Original Article

An *In Vitro* Study to Evaluate and Compare the Flow Property of Different Commercially Available Zinc Oxide Eugenol Impression Materials

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Abstract

Introduction: Impression making is one of the most important steps in prosthodontic rehabilitation of edentulous patients. Zinc oxide eugenol (ZOE) impression paste is the most commonly used material for complete denture wash impression due to its cost-effectiveness and ease of manipulation, while providing the advantage of ability to record fine minute tissue details. Rheological property like flow is a critical factor influencing the success of any impression material, especially in intraoral conditions. Therefore, with so many brands of commercially available impression materials flooding the markets, the aim of this study was to evaluate and compare the flow property of four commercially available ZOE impression materials under simulated intraoral condition. **Materials and Methods:** The testing method used was according to the American Dental Association (ADA) specification no. 16 for ZOE impression pastes. **Results:** At room temperature, maximum flow was seen with Denzomix followed by Dental Product of India (DPI), Neogenate, and Cavex in descending order, respectively, at 30 s, 1 min, and 10 min of load application. At 37°C in saliva, maximum flow was seen with Denzomix followed by Neogenate, DPI, and Cavex in descending order, respectively, at 30 s, 1 min, and 10 min of load application. Of the four ZOE impression pastes, only the flow of Cavex was considerably less than ADA specified value. **Interpretation and Conclusion:** Results obtained from this study showed that there is considerable variation in the flow values of different commercially available ZOE impression materials. Change in temperature and presence of saliva had a significant influence on the flow of ZOE impression materials.

Keywords: *American Dental Association specification, flow, zinc oxide eugenol impression material*

Introduction

Impression making is the most critical step in determining the success of complete denture prosthesis.[1] The ability of the wash impression material to record the tissue details depends on the rheological properties and wettability of the impression material. Flow is the property of a material to change its shape under the influence of external load or under its own weight.[2] The gold standard for complete denture impression materials is zinc oxide eugenol (ZOE) impression paste.[2] ZOE impression pastes are the most widely used material for making the wash impression of edentulous arches. It provides the advantage of being economical and easy to use by dental students as well as clinical practitioners. A number of companies are available which market various zinc oxide paste systems claiming to have best flow and ability to register best tissue details. The change in temperature, humidity, and presence of water on the paste has infl uence on fl ow property of ZOE impression material.[3] However, the flow of zinc oxide paste has not been checked in the presence of saliva under intraoral conditions which is a very important factor to predict the accuracy of the impression. An understanding of the physical characteristics of each material is necessary for its selection for use in clinical dentistry.

Therefore, the present study was aimed to evaluate the property of flow of various commercially available ZOE impression pastes used as final impression material for complete denture under simulated intraoral conditions.

Materials and Methods

Four commercially available ZOE impression pastes used for the study were as follows:

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Quick Response Code:

1. Dental Product of India (DPI) – Group A
2. Neogenate (Septodont) – Group B
3. Cavex (Cavex Holland B.N) – Group C
4. Denzomix (Mixodont) – Group D.

The testing method used for flow was according to the American Dental Association (ADA) specification no. 16 for dental impression pastes. The apparatus used to measure flow property of different ZOE test materials consist of a glass syringe (with inside diameter of 10 mm) to deliver a definite volume (0.5 ml) of mixed test material on a marked glass slab. Another glass plate (20 gm) was placed on the top of this material, and a weight of 500 g was applied (total weight 520 gm) for 10 min. Diameter of specimen was noted at 30 s, 1 min, and 10 min of load application [Figures 1-3].

Method of collection of data

Equal lengths of the base and accelerator paste of test materials were taken on oil impervious pads supplied with each material and mixed with a rigid stainless steel spatula as per manufacturer's recommendation till a homogeneous mix was obtained. The mixed material was loaded in the glass syringe, and 0.5 ml material was injected on a cellophane sheet placed on a marked glass slab. A cellophane sheet, glass plate (20 gm) and 500 g weight was carefully placed on freshly dispensed ZOE impression paste sequentially after 1½ min from the start of mix [Figure 2].

The diameter of the mix was noted after 30 s, 1 min, and 10 min of load application. This diameter gave the flow of material. For each test material, ten test samples were measured for flow [Figures 4 and 5]. Mean value was calculated for each group.

