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The dimensional stability of dental impression materials following immersion in disinfecting solutions

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ABSTRACT

Objectives. This investigation examined the effect of several disinfectant systems upon the dimensional stability of a range of common dental impression materials. A new disinfection process based upon hypochlorous acid was one of those examined (Sterilox®).

Methods. Test specimens of commercially available impression materials from the following categories were investigated: alginates, addition-cured silicones, condensation-cured silicones and polyether. Three disinfection regimes were tested: sodium hypochlorite 5.25%, Perform ID® and Sterilox®.

A custom-built automatic laser micrometer was used to measure the dimensions of sample discs of the test materials before disinfection, immediately after and then following 24 h storage. Analysis of variance was employed to identify statistically significant differences within groups and across groups.

Results. All the disinfection routines tested resulted in acceptable levels of dimensional stability within the category of normal use of each impression material.

All the materials tested can be disinfected with 10% Sterilox without undergoing unacceptable levels of dimensional change.

Significance. All the disinfection routines tested resulted in acceptable levels of dimensional stability within the category of normal use of each impression material.

1. Introduction

In the past, the most biologically contaminated item to leave the dental surgery for further handling was the dental impression on its way to the dental laboratory. Dental impressions become contaminated with the patient's saliva, bacterial plaques, and blood. This offers a significant cross-infection vehicle for dangerous pathogens such as the human immunodeficiency virus and hepatitis-B virus among others. It is now a requirement of standard cross-infection protocols that impressions are delivered to the laboratory after disinfection [1–3].

A wide range of disinfectants has been advocated and of these, sodium hypochlorite [4–7], sodium metabisulphite [4,8], and glutaraldehyde [9–11] are probably the most popular. Other experimental techniques use ultraviolet radiation [12] and microwave radiation [10]. None of these solutions have become a universally accepted standard and as the range of disinfecting solutions increases, so does the number of protocols in use [13–15]. The challenge of effective

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decontamination is compounded by the range of impression materials that are available. Reversible and irreversible hydrocolloids; addition and condensation reaction silicones; polyethers; polysulphides and gypsum-based products all have specific clinical applications and must be accounted for in any decontamination protocols.

This investigation examined the magnitude of the effect of several disinfection protocols upon a range of commonly used impression materials. The protocols included an innovative system based upon hypochlorous acid generated electrolytically on site using a self-contained proprietary electrolytic cell (Sterilox, Optident Ltd. West Yorkshire, U.K.).

The disinfection process aims to eliminate microorganisms from the surface of the impression. However, an undesirable side-effect of the disinfection process is the potential for a change in the dimensions of the impression that may be associated with a chemical or physico-chemical interaction between the set material and the disinfecting solution. The change of dimension of impression materials following the setting reaction or the immersion in disinfection solutions has been the subject of a number of studies [5,16–22].

The most recognized specifications for the behavior of alginate and non-aqueous elastomeric impression materials are those set by ANSI/ADA [23,24]. These specifications detail a range of testing procedures, which includes among others, techniques for the measurement of dimensional change after setting. The technique as specified by ANSI/ADA relies on direct measurement of an impression of a machined ruled block using the impression material under investigation. Measurements are taken with a travelling microscope, having a micrometer stage with an accuracy of 0.005 mm. The accuracy of such a method is limited and is subject to the accuracy of the translation screw of the travelling microscope and the skill of the operator who takes the measurements. Some studies have used this method [16–18], while others have introduced modifications [4,5,9,19–21]. The modifications appear to offer no obvious advantage as the technique requires the fabrication of a test block from an impression, hence introducing errors associated with the dimensional changes that may occur in the cast material.

Since the ADA specifications were first written, 1969 for alginates and 1977 for elastomeric materials, technological advances have made possible the use of more sophisticated and accurate methods of assessing the dimensional stability of dental materials.

The technique used in this investigation enables the direct measurement of the impression material, without the need to pour a cast as previously required. This measurement is non-contact, highly accurate and with a resolution of 0.0001 mm, which is 200 times the resolution of the ADA specification. The measurement cycle is fully automated and requires no skill from the operator. In addition, this technique enables the calculation of both the linear and volumetric change in dimension over time.

This system was developed by Martin and Jedynakiewicz, originally for the assessment of dimensional changes that occur in resin-based dental restorative materials [25–27]. It has subsequently been adopted by industry for the same purpose. The apparatus is highly versatile and has been modified to enable its application to this project.

1.1. Aim

The aim of the study was to determine the dimensional stability, as a function of time, of dental impression materials following immersion in a range of disinfecting solutions.

1.2. Objectives

The objective of the study was to obtain measurements of the changes in dimension that occur as a result of immersion in a range of standard disinfectant solutions. The data should encompass three relevant time intervals; immediately after the impression was taken; immediately after disinfection and finally after 24 h in transportation conditions as this latter stage would represent the transfer from the surgery to the dental laboratory.

2. Materials and methods

2.1. Test materials

The test materials represented four common groups of impression materials. The irreversible hydrocolloids (alginates) were represented by Alginoplast® (Heraeus Kulzer Lot 17 57875). Addition-cured vinyl polysiloxanes were represented by two putty-wash systems. The two materials in the first system were Provil® Putty soft regular set (Heraeus Kulzer Lot 200073/200041) and Provil® Light CD2 regular set (Heraeus Kulzer Lot 160285). The second system was Aquasil® Soft Putty regular set (Dentsply, Caulk, USA Lot 0311000142) and Aquasil® Monophase (Dentsply, Caulk, USA) Lot 030905). A putty-wash system based upon a condensation reaction silicone was represented by Xantopren® L-Blue (Heraeus Kulzer Lot 200318) and Optosil® Comfort Putty (Heraeus Kulzer) Lot 190591). The polyether material was Impregum F® (ESPE, Lot 162789).

2.2. Disinfection solutions

- Sodium hypochlorite 5.25%—used as published [4–7].
- Perform-ID® (Schülke & Mayr GmbH, Germany)—Used in accordance with the manufacturer's recommendations.
- Sterilox®—Used at 10% dilution and as a concentrated solution.

2.3. Specimen preparation

2.3.1. Disc fabrication method

Test specimens were prepared using a precision-machined cylindrical mould as shown in Fig. 1. The mould has an internal diameter of approximately 19 mm and a height of 4 mm with an extrusion orifice 3 mm in diameter. The impression material was placed into the cylinder and packed. The material was then compressed against a glossy plastic release film borne over a glass slab. The mould was seated until it was flush with the rim of the cylinder. Excess material was allowed to flow through the extrusion orifice at the base of the chamber. The set-up was allowed to rest undisturbed at a temperature of 37 °C for the required time to allow full gelation and subsequent setting of the various materials according to the manu-