J Indian Prosthodont Soc (Oct-Dec 2014) 14(4):393–399
DOI 10.1007/s13191-013-0338-7

ORIGINAL ARTICLE

To Study the Flow Property of Seven Commercially Available Zinc Oxide Eugenol Impression Material at Various Time Intervals After Mixing

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Received: 11 September 2013 / Accepted: 25 November 2013 / Published online: 25 January 2014

Abstract Aims and objective of the study was to evaluate the flow property of seven commercially available zinc oxide eugenol impression materials at various time intervals, after mixing 49 samples (seven groups) were fabricated for flow property of the material. The sample were fabricated as equal length of base and accelerator paste of the test materials was taken on the glass slab and mixed with a rigid stainless steel spatula as per manufacturers recommendation till the homogenous mix was obtained. The mix material was loaded in glass syringe and 0.5 ml material was injected on a cellophane sheet placed on marked glass plate. A cellophane sheet and glass plate 70 and 500 g weight was carefully placed on freshly dispensed zinc oxide eugenol impression paste sequentially. The diameter of the mix was noted after 30 s and 1 min of load application and also after the final set of material. The diameter gives the flow of material. The samples were stored at the room temperature. The data of the flow property was analyzed with analysis of variance, Post hoc test and *t* test. The flow of the zinc oxide eugenol impression paste after 30 s, 1 min and final set of load application for Group A to Group G was noted. Maximum flow was seen for Group G zinc oxide eugenol impression material followed by Group F, D, E, B, C and A in descending order respectively after 30 s, where as the flow property changed after 1 min in the sequence of maximum for Group G followed by Group E, D, B, A, C, and F. Lastly after final set of the impression material the flow maximum for Group G followed by Group E, D, C, F, A and B in descending order. Based on statistical analysis of the results and within in the limitations of this in-vitro study, the following conclusions were drawn that; the flow of zinc oxide eugenol impression material after 30 s, 1 min and that after the final set was maximum for P.S.P. (Group G) and the flow for PYREX (Group A) was minimum.

Keywords Flow · Zinc-oxide eugenol · Impression paste

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Introduction

Impression making is one of the primary and most important steps in clinical Prosthodontic practice. The importance of the impression lies in order to produce an accurate positive form or casts of the recorded tissues on which prosthesis is fabricated. The final outcome of any Prosthodontic treatment is directly related to the accuracy of impression.

Ideally, an impression material used to make complete denture impressions should be viscous enough to be contained in the tray but fluid enough to adapt to the oral tissues. They should record tissue details accurately and should be dimensionally stable. Proper flow of the impression material to record all the fine details, and dimensional accuracy for the close adaptation of the prosthesis to the underlying tissues are prime requirements of an impression material.

Flow is the property of a material to spread under a constant load. If the material has adequate flow it results in an impression that captures the tissues in a rest condition with little or no compression, where as if the material has a thick consistency or high viscosity it can compress the tissues [1, 2]. If the material has excessive flow rate it will be difficult to handle and unable to load in the tray and while making the final impression with such type of the material the tray will be displaced in the patient's mouth resulting in distorted tissue records. In order to record accurate tissue details the impression materials should have adequate flow [3].

The gold standard for complete denture impression materials is zinc oxide eugenol paste [4]. zinc oxide eugenol impression pastes have been available to the profession since 1930s and since then is the most commonly used impression material for making the final impression of completely edentulous ridges, because of its free flowing nature, accurate recording of tissue details and dimensional stability. In addition to this, they do not exert any pressure to the tissues [1, 2, 5, 6] (Fig. 1).

Currently zinc oxide eugenol impression pastes are marketed by various manufacturing companies. 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 flow property of various commercially available zinc oxide eugenol impression pastes used as final impression material for complete denture.

Materials and Methods

This study was conducted in the Department of Prosthodontics, Darshan Dental College and Hospital, Udaipur, Rajasthan, to evaluate the flow property of different commercially available zinc oxide eugenol impression materials.