The test was carried out under two conditions:

1. At room temperature
2. At 37°C in 100% humidity. (Specimen was immersed in artificial saliva).

Preparation of the artificial saliva

It is prepared in the laboratory from 0.4 g sodium chloride (NaCl), 0.4 g potassium chloride (KCl), 0.69 g sodium dihydrogen dihydrate ($NaH_2PO_4.2H_2O$), 0.005 g hydrated sodium sulfide ($Na_2S.9H_2O$), 1 g urea $CO(NH_2)_2$, and 1000 ml of deionized water. 10N sodium hydroxide was added to this mixture until the pH value was measured to be as 6.75. Later, the mixture is sterilized in the autoclave.[4]

The procedure for testing of flow of the materials in saliva at 37°C is same as described above till the application of load. Once the load is applied, the whole assembly was carried into the artificial saliva which was kept in the incubator, and the diameter of the mix was noted

Figure 1: Armamentarium

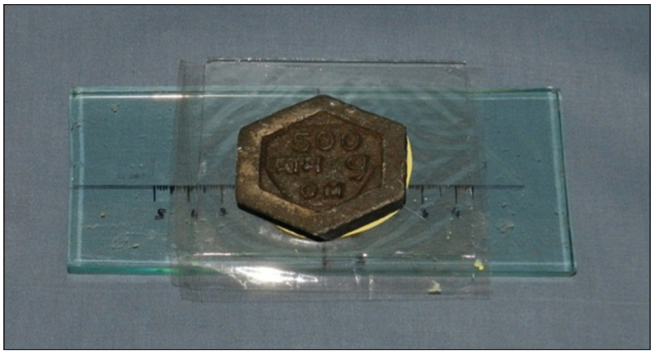

Figure 2: Assembly for measuring flow of zinc oxide eugenol impression material at room temperature

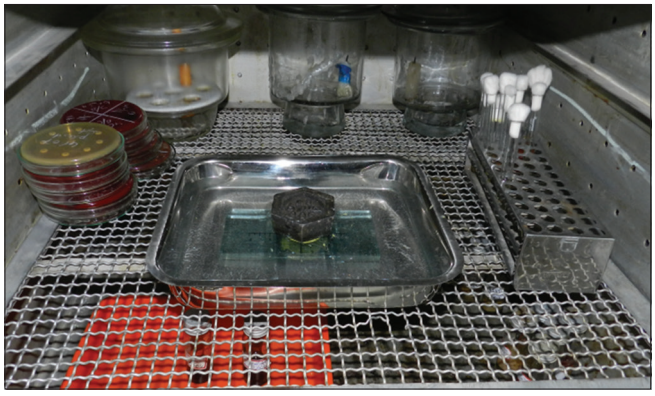

Figure 3: Assembly for measuring flow of zinc oxide eugenol impression material in incubator at 37°C in saliva

Figure 4: Test samples showing flow of zinc oxide eugenol impression material at room temperature

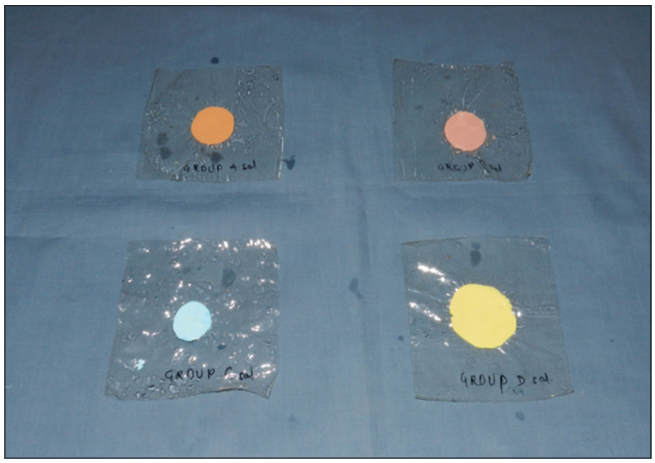

Figure 5: Test samples showing flow of zinc oxide eugenol impression material in saliva at 37°C

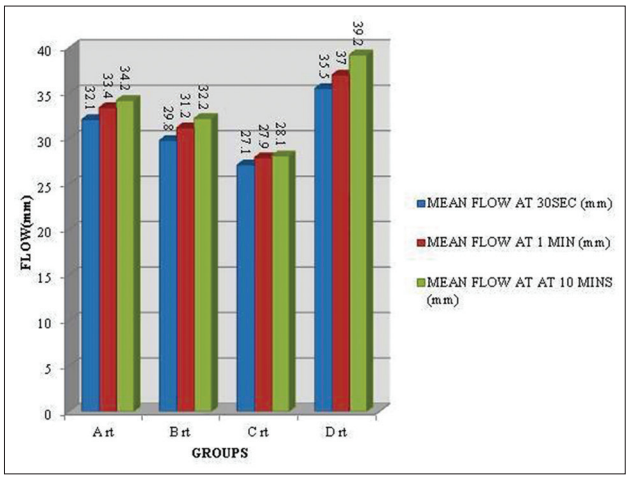

Figure 6: Mean flow of zinc oxide eugenol impression paste test samples at room temperature at 30 s, 1 min, and 10 min of load application

