10.5005/jp-journals-10024-2176

ORIGINAL RESEARCH

Self-disinfecting Alginate *vs* Conventional Alginate: Effect on Surface Hardness of Gypsum Cast—An *in vitro* Study

[1]Ranjith Madhavan, [2]Navia George, [3]Niharika R Thummala, [4]SV Ravi, [5]Ajay Nagpal

ABSTRACT

Introduction: For the construction of any dental prosthesis, accurate impressions are necessary. Hence, we undertook the present study to evaluate and compare the surface hardness of gypsum casts poured from impressions made using conventional alginate and self-disinfecting alginate.

Materials and methods: A total of 30 impressions of stainless steel die were made, out of which 15 impressions were made with conventional alginate and 15 were made with self-disinfecting alginate and poured using Type III dental stone. Thirty stone specimens were subjected for hardness testing. Data were analyzed using independent samples t-test to compare the mean surface hardness.

Results: Difference in surface hardness was statistically insignificant ($p > 0.05$).

Conclusion: Surface hardness of gypsum casts poured using impressions made from self-disinfecting alginate and conventional alginates were comparable.

Clinical significance: Self-disinfecting alginates may be employed in clinical practice as safe and effective materials to overcome the infection control issues without compromising on the properties of the material.

Keywords: Alginate, Gypsum cast, Hardness, Hydrocolloid.

How to cite this article: Madhavan R, George N, Thummala NR, Ravi SV, Nagpal A. Self-disinfecting Alginate *vs* Conventional Alginate: Effect on Surface Hardness of Gypsum Cast—An *in vitro* Study. J Contemp Dent Pract 2017;18(11):1061-1064.

Source of support: Nil

Conflict of interest: None

[1]Department of Prosthodontics, Crown and Bridge, KMCT Dental College, Calicut, Kerala, India

[2]Private Practitioner, Calicut, Kerala, India

[3]Private Practitioner, Hyderabad, Telangana, India

[4]Department of Conservative Dentistry and Endodontics, KMCT Dental College, Calicut, Kerala, India

[5]Department of Conservative Dentistry and Endodontics, K.D. Dental College & Hospital, Mathura, Uttar Pradesh, India

Corresponding Author: Ranjith Madhavan, Department of Prosthodontics, Crown and Bridge, KMCT Dental College Calicut, Kerala, India, Phone: +918979712525, e-mail: drranjith_madhavan@yahoo.co.in

INTRODUCTION

Accurate impressions are necessary for construction of any dental prosthesis. Irreversible hydrocolloid (or alginate) is the most popular dental impression material in everyday practice.[1] They are more popular among dentists because these are inexpensive, fast setting, and simple to use. Dentistry is quite different from other fields of medical science in that all the clinical procedures are undertaken in an environment in which there are saliva and blood contaminated with microorganisms.[2]

Infections in the oral cavity can come from any external source including any type of dental instrument and impression material. Impressions have been identified as an area of concern. Dental impressions can easily become contaminated with patient's blood and saliva.[3] This impression material may act as a medium for the potential transfer of organisms from patient to operator, to other patients, and to dental auxillaries.[2]

Concerns regarding the transmission of infectious organisms have prompted a rise in the measures for infection control throughout the health-care field.[4] All the patients must be individually categorized under the category of potentially infectious group, and therefore, separate handling of the impression should be done with great care.[5] The rising profile of conditions, such as hepatitis B and human immunodeficiency virus has helped to increase awareness of the risk of transmission of infection within the dental environment. The hazard can be reduced by adequate chemical disinfection before the work leaves the clinic.[6] For disinfection for irreversible hydrocolloid impression materials, various methods

have been proposed. Spray and immersion techniques are the two most widely used techniques in clinical practice. However, these conventional techniques present several disadvantages.[7]

It is of utmost importance that the disinfecting agent not only be an effective antimicrobial. As the casts are used for the fabrication of prostheses, the changes in the hardness are clinically significant.[8]

Efficacy regarding the antimicrobial activity of self-disinfecting alginate impression material has been proved; however, little work has been done regarding their effect on the physical properties of gypsum cast. Hence, the purpose of the study is to evaluate and compare the effect of commercially available conventional alginate, with the self-disinfecting alginate on the surface hardness of the resulting gypsum cast.

