Sodium carbonate improves adherence of two-layer alginate for preliminary impressions of complete dentures.

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Adherence between two layers of irreversible hydrocolloid with sodium carbonate : a preliminary study.

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ABSTRACT

Statement of problem. An irreversible hydrocolloid wash impression technique improve the suitability of preliminary impression in removable complete denture. However, irreversible hydrocolloid does not adhere to itself naturally.

Purpose. The purpose of this in vitro study was to investigate the effect of the concentration of sodium carbonate (Na_2CO_3) with or without brushing to the surface first layer of irreversible hydrocolloid, on the adhesion between two layers.

Material and methods. The adhesion between two layers of irreversible hydrocolloid brushed with three different Na_2CO_3 concentrations (.1%, .7% and 7.0% in weight) and control were evaluated by bond strength. After optimization of concentration, the adhesion between two layers was evaluated with (B) and without brushing (WB) surface (n=8/group). The normality of data distribution was verified using the Kolmogorow-Smirnov test. The optimal concentration was analyzed using the 1-way Kruskal-Wallis test and Dunn post hoc test. The optimal conditioning surface was analyzed using the Mann-Whitney test (GraphPad 5; Prism) (α=.05).

Results. The 0.7-B specimen (.027 ± .008 MPa) and control (.024 ± .007 MPa) displayed significantly higher bond strength ($P<.05$). 0.7-B specimen showed only cohesive failure. The bond strength values of the 0.7-B specimen were significantly higher than without brushing surface (.020 ± .005 MPa) ($P<.05$).

Conclusion. The 0.7-B specimen improved the reliability of adhesion and showed the highest bond strength values between two layers of irreversible hydrocolloid.

CLINICAL IMPLICATIONS.

Conditioning surface with .7% of Na_2CO_3 brushed of the first layer optimized the adhesion between two layers of irreversible hydrocolloid. This process will help clinician to improve the reliability of preliminary impression by wash impression technique in removable complete denture.

INTRODUCTION

Irreversible hydrocolloid is the material most commonly used for preliminary impression in removable complete denture.[1,2] This an effective material to avoid the major drawbacks associated with plaster, which involves anatomic limitations as without undercuts, xerostomia, and difficult of manipulation.[3]

Since 1881[4], sodium carbonate (Na_2CO_3) is used to extract irreversible hydrocolloid of brown seaweed. Insoluble irreversible hydrocolloid is a polysaccharide obtain by the chemical reaction among water and powder of soluble irreversible hydrocolloid and sodium phosphate. After gelation, these cross-links are composed of an agglomerate of dispersed and dispersion phases.[5] The crosslinked gel is composed of a linear copolymer β-D-mannuronic acid and α-L-guluronic acid.[6] Ions calcium accelerate than that cations sodium delay this reaction.

Basker and al[7] described an irreversible hydrocolloid wash impression technique for preliminary impression. The aim of this impression is to product a reliable preliminary cast in order to produce custom tray for definitive impression. This two-step procedure allows to limit defects on mucobuccal and sublingual folds, and denture-bearing area compared to single-step procedure. The two impressions of irreversible hydrocolloid wash impression technique are both composed of the same material but with variation of viscosity. The first viscosity is in accordance with manufacturer recommendations, whereas the lowest viscosity of the second step permits to limit compressive relining.[8,9] Margins of the first impression are prepared to produce a space for the relining, such a custom tray. The quality of preliminary impression depends on the bond strength among the irreversible hydrocolloids.[10-12]

A polysaccharide multilayer shows poor intermolecular hydrogen bond. Na_2CO_3 is a biocompatible agent of irreversible hydrocolloid than that increase the adhesion of polysaccharide multilayer. The ion Na^+ in the salt decreases the rate of crosslink unzipping in the irreversible hydrocolloid (Figure 1).[13,14] Na_2CO_3 is commonly used in many fields[15-20] with concentration until 10%.[21] An optimal concentration must be found for clinical application to wash impression technique. A lowest concentration is insufficient to unzipping the insoluble irreversible hydrocolloid whereas highest concentration limits the crosslink of the second impression of irreversible hydrocolloid. Additionally, Xiao and al showed that agitation of Na_2CO_3 increases this chemical reaction.[22] Adhesion between the two layers must be optimized, so the effect of the concentration of Na_2CO_3 on the surface of irreversible hydrocolloid must be studied in order to increase the bond strength. This will allow to determine the optimal concentration and necessary of conditioning surface on the first layer.

The purpose of this in vitro study was to evaluate preliminary the effect of the concentration of Na_2CO_3 in aqueous solution and, secondly, conditioning surface (with or without brushing) of the first layer of irreversible hydrocolloid, on the adhesion between two layers.

The null hypotheses were that the concentration of Na_2CO_3 and the conditioning surface of the first layer have no effect on the adhesion between two layers of irreversible hydrocolloid.