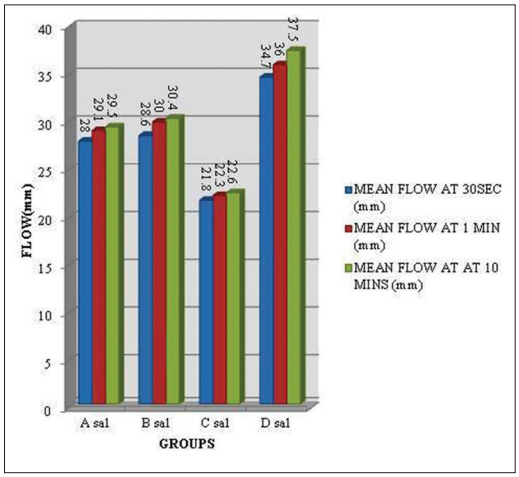

Figure 7: Mean flow of zinc oxide eugenol impression paste test samples at 37°C in saliva at 30 s, 1 min, and 10 min of load application

after 30 s, 1 min, and 10 min of load application. Again, ten test samples were measured for flow for each group, and mean value was calculated for each group.

Results

Data and results of the study are presented in Tables 1-6. Figures 6 and 7 show the graphical representation of mean flow of zinc oxide eugenol impression paste test samples at room temperature and at 37 o C in saliva respectively at 30 s, 1 min, and 10 min of load application.

At room temperature, maximum flow was seen with Denzomix followed by DPI, Neogenate, and Cavex in descending order, respectively, at 30 s, 1 min, and 10 min of load application. At 37°C in saliva, maximum flow was seen with Denzomix followed by Neogenate, DPI, and Cavex in descending order, respectively, at 30 s, 1 min, and 10 min of load application. Of the four ZOE impression pastes, only the flow of Cavex was considerably less than ADA specified value. The flow of four ZOE impression pastes was reduced at 37°C in saliva compared to room temperature at 30 s, 1 min, and 10 min of load application.

Discussion

An ideal impression material for complete denture impressions should have adequate flow and consistency so that it records the tissue details properly without causing distortion of the tissues.[5-7] Recording of accurate tissue details is one of the primary requisites of ideal impression materials. Today, we have various newer materials such as light body polyvinylsiloxane for more accurate impression. However, their cost is still a major concern, especially in teaching institutes and even in practice. This makes ZOE impression paste as a most widely used impression material.

Impression details are influenced by factors such as viscosity, wettability, handling properties and presence of voids.[6] Wettability of an impression material relates to the ability of the material to flow in the smaller areas.[8] The flow of the impression materials before setting, at the time impression is being obtained, is of considerable importance in relation to the detail of the impression and displacement of tissues.[9]

Flow is the property of a material to change its shape under the influence of external load or under its own weight. A material with a high degree of flow causes less pressure on the tissues and thus records tissues in an undistorted and undisplaced condition.[10,11] Woelfel[12] graphically demonstrated that tissues covering an edentulous ridge can be displaced by an impression procedure. The exact degree of flow most desirable for making secondary impression is one of the more controversial subjects in the field of prosthetic dentistry. Some operator prefers a thin impression material, believing that this will reduce or eliminate soft-tissue displacement. Other prefers a stiffer material and argues that the thin mix is more difficult to contain in the tray, will tend to incorporate air in the form of bubbles,

Table 1: Mean flow of zinc oxide eugenol impression paste test samples (mm) at room temperature at 30 s, 1 min, and 10 min of load application

Group	Mean±SD at 30 s	Mean±SD at 1 min	Mean±SD at 10 min
A room temperature	32.10±0.738	33.40±0.699	34.20±0.789
B room temperature	29.80±0.789	31.20±1.033	32.20±0.632
C room temperature	27.10±0.568	27.90±0.738	28.10±0.568
D room temperature	35.50±0.527	37.00±0.667	39.20±0.632

SD: Standard deviation

Table 2: Mean flow of zinc oxide eugenol impression paste test samples (mm) at 37°C in saliva at 30 s, 1 min, and 10 min of load application

Group	Mean±SD at 30 s	Mean±SD at 1 min	Mean±SD at 10 min
A saliva	28.00±0.816	29.10±0.738	29.50±0.850
B saliva	28.60±0.516	30.00±0.471	30.40±0.516
C saliva	21.80±0.919	22.60±0.516	22.60±0.516
D saliva	34.70±0.675	36.00±0.949	37.50±0.707

SD: Standard deviation

Table 3: Mean flow comparison (mm) at room temperature and at 37°C in saliva for Group A at 30 s, 1 min, and 10 min of load application