MATERIALS AND METHODS

The materials used in the study are listed in Table 1. Following the specification number 18 given by American National Standard/American Dental Association, fabrication of a stainless steel test die was done for alginate impression materials. In addition to the stainless steel dies, a stainless steel ring with stainless steel wire in the center was also fabricated for the purpose of retaining of impression materials. The circular stainless steel die had a diameter of 46 mm, and a circular step with height of 4 mm, which acted as a guide for the placement of the ring. The stainless steel ring measuring 9 mm, with the internal diameter of 47 mm, was inserted onto the step which provided 5 mm space for alginate. Engraving of three 25 mm lines with V-shaped transverse section and having 25 µm (Y), 50 µm (X), and 75 µm (Z) width was done with the help of neodymium-doped yttrium aluminum garnet laser machine. Engraving of two additional lines in the horizontal direction was done, which were made 25 mm apart. These lines were drawn perpendicular to the previous lines.

Making the Impressions

Petroleum jelly was used for the lubrication of the stainless steel ring. This was followed by cleaning of the ring with alcohol and then giving enough time for its drying. Before the impression-making procedure, the placement of the stainless steel ring was done in the die. Mixing of the alginate powder was done at room temperature as per manufacturer's instructions. In the center of the die surface, the placement of the mixed material was done. An acrylic sheet with perforations was placed on the ring surface with sufficient force to distribute the alginate along the test surface and to squeeze out the excess alginate material. The acrylic sheet was then loaded with 1 kg weight on top of it. About 3 minutes after the minimum setting time recommended by the manufacturer, the stainless steel ring was separated along with the impression from the stainless steel die surface. Therefore, the separation time was approximately 5 minutes from the start of mixing.

Pouring of the Gypsum Casts

Type III dental stone was used for making the cast of the impressions. Manual addition of the dental stone was done followed by vacuumed mixing for 30 seconds. Following the setting, the casts were retrieved and numbing of the specimens was done for identification.

A total of 30 alginate impressions of the metal die were made and poured using dental stone. Fifteen impressions were made with conventional alginate, and 15 impressions were made with self-disinfecting alginate.

Resultant dental stone specimens obtained were divided into two groups of 15 specimens each for evaluation of surface hardness.

Group I (control group): surface hardness of specimens obtained from impressions made from conventional alginate.

Group II (experimental group): surface hardness of specimens obtained from impressions made from commercially available self-disinfecting alginate.

Numbering of Specimens

The retrieved specimens were numbered using a permanent marker in three-digit code.

- First digit denoted the group to which the specimens belonged
- Second digit denoted the parameter surface hardness
- Third digit denoted the specimen number

Surface Hardness of Stone Casts

Surface hardness was determined using Vickers hardness testing machine. Each specimen was placed on the platform and loaded on the flat surface with a force of

Table 1: Materials used in the study

Materials	*Trade name*	*Type*	*Manufacturer*
Alginate	Jeltrate plus	Fast set, antimicrobial, dustless	Dentsply Caulk, USA
Alginate	Jeltrate	Fast set, dustless	Dentsply Caulk, USA
Dental stone	Kalstone	Type III	Kalabhai Karson Private Limited, Mumbai, India
Demineralized water	Nice		Nice Chemicals, Kochi, India

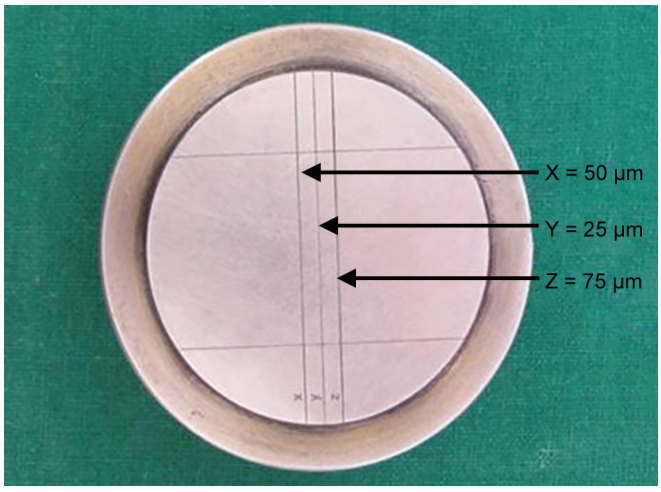
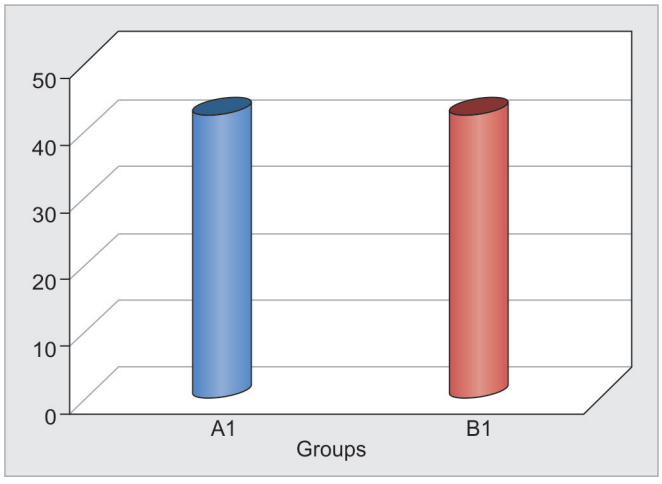


