Investigation of Preferred Viscosity of Irreversible Hydrocolloid on Preliminary Impression for Edentulism

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Received May 27, 2004/Accepted July 12, 2004

This study aims to investigate the preferred viscosity of irreversible hydrocolloid used in the preliminary impression for edentulism. Thirteen modalities of irreversible hydrocolloid were prepared by changing the W/P ratio. Discrimination test for the preferred viscosity was performed on 11 prosthodontists (10.4±5.3 years of prosthetic experience). The parameter of discrimination test (P%) was calculated as the ratio of the number of adequate tests to the total number of tests. The P% and apparent viscosity coefficient (ηa) values measured by rheometer demonstrated good correlation (Y=−35.8X²+118.4X−22.8, r=0.86, p<0.01). Prosthodontists could judge the preferred viscosity based on their clinical experiences. On the preliminary impression for edentulism, the preferred viscosity demonstrated in vitro using a polyurethane maxilla model was 1.21×10² Pa·s.

Key words: Irreversible hydrocolloid, Edentulism, Preliminary impression

INTRODUCTION

The preliminary impression in the edentulous arch frames the outline of the denture base saddle — which is very important for complete denture retention1,2). Provision must be made for the outline of the denture saddle to be expanded within its maximum range to facilitate the functional movements of surrounding tissues that exist in the denture saddle border; only a few surrounding tissues adjacent to the denture saddle exhibit complex functional movements3). Such a provision helps to prevent bone resorption and distribute occlusal force4,5). Two types of impression material are currently available for the preliminary impression: modeling compound and irreversible hydrocolloid. When denture foundations of maxilla were fabricated using both materials, it was found that the sizes of the two foundation areas did not differ6). Generally, modeling compound impression technique is recommended for the preliminary impression in the edentulous arch3,7,8). However, the irreversible hydrocolloid impression technique offers other advantages such as simplicity of use and shortened chairtime.

The surrounding tissues of the denture exclude the irreversible hydrocolloid with low viscosity. To make border molding adequate, prosthodontists usually decrease the water per powder (W/P) ratio of irreversible hydrocolloid in preliminary impressions. The W/P ratio of the irreversible hydrocolloid could be intuitionally modified judging from the property or flexibility of the mucosa at the border area of the denture base saddle.

This study aims to investigate whether some range of preferred viscosities of irreversible hydrocolloid exists for the preliminary impression in the edentulous arch.

MATERIALS AND METHODS

The irreversible hydrocolloid used in this study was the Aroma Fine Mixer Type (GC, Tokyo, Japan). The material was mechanically mixed for 20 seconds at room temperature using a mixing instrument (Super Rakuneru, GC). The mixing proportion of the irreversible hydrocolloid was provided for 13 modalities by changing the amount of water (23°) from 40ml (W/P=2.38, manufacturer's instruction) to 28ml (W/P=1.67) in 1-ml intervals to 16.8g powder.

At 40 seconds after mixing started, the value of drag of each sample was measured by the rheometer (Fudo Rheo Meter, Rheotech, Tokyo, Japan) and the pen recorder (Servocorder SR6221, Graphtec Corp., Yokohama, Japan) for 25 seconds. Briefly, a metal ball of 6.84-mm diameter (r) directly connected with the load cell was inserted into the mixed paste at a speed (v) of 6 mm/min. The value of drag (f) of each sample was assumed to be the average of three measurements. The apparent viscosity coefficient
The value of apparent viscosity coefficient ($\eta_a$) was calculated by the equation, $\eta_a = f/6 \pi rv^3$.

The discrimination test for the preferred viscosity was performed on 11 prosthodontists (10.4±5.3 years of prosthetic experience). The procedure of this test was as follows: (1) After machine mixing ended, the paste was handed to the subject at once; (2) The subject transferred the paste to the edentulous jaw tray (NET TRAY F, Hayashi Dental Supply, Tokyo, Japan); (3) At 45 seconds after mixing started, the subject took an impression of the edentulous maxilla model by applying a pseudomucous membrane, which was made of polyurethane (G10-402K, Nissin, Kyoto, Japan); (4) Upon taking impression, the subjects evaluated the hardness of the irreversible hydrocolloid by judging each sample as having "low consistency", "adequate consi
Fig. 2 Relationship between the parameter of discrimination test (P%) and the apparent viscosity coefficient (η a).

As the W/P ratio decreased, the rate at which apparent viscosity (η a) increased became rapid (Fig. 1(a)). The value of η a for each sample from 1.67 to 2.38 at 45 seconds after mixing started was 3.21, 2.80, 2.38, 2.04, 1.69, 1.45, 1.21, 1.00, 0.79, 0.71, 0.63, 0.52, and 0.42×10³ Pa·s respectively (Fig. 1(b)).

The values of P% and η a were shown by the quadratic equation (Y = −35.8X² + 118.4X − 22.8, Fig. 2). Moreover, a significant coefficient of multiple correlation was shown between the values of P% and η a (r = 0.86, F-test, p < 0.01). The η a value at which P% was at its highest (P%M = 78.8%) was 1.21×10³ Pa·s (Fig. 2).

**RESULTS**

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**DISCUSSION**

Stevens's power law (E = aR^b) expresses a constant relationship between stimulus intensity (R) from the outside and the sensory response from human maniaphalanx or skin (E)\(^{10}\). The P% and η a parameters of this study are thought to correspond to sense and stimulus intensity respectively. The relationship between the values of P% and η a showed significant coefficient correlation (r = 0.86, p < 0.01, Fig. 2). This phenomenon may indicate that the sense of the prosthodontists in this study depended on the stimulus intensity from the rheological property of the irreversible hydrocolloid. Moreover it was possible that the prosthodontists were judging the viscoelasticity of the irreversible hydrocolloid impression material by comparing the sensation experienced against their own clinical experiences of making preliminary impressions for edentulous patients.

The preliminary impression of the edentulous arch is extremely important in determining the outline of the denture base saddle\(^5\). When considering the preliminary impression, various parameters pertaining to the viscoelastic properties of irreversible hydrocolloid\(^{11,12}\) or the custom-made impression tray for the severely resorbed mandible arch\(^\text{13}\) — have been investigated to determine how to best attain a complete denture. Prosthodontists have been reported to use an irreversible hydrocolloid W/P ratio below that which recommended by the manufacturer in an attempt to facilitate border molding\(^6\). The W/P ratio of the irreversible hydrocolloid could be intentionally modified judging from the property or flexibility of the mucosa at the border area of the denture base saddle. The preferred viscosity (1.21×10³ Pa·s) demonstrated in this study was determined in vitro using a polyurethane model of an edentulous arch. Material used in making the preliminary impression of the mandibular edentulous arch is usually more viscous than that for the maxilla. Thus in denture construction, it is extremely important to obtain a record of the entire denture bearing area. In the case of preliminary impressions made using irreversible hydrocolloid, this may be done at the expense of accuracy\(^{14,15}\) on the impression surface due to use of a decreased W/P ratio.

In conclusion, prosthodontists may arrive at their desired viscosity of irreversible hydrocolloid based on their clinical experiences. Through this study, the preferred value for the viscosity of irreversible hydrocolloid used in preliminary impressions was 1.21×10³ Pa·s, which was determined in vitro using a polyurethane model of a maxillary edentulous arch.

**ACKNOWLEDGEMENTS**

We thank Dr Katsuichiro Inoue, Biomaterials Research Laboratory, Shimonoseki, Japan, for his help with this experimental design and protocol.

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