	Mean±SD at 30 s	Mean±SD at 1 min	Mean±SD at 10 min
Room temperature	32.10±0.738	33.40±0.699	34.20±0.789
37°C in saliva	28.00±0.816	29.10±0.738	29.50±0.850

SD: Standard deviation

Table 4: Mean flow comparison (mm) at room temperature and at 37°C in saliva for Group B at 30 s, 1 min, and 10 min of load application

	Mean±SD at 30 s	Mean±SD at 1 min	Mean±SD at 10 min
Room temperature	29.80±0.789	31.20±1.033	32.20±0.632
37°C in saliva	28.60±0.516	30.00±0.471	30.40±0.516

SD: Standard deviation

Table 5: Mean flow comparison (mm) at room temperature and at 37°C in saliva for Group C at 30 s, 1 min, and 10 min of load application

	Mean±SD at 30 s	Mean±SD at 1 min	Mean±SD at 10 min
Room temperature	27.10±0.568	27.90±0.738	28.10±0.568
37°C in saliva	21.80±0.919	22.60±0.516	22.60±0.516

SD: Standard deviation

and will produce inferior surface details.[13] Many researchers have concluded in their studies that ZOE paste causes least pressure on tissues among different impression materials.[9,14-21] A large number of ZOE pastes are available which are essentially similar in general properties but differ in their clinical behavior. Variations are noted from one product to another chiefly in relation to setting times, consistency, and flow and physical properties of set material. These require the comparison of different characteristics of various products available to aid the profession in choosing and using these materials. The performance of material *in vitro* and *in vivo* varies mainly owing to the presence of saliva in the mouth. Therefore, it is necessary to check the flow property in the presence of saliva to simulate oral environment closely. Although many studies have checked flow property of impression pastes,[22] none have done it in the presence of saliva. In the present study, the method used to measure flow was in accordance with the ADA specification no 16. A similar method with some variations was used in the past by various researchers.[9,13,18,19] According to the ADA specification no. 16 for ZOE impression materials, flow for Type I paste should be minimum 30 mm and maximum 50 mm after 10 min of load application.

In the present study, it was observed that flow of ZOE impression material at room temperature and at 37°C in saliva did not increase much after 30 s of load application [Tables 1 and 2]. Clark and Philip[13] in their study found correlation between flow and setting time. Shorter the setting time lesser the flow of ZOE impression material. Initial setting of ZOE impression material occurs at 2 to 2½ min after start of the mix. This explains why there was not much of increase in the flow of ZOE impression material after 30 s of load application. Asgarzedah[19] *et al*. found that change in temperature, humidity, and presence of water on the paste had influence on flow property of ZOE impression material. In the present study, reduced flow of ZOE impression material in saliva at 37°C was found as compared to flow at room temperature. Reduced flow observed may be due to the presence of saliva and increased temperature. Both of these factors decrease setting time of ZOE impression material, and this in effect reduces flow of ZOE impression material. In the present study, it was found that all ZOE test materials exhibited different flow at different time intervals both at room temperature and at 37°C in saliva. Flow of three ZOE impression pastes (DPI, Neogenate, and Denzomix) complied with the ADA specified values, while flow of Cavex was not in accordance with ADA specification.

Conclusion

It was not purpose of the study to decide whether one paste is better than other but was to evaluate flow property at different conditions and to check whether available ZOE paste systems are following ADA specifications prescribed for flow.

On the basis of the result obtained, it was concluded that

1. Flow of Denzomix (Group D) was maximum and flow of Cavex (Group C) was minimum both at room

Table 6: Mean flow comparison (mm) at room temperature and at 37°C in saliva for Group D at 30 s, 1 min, and 10 min of load application

	Mean±SD at 30 s	Mean±SD at 1 min	Mean±SD at 10 min
Room temperature	35.50±0.527	37.00±0.667	39.20±0.632
37°C in saliva	34.70±0.675	36.00±0.949	37.50±0.707

SD: Standard deviation

temperature and at 37°C in saliva

2. Of the four ZOE impression paste, only the flow of Cavex (Group C) was not in accordance with ADA specified value
3. Maximum flow was seen only up to 30 s of load application, and there was not much increase in flow after 1 min and 10 min of load application
4. Presence of saliva and increase in temperature reduced flow of all the four ZOE impression pastes.

Clinical implications and limitation of study

The presence of saliva reduces the flow of ZOE impression paste in all the groups. All pastes have working time up to 30 s with optimal flow. In terms of flow properties, Denzomix was found to be the most acceptable material. The only limitation of the present study is that other properties such as dimensional accuracy have not been checked. Further clinical studies are recommended to check the impression pastes for other properties as well.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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