Fig. 1: Stainless steel test die



Graph 1: Mean surface hardness in the two study groups

294.3 N for 15 seconds to obtain three diamond-shaped indentations. The specimens were viewed under a microscope to calculate the mean value of two diagonals of the diamond-shaped indentation that formed the determinant of the hardness number and a mean was calculated. Fifteen dental stone specimens made using self-disinfecting alginate and 15 dental stone specimens made using conventional alginate were evaluated for surface hardness (Fig. 1). Hardness was calculated using the following formula:

$$VHN = \frac{0.1891 \times P}{D^2}$$

where VHN is the Vickers hardness number, P is the force used to load the instrument in Newton, and D is the mean value of two diagonals of the diamond-shaped indentation in millimeters.

RESULTS

Descriptive statistics, independent samples t-test, and crosstab procedure were used for the statistical analysis of this study. All the statistical methods were carried out through the Statistical Package for the Social Sciences for Windows (version 16.0). The mean surface hardness (Graph 1) of group I was found to be 42.5440 and that of group II was found to be 42.4967 (Table 2). Independent samples t-test showed statistically insignificant difference for surface hardness between control group (I) and experimental group (II). Thus, difference in surface hardness was statistically insignificant ($p > 0.05$). A comparison of the mean percentage difference in surface hardness between control group and experimental group (Table 3) was also done.

Table 2: Comparison of surface hardness between control group (I) and experimental group (II)

	Group	*n*	*Mean ± SD*	*Significant (two-tailed)*
Surface hardness	I	15	42.5440 ± 1.1464	0.913
	II	15	42.4967 ± 1.2116	

SD: Standard deviation

Table 3: Comparison of the mean percentage difference in surface hardness between control group and experimental group

Parameter	*Groups*	*Percentage*
Surface hardness	Group I > group II	0.11

DISCUSSION

The human mouth is usually the first to be exposed to microorganisms at birth. With the passage of time, the child is exposed to microorganisms from the environment. Eruption of primary teeth results in a major change in this environment, providing tooth surfaces and gingival crevices which make further opportunities for infection in the mouth.[2]

Dentists and dental technicians are subjected to higher risk of development of infectious diseases from patients.[9] Irreversible hydrocolloid impression material is the most commonly and frequently used impression material in prosthetic dentistry. Impression making is one widely used procedure where clinicians must balance the requirement to maintain an intact antibacterial barrier system with the need to produce accurate dental casts.[10] For an optimum cast, the relation between static and mobile structure must be reproduced accurately.[11] By disinfecting the orally soiled impression materials, the chance of transmission of diseases is reduced.[3] Leung and Schonfeld observed that bacteria can be transferred from contaminated impressions to stone casts and contaminate the equipments, surroundings, and the personnel.[8] As alginate does not possess any antimicrobial properties, it would require disinfection following exposure to saliva and/or blood. From the prosthodontic point of view, impressions of comprised quality are not acceptable.[12] Disinfection procedures using spray or immersion can

