a Rotheram based company. The constituents of Perform ID as stated in its literature are potassium peroxomonosulphate ~ 20 grams, sodium benzoate ~15 grams and tartaric acid ~ 10 g.<sup>8</sup> It was prepared by adding one scoop of powder to 1000 ml. of water.

Before mixing the alginates, containers of both types of alginates were shaken to allow for even dispersion of the various components. The rubber-mixing bowl and the steel spatula that were used for mixing were thoroughly cleansed with tap water, and dried, to prevent any adverse effects/contamination during the mixing and setting of the alginate material.

The water to powder ratio in the case of Hydrogum was 15ml of water to 7g powder. The water to powder ratio for Blue Print Cremix was 34ml of water to 14.7g powder. These ratios were those recommended by the manufacturers. Modelling wax moulds were used to make rectangular samples of the impression materials. The dimensions of the wax moulds were 60 mm in length to 10 mm in width. The wax moulds were made of two different thicknesses: 1.5mm and 3mm respectively.

Sample preparation took place by the addition of one scoop of the alginate powder to water. Rigorous mixing for the time period stated by the manufacturers was followed. The mixing time with the working time was ~ 1 minute and 40 seconds for Hydrogum. The working time of Blueprint Cremix was ~ 1 minute. The material was then placed into a wax mould that was placed on a glass slab. As soon as the material was loaded into the wax mould it was carefully covered by another glass slide. It allowed excess material to flow out of the wax mould. A slight pressure was applied on the top glass slide to simulate the clinical condition, in which the materials, after being placed into oral cavity, are slightly pressed to

facilitate the setting of the mixed mass and to allow the excess material to escape through the tray perforations. After the material has set during the given setting time (~two minutes for Hydrogum) and (~ one and a half minute for Blueprint Cremix) the alginate sample was removed from the mould. As soon as the samples were prepared they were placed in a Polytetrafluoroethylene (PTFE) trough. The trough consisted of a fixed pin to which one end of the sample was attached. Then, another pin was placed on the opposite end of the sample. The room temperature was maintained at 23°C +/-1°C.

The dimensional changes taking place in alginate materials when they were placed in disinfectant solution, distilled water and air, were measured by a Chesterman travelling microscope. The distance between the fixed pin and the opposite edge of the sample, closest to the movable pin, was measured as soon as the material was placed in the trough, to obtain a baseline reading, which was documented as a 0 minute reading. This was followed by measurements, on the opposite edge of the sample, every 5 minutes for over a period of an hour. For measurements in air, the trough was left empty,

The control that was used in this study was distilled water. Measurements were also made in air. The changes in air were measured to correspond to the clinical situation in which the impression material is exposed to air soon after the impression is taken and before it is poured to make a cast. The number of samples for each of the experiments was five.

The data recorded were subjected to statistical analysis using the independent t Test to analyze any statistical difference of linear shrinkage between the two thicknesses (1.5mm and 3mm) of the alginate impression material.

## Results

In Table, on immersion in Water; 1.5mm

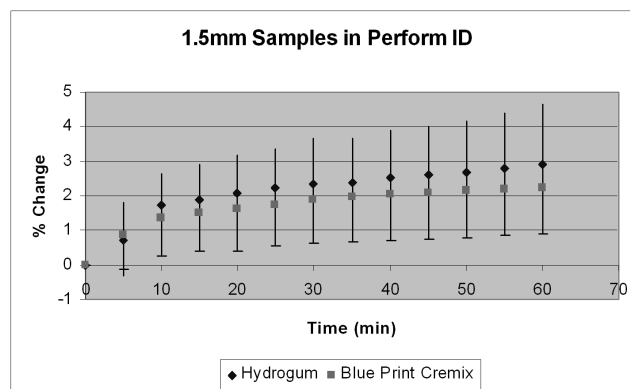


Figure-1: Comparison of shrinkage pattern of 1.5mm thick samples of Hydrogum and Blueprint Cremix immersed in Perform ID at different time intervals.

**Table: Comparison of shrinkage pattern in 1.5 mm and 3.0 mm thick impression samples of Hydrogum and BluePrint Cremix when kept immersed in distilled water or exposed in air for an hour.**

Environment	10 mins % change	20 mins % change	30 mins % change	40 mins % change	50 mins % change	60 mins % change
<b>Water / Material</b>						
Hydrogum 1.5mm	- 0.5	- 0.3	0	0	0	0.1
BluePrint 1.5mm	0.6	1.2	1.5	1.7	2	2
Hydrogum 3mm	0.2	0.4	0.6	0.6	1	1
BluePrint 3mm	0.6	0.7	0.9	1.2	1.3	1.4
<b>Air / Material</b>						
Hydrogum 1.5mm	1	1.9	2.5	3	3.8	4
BluePrint 1.5mm	1	1.7	2	3	3.9	4.1
Hydrogum 3mm	0.7	0.9	1.2	1.8	2.1	2.7
BluePrint 3mm	0.5	0.9	1.1	1.3	1.5	1.8