Source of Material

The materials for the study were sourced from commercially marketed products and were stored at room temperature.

Test Materials

1. PYREX (Pyrex polymers) Group A (seven samples)
2. CAVEX (Cavex Holland B.N) Group B (seven samples)
3. NEOGENATE (Septodont) Group C (seven samples)
4. IMAGE (Prime Dental PRO.LTD) Group D (seven samples)
5. DENZOMIX (Mixodont) Group E (seven samples)
6. D.P.I (Dental Product of India) Group F (seven samples)
7. P.S.P (P.S.P Dental CO. LTD.) Group G (seven samples)

Measurement of Flow Property

Armamentarium

1. 500 g weight measure
2. Glass syringe (glass van) with inner diameter of 10 mm
3. One marked glass plate
4. One glass plate (70 g)
5. DPI separating sheets
6. Stainless steel spatula
7. Stop watch
8. Glass slab (Fig. 2)

Fig. 1 Different commercially available zinc-oxide eugenol impression paste

Fig. 2 Glass plate, glass slab, stainless steel spatula, glass syringe, stop watch, 500 g weight for flow property

Theoretical Consideration

The testing method used for flow was according to A.D.A. specification no. 16 for dental impression paste.

The apparatus used to measure flow property of different zinc oxide eugenol test materials consists of a glass syringe (with inner diameter approx. 10 mm) to deliver a definite volume of (0.5 ml) of mixed test material on a marked glass plate. Another glass plate (70 g) was placed on top of this material and a weight of 500 g applied (total weight 500 + 70 g) for 10 min. Diameter of specimen was noted at 30 s and 1 min after load application and after the material was set. Setting time was also noted.

Method

Equal lengths of the base and accelerator paste of test materials was taken on glass slab and mixed with a rigid stainless steel spatula as per manufacturer's recommendation till a homogenous 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 marked glass plate. A cellophane sheet, glass plate (70 g) and 500 g weight were carefully placed on freshly dispensed zinc oxide eugenol impression paste sequentially (Fig. 3).

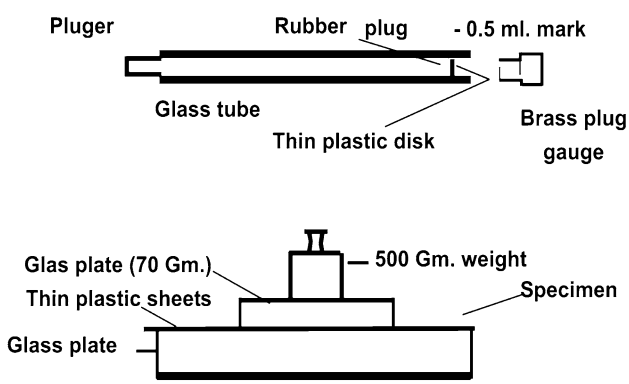

Fig. 3 Method

The diameter of the mix was noted after 30 s and 1 min of load application and also after final set of the material. This diameter gives the flow of material. The setting time of the material was also noted (Fig. 4).

For each test material, seven test samples were measured for flow and setting time. Thus flow and setting time was measured for a total of 49 samples (seven groups) and mean value were calculated for each group (Fig. 5). The test and the samples has been stored at room temperature.

Results

An in-vitro study was undertaken to evaluate and compare flow of different commercially available zinc oxide eugenol impression materials.

The results obtained were tabulated and subjected to statistical analysis.

The mean and standard deviations for each group was calculated. Data of flow was analyzed with analysis of variance (ANOVA) Post hoc test and *t* test.

The results of present study are tabulated in Tables 1, 2, 3, 4, 5, 6 and 7.

