The Influence of Disinfectants Incorporation on Die Stone Linear Expansion

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Abstract

Purpose: The aim of this paper was to analyze the influence of incorporation of disinfectants during the die stone linear expansion. Materials and Methods: Die stone type IV specimens with disinfection solutions (sodium hypochlorite 1%, chlorhexidine 2%) were incorporated in two concentrations (50%, 100%). The dimensional stability was tested in accordance with ADA recommendations. Results: Addition of undiluted sodium hypochlorite determines the significant reduction of expansion setting, in a percentage more important than diluted chlorhexidine. Conclusions: Use of undiluted hypochlorite negatively affects the model sizes, while using 50% dilution or 50 or 100% chlorhexidine did not significantly alter its stability.

Keywords: antiseptic, linear variation, models

1. Introduction

Disinfection of plaster models became an important procedure given the potential transfer of infectious agents from blood or saliva through dental impression materials. In 1996, ADA together with the National Association of Dental Laboratories of the United States (NADL) formulated "Recommendations for infection control in the dental office and laboratory", both included within the same document, in a first stage [1]. Due to the possibility of cross-contamination, there were concerns which have become more concerted in establishing standardized protocols that apply to the fingerprinting and/or die plaster models. [2-4]Studies conducted on the effect of disinfectants on the dental impression materials [5-13] often show that, the application time necessary to obtain an optimal disinfection alters their properties. Disinfection of plaster models can be carried out by spraying or immersion in a disinfecting solution [14, 15], as well as by the incorporation of antimicrobial agents into the plaster mass [16, 17]. However, some authors have pointed out that the immersion of model can be detrimental to the final quality of models compared with spraying [17], which in its turn has the disadvantage of an insufficient disinfection due to the porosity of the model [18]. Because dental casts disinfection must be effective without altering their quality,
incorporating plaster disinfectants seems a promising alternative. The purpose of this study in vitro is to analyze the influence of disinfectants used in the preparation of plaster models on dimensional linear variation of the final model.

2. Materials and Methods

This study was conducted accordingly to the ADA Specification No. 25 [18], which states that research on plaster products is to be conducted in environments with temperature of 25°C (± 2°C) and relative humidity of 50% (± 10%). Within those parameters, the research was conducted with the following materials and equipment: die stone Type IV molds, extra hard, (INFRAROCK- INFRADENT); 1% sodium hypochlorite; 2% chlorhexidine gluconate; digital Caliber meter; device for measuring the plaster expansion (SAM EMI 100). The study was conducted through four experimental groups and a control group, as follows: Control group: plaster is mixed according to the manufacturer’s instructions; GROUP 1: 100% replace water with 1% sodium hypochlorite; GROUP 2: 50% replace water with 1% sodium hypochlorite; GROUP 3: 100% replace water with 2% chlorhexidine gluconate; GROUP 4: 50% replace water with 5% chlorhexidine gluconate.

We made 20 tests in each experimental group. The cast is prepared in a vacuum mixer and poured in a vibrating container. The container is connected to a tool which ensures the expansion of the plaster by means of which we measure the setting expansion and the dimensional change up to two hours (Figures 1-3).

The sample is removed from the holder and measured by caliber meter to find out the length L two hours after the settings. To learn the initial length at setting we calculated \( L_0 = L - \Delta L \). The percentage dimensional change will be: \( ADL = \Delta L / L \times 100 \). The results are synthesized in a table and are statistically analyzed by a specialized statistician using SPSS 13.0.

3. Results and Discussions

Linear expansion of the plaster mass during hydration of calcium sulphate has been investigated in numerous studies [19, 20], these concluding that variation depends on plaster composition and calcination process. In the research conducted, we obtained values between 0.06 and 0.5% of the total volume of plaster [21, 22].
**Descriptive statistical analysis of test groups**

In the first experimental group, the results show a normal distribution, slightly asymmetric to the left because the average has a lower value than the median values. This difference is maintained both in the case of measuring the sample length at setting, as well as 2 hours after the setting, the average difference in length between the two phases was of 0.0067. The dispersion of values within the group is very small, of 0.04, and differences in length of 0.005, which shows that value of all tests is close to the average value.

All average values in the group of tests are under control test values, which suggest a decrease in expansion setting under the influence of Na hypochlorite.

Within group 2, the distribution is asymmetrical to the right, both at setting as well as after two hours (the medium is greater than the median), regarding the difference between the two lengths of 0.2 mm is perfectly symmetrical (medium and median difference are equal) within the group. The values are lower than the control test but the difference from this group is less than that of group 1, which suggests that the addition of water with hypochlorite improves dimensional model alteration.

For group 2, the initial and final value is constant in all 9 tests, keeping an average difference in length between the initial setting and the one after 2 hours of 0.2 mm. Using chlorhexidine digluconate caused the attainment of constant results, with lower values than the control test, but with a difference in length which is close to the previous group.
Group 3 shows a normal distribution, tipped to the left (less than the median) in terms of initial length and at 2 hours, perfectly symmetrical in case of the difference between the two. The dispersion of results in the group is approximately equal to the initially and finally.

Although the addition of water with chlorhexidine determined the attainment of initial and final lengths lower than the standard, the change of setting was equal to the test with hypochlorite and water, and the one with full chlorhexidine.

Average percent change in length between the setting phase and after 2 hours is an average of 0.006% in Group 1, the lowest of the tests, the other groups showing 0.019%. Our control test registered 0.029%, i.e. a difference in length compared to the last three tests of 0.01 mm (10 microns), the difference clinically offset.

**Group comparison with standard test**

From the point of view of the difference between the measurements of the standard group with the test groups, the average difference between the measurements of Group 1 was significantly lower $T(8) = -14, p <.001, CI 95\% = (-0.0272 - 0.0195)$. This test suggests that full replacement of water with sodium hypochlorite in the composition of plaster results in a setting contraction of the model, providing a significant size difference to the witness group, a result similar to that provided by Lucas et al. [11]. According to the information from the literature [9, 10, 23, 24, 25] chemical agents which regulate setting time of plaster, generally reduce the expansion occurring during hydration of the calcium sulphate. Dimensional alteration occurred at introducing sodium hypochlorite was expected, given that it is one of the setting inhibitors. Compared to the difference between measurements of the standard test, the average difference between the measurements in Group 4 is significantly lower $T(8) = -3.5, p = 0.009, 95\% CI = (-0.0167, -0.0033)$. Chlorhexidine with water decreases setting expansion, changing model quality but in a less accentuated extent than hypochlorite. The result is different from other studies [26] stating that setting expansion is similar to the standard group.

**Comparison between the test groups**

Applying comparative tests between groups (ANOVA), we found that there is a difference between test groups regarding the average gap length, $F(3.32) = 16, p<0.001$, the various components of the liquid causing differences between the groups as to the setting
expansion. We further tested this result to see in which of the groups the comparisons are considerable and applied post-hoc Games-Howell test. For Group 1, we found the average gap length was significantly lower compared with the other groups (see table).

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean Difference (I-J)</th>
<th>Std. Error</th>
<th>Sig.</th>
<th>95% Confidence Interval</th>
<th>Games-Howell</th>
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<td>-.0035</td>
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</table>

4. Conclusions

According to the methodology of this study, we can conclude that: i) the addition of hypochlorite and 50% chlorhexidine led to differences statistically proven by the control test, to inhibit setting expansion; ii) the addition of 1.0% hypochlorite led to dimensional changes during setting, significantly more important than the other tests; iii) the mean percent changes in length between setting stage and after 2 hours, if the addition of 50% hypochlorite, 50% or 100% chlorhexidine led to minor changes compared to the control test.

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References