cause unacceptable dimensional changes in impressions recorded in alginate. Agent added should possess a broad-spectrum activity against all microbes, should be stable on storage, and should not reduce the normal shelf life of the product.[13] Disinfection procedures using spray or immersion are time consuming, and since alginates have the property of syneresis and imbibition, it invariably results in dimensional changes in alginate impressions.[14] The difficulties associated with disinfecting irreversible hydrocolloid impression material have resulted in the development of self-disinfecting irreversible hydrocolloid impression materials that are preimpregnated with disinfectants.[7] We also observed that in gypsum casts made from impressions using self-disinfecting alginate and the conventional alginate, the surface hardness did not vary significantly. Hamedi Rad et al[15] assessed the alginate impression materials and analyzed their dimensional stability following spray and immersion technique of disinfection. They selected four different disinfecting agents and divided the impressions randomly into four study groups with 24 impressions in each study group. Nondisinfected impression was taken as control group. Type III dental stone plaster was used for pouring the impression. They observed a significant change in the mean length and height of the impressions in the various study groups. Maximum and minimum change in the height was noticed in the glutaraldehyde and deconex in the immersion method respectively. From the results, the authors concluded that disinfection of the alginate impression materials by sodium hypochlorite, deconex, and glutaraldehyde is not a recommended method.[15]

CONCLUSION

There were no statistically significant differences in the surface hardness of gypsum casts poured using impressions made from self-disinfecting alginate and conventional alginate. Hence, it can be concluded that self-disinfecting alginates may be used in the clinical practice as a safe and effective material to overcome the infection control issues without concern for the properties of the material.

REFERENCES

1. Rueggeberg FA, Beall FE, Kelly MT, Schuster GS. Sodium hypochlorite disinfection of irreversible hydrocolloid impression material. J Prosthet Dent 1992 May;67(5):628-631.
2. Dandakery S, Shetty NS, Solomon EG, Prabhu VD, Rao S, Suvarna N. The effect of 0.5% sodium hypochlorite and 2% glutaraldehyde spray disenfectants on irreversible hydrocolloid impression material. Indian J Dent Res 2003 Oct-Dec;14(4):187-193.
3. Flanagan DA, Palenik CJ, Setcos JC, Miller CH. Antimicrobial activities of dental impression materials. Dent Mater 1998 Nov;14(6):399-404.
4. Abdelaziz KM, Combe EC, Hodges JS. The effect of disinfectants on the properties of dental gypsum, Part 2: surface properties. J Prosthodont 2002 Dec;11(4):234-240.
5. Kern M, Rathmer RM, Strub JR. Three-dimensional investigation of the accuracy of impression materials after disinfection. J Prosthet Dent 1993 Nov;70(5):449-456.
6. Boden J, Likeman P, Clark R. Some effects of disinfecting solutions on the properties of alginate impression material and dental stone. Eur J Prosthodont Restor Dent 2001 Sep-Dec;9:131-135.
7. Wang J, Wan Q, Chao Y, Chen Y. A self-disinfecting irreversible hydrocolloid impression material mixed with chlorhexidine solution. Angle Orthod 2007 Sep;77(5):894-900.
8. Vandewalle KS, Charlton DG, Schwartz RS, Reagan SE, Koeppen RG. Immersion disinfection of irreversible hydrocolloid impressions with sodium hypochlorite. Part II: effect on gypsum. Int J Prosthodont 1994 Jul-Aug;7(4):315-322.
9. Look JO, Clay DJ, Gong K, Messer HH. Preliminary results from disinfection of irreversible hydrocolloid impressions. J Prosthet Dent 1990 Jun;63(6):701-707.
10. Hall BD, Muñoz-Viveros CA, Naylor WP, Sy J. Effects of a chemical disinfectant on the physical properties of dental stones. Int J Prosthodont 2004 Jan;17(1):65-71.
11. Rubel BS. Impression materials: a comparative review of impression materials most commonly used in restorative dentistry. Dent Clin North Am 2007 Jul;51(3):629-642, vi.
12. Tan HK, Hooper PM, Buttar IA, Wolfaardt JF. Effects of disinfecting irreversible hydrocolloid impressions on the resultant gypsum casts. J Prosthet Dent 1993 Dec;7:532-537.
13. Ghani F, Hobkirk JA, Wilson M. Evaluation of a new antiseptic-containing alginate impression material. Br Dent J 1990 Aug;169(3-4):83-86.
14. Anusavice KJ. Phillips' science of dental materials. 11th ed. Philadelphia: W B Saunders; 2003. p. 239-248.
15. Hamedi Rad F, Ghaffari T, Safavi SH. *In vitro* evaluation of dimensional stability of alginate impressions after disinfection by spray and immersion methods. J Dent Res Dent Clin Dent Prospects 2010 Autumn;4(4):130-135.