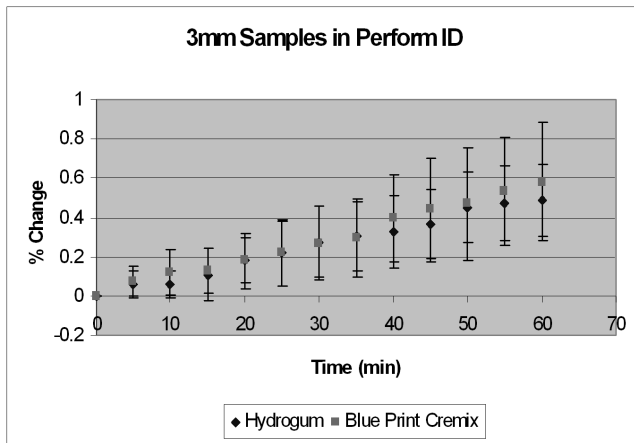


Figure-2: Comparison of shrinkage pattern of 3.0 mm thick samples of Hydrogum and BluePrint Cremix immersed in Perform ID at different time intervals.

Hydrogum in comparison with 1.5mm BluePrint Cremix reveals that Hydrogum expanded for a very short time ~ 20 minutes before it started to shrink. The 1.5mm BluePrint Cremix appears to be shrinking more as compared to 1.5mm Hydrogum. While, 3mm BluePrint Cremix seems to be shrinking more rapidly as compared to 3mm Hydrogum.

In Table, on exposure to Air for one hour both the 3mm Hydrogum and 3mm BluePrint Cremix samples showed linear shrinkage. The shrinkage pattern was almost the same for around 35 minutes; however after the lapse of 35 minutes, Hydrogum appears to have undergone more shrinkage than BluePrint Cremix. There is also shrinkage of 1.5mm samples of Hydrogum and BluePrint Cremix when placed in air for 1 hour. It reveals 1.5mm Hydrogum to be shrinking more for first 30min; from then onwards 1.5mm BluePrint Cremix seems to shrink more as compared to Hydrogum

Figure-1 reveals uniform shrinkage pattern of 1.5mm thick samples of Hydrogum and BluePrint Cremix when they are immersed for 1 hour in Perform I.D. with Hydrogum appears to be showing more shrinkage than

BluePrint Cremix.

Figure-2 shows shrinkage of both 3mm Hydrogum & 3mm BluePrint Cremix where BluePrint Cremix seems to be shrinking more than the Hydrogum when the materials are immersed in Perform I.D. for 60 minutes ( $p < 0.05$ ).

## Discussion

It is evident that all materials shrink in solutions, although 1.5mm Hydrogum and BluePrint Cremix in distilled water exhibited a small transient expansion before the onset of shrinkage. These findings related to dimensional changes in distilled water and Perform ID are similar to those noted by Martin et al<sup>8</sup> and Nallamuthu.<sup>9</sup>

The above observations raise the question of the reason for shrinkage. Alginate itself contains water. It is suggested here that in the case of water, there may be an initial expansion, due to the ions present in the alginate (e.g.  $\text{Na}^+$ ,  $\text{SO}_4^{2-}$ ,  $\text{PO}_4^{3-}$ ) creating an osmotic potential. However, subsequently the ions diffuse out into the surrounding water, reversing the osmotic potential, so that some water diffuses out again.

When the external solution itself contains ions i.e. in the case of Perform I.D, then there will be a two way transport of ions, until the set alginate is in equilibrium with the external solution. Clearly in all the cases studied this involves some water loss and hence shrinkage.

Mann-Whitney U test, showed significant differences (probability of null hypothesis  $< 0.01$ ) between 1.5 and 3mm thicknesses of both Hydrogum and BluePrint Cremix at 10 minutes in Perform ID (Figures 1 & 2). This is very important in that shrinkage in specimens of complex geometry will be accompanied by distortion.

Furthermore, the results of our study indicate a significant difference in the shrinkage pattern of both BluePrint Cremix and Hydrogum even at 1 hour in

Perform ID, with 1.5mm thick sample showing a much higher shrinkage than 3mm thick sample.

This may have important clinical implications. Shrinkage appears to increase monotonically with time. Therefore, the time of immersion should not exceed that specified by the manufacturer. It would also appear that any disinfectant requiring prolonged immersion of the impression is contra-indicated.

We conclude that immersion of alginates in disinfectant solution had similar effects to immersion in distilled water; namely a net shrinkage of ~ 0.4-2.5% at ten minutes; the range being a consequence of the variability discussed above. This variability is a result of the standard way of dispensing alginates as a powder, which is mixed with water. It would seem there is a case for the development of a Two Paste Alginate System. However, there are significant differences in the 10 minute values between the two thicknesses studied; this indicates the possibility of distortion in actual impressions where the geometry is complex. This effect is very much more pronounced when Perform ID is the disinfectant

More detailed work is necessary to explore some of the issues highlighted in the current work, particularly the differences between a wider range of alginates and disinfectant solutions. In particular, the effect of specimen thickness when the alginate is immersed in Perform ID needs investigating for a wider range of alginates. The possibility of developing two-paste alginate merits further study, to reduce variability in properties of alginates.

Finally the work carried out by Nallamuthu on self-disinfecting alginates should be explored further.<sup>9</sup>

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