MATERIAL AND METHODS

Samples were prepared with an irreversible hydrocolloid (Table1) (ColorChange; Cavex), contained a colored indicator which allows to highlight the chemical reaction of gelation from pink to white and the action of Na_2CO_3 on this reaction from white to pink.

Three concentration (.1%, .7% and 7.0% in weight) were used with brushing surface (respectively 0.1-B, 0.7-B and 7.0-B). Samples prepared without Na_2CO_3 and brushing surface were used as controls. After optimization of concentration of (0.7-B), one more experimental group was formed based on suppression of brushing surface (0.7-WB)(Figure 2).

Two metallic plates (3.2 x 3.2 cm) both containing 9 perforations (4.5 mm in diameter) were used to attach irreversible hydrocolloid to the upper and lower of universal machine (TA.XT Plus; Stable Micro Systems)(Figure 3). Plates were coated with adhesive (Alginate Adhesive Spray; Henry Schein). A first irreversible hydrocolloid was mixed by single operator as the manufacturer-recommendation (ratio powder/liquid: 1/1) and spread on the upper plate. After gelation, excess out the parts was scalped (11; Swann-Morton). This first layer of irreversible hydrocolloid was conditioned according the experimental groups. A second irreversible hydrocolloid with low viscosity (ratio powder/liquid: 2/3) was mixed and spread on the lower plate. The upper head was moved to connect the two layers of irreversible hydrocolloid with load of 1MPa during gelation time.

After gelation of the second irreversible hydrocolloid, the bond strength (n=8/group) was determined with a progressive central load (1mm/s) and was recorded at a capture rate of 200 points/s. The first load peak was recorded during the initial crack between the two layers (Figure 4). The bond strength (MPa) was:$b = F/S$, where S is the area of plates (m^2) and F is the first peak load (N).

The normality of data distribution was verified using the Kolmogorov-Smirnov test. The optimal concentration was analyzed using the 1-way Kruskal-Wallis test and Dunn post hoc test. The optimal conditioning surface was analyzed using the Mann-Whitney test (GraphPad 5; Prism) (α=.05).

RESULTS

The results of the bond strength are summarized in table 2 and 3. Figure 5 shows box plot of these results. The bond strength of 0.7-B specimen (.027 ± .008 MPa) was similar to the control (.024 ± .007 MPa) (P>.05), and both were significantly higher than that of the 0.1-B (.013 ± .004 MPa) and 7.0-B (.013 ± .003 MPa) (P<.05). The application of 0.7-B and 7.0-B changed the surface color of the first layer. The excessive concentration of 7.0-B made it impossible the gelation of the second

layer that remained pink. The bond strength 0.7-B specimen was significantly higher than that of the 0.7-WB specimen (.020 ± .005 MPa) (P<.05). All cohesive failure were observed only for 0.7-B specimens.

DISCUSSION

The null hypotheses that the concentration of Na_2CO_3 and the conditioning surface of the first layer have no effect on the adhesion between two layers of irreversible hydrocolloid were rejected.

The bond strength of irreversible hydrocolloid depended of the concentration of Na_2CO_3. The values of 0.7-B were similar those of the control, and both they were higher than that lowest and highest concentrations. The .7 % of Na_2CO_3 was the most suitable concentration for the adhesion between two layers of irreversible hydrocolloid. This concentration permitted a crosslink efficient with a reliable cohesive failure. A lower concentration was insufficient for crosslink unzipping reaction and pollutes the first layer surface. Conversely, an excessive concentration to .7% degraded the irreversible hydrocolloid. In this condition, the first layer surface of irreversible hydrocolloid still uncrosslinked after the gelation of second layer . An excessive concentration of cation sodium limited the gelation of irreversible hydrocolloid.[23] Concentration of 7.0 % is used preferably to extract for irreversible hydrocolloid of brown seaweed.[21] Further refinement of Na_2CO_3 concentration close to .7% is thus required .

The mechanical action of brushing increased the chemical reaction of Na_2CO_3 with irreversible hydrocolloid. Patel[14] described irreversible hydrocolloid as sensitive to physical stimuli. Additionally, in the pharmaceutical industry, temperature or ultrasound are used to decrease reaction time of irreversible hydrocolloid.

The optimal process to increase reliability of preliminary impression was to brush the first layer of irreversible hydrocolloid with a Na_2CO_3 solution at concentration of 0.7%. These results were similar to bond strength values between irreversible hydrocolloid and tray with adhesive.[24] Further

studies were necessary to evaluate the clinical reliability of preliminary impression with this method.

CONCLUSION

Within the limitations of the present in vitro study, it can be concluded that a brushing solution of sodium carbonate at .7 % allows the adherence between the two layers of irreversible hydrocolloid of the preliminary impression in removable complete denture with wash impression technique.

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