The flow of zinc oxide eugenol impression paste after 30 s of load application for Group A to Group G was 15.14 ± 0.690, 16.00 ± 0.577, 15.71 ± 0.756, 16.29 ± 0.756, 16.29 ± 0.756, 16.43 ± 0.535, 23.14 ± 0.900 mm respectively. Maximum flow was seen in Group G followed by F, D, E, B, C and A in descending order respectively (Table 2).

On statistical analysis (Post hoc test) flow at 30 s after load application for Group G was significantly different

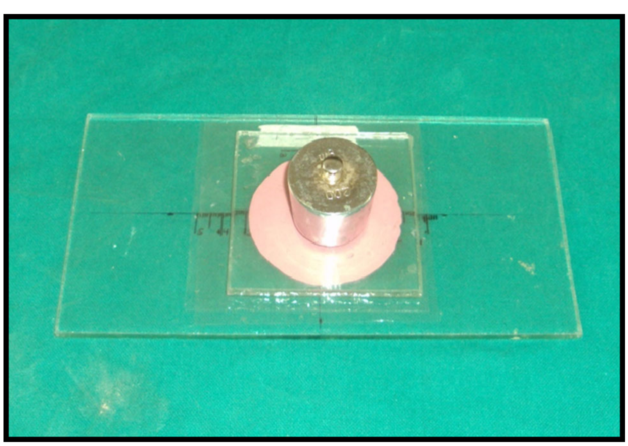

Fig. 4 Preparation of sample

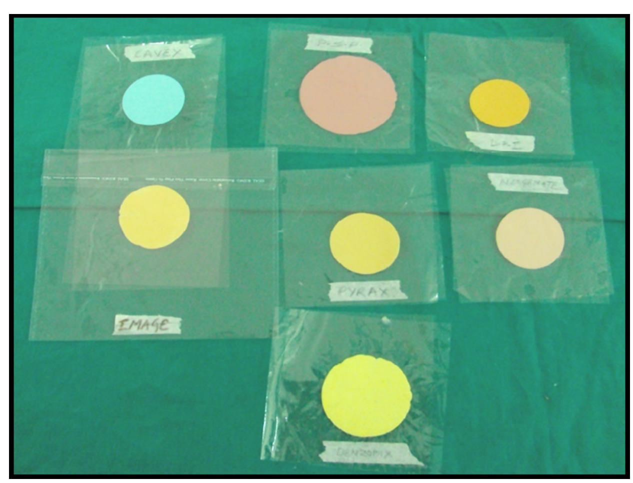

Fig. 5 Test samples of flow property

Table 1 Flow and setting time of zinc oxide eugenol impression paste test samples

S. no.	Group	Sample	Flow at (30 s) mm	Flow at (1 min) mm	Flow at (set) mm	Setting time (s)
1	A	A1	15	18	20	182
		A2	15	18	20	182
		A3	14	18	20	183
		A4	15	18	21	181
		A5	15	18	20	182
		A6	16	19	20	181
		A7	16	20	22	183
2	B	B1	16	19	19	196
		B2	16	19	19	194
		B3	16	20	21	194
		B4	16	19	21	191
		B5	15	19	20	192
		B6	16	20	21	194
		B7	17	20	21	196
3	C	C1	15	19	20	230
		C2	16	19	21	230
		C3	16	20	21	228
		C4	16	19	21	230
		C5	15	18	20	231
		C6	15	18	20	228
		C7	17	21	23	228
4	D	D1	17	20	21	248
		D2	16	20	21	246
		D3	16	20	22	246
		D4	16	20	21	247
		D5	17	20	22	248
		D6	15	18	20	248
		D7	17	20	23	248
5	E	E1	16	21	24	328
		E2	17	21	24	330
		E3	16	20	23	330
		E4	16	19	22	328
		E5	17	21	23	329
		E6	15	20	23	330
		E7	17	21	25	330
6	F	F1	17	19	19	185
		F2	16	19	20	185
		F3	16	19	20	183
		F4	17	20	21	185
		F5	17	19	22	182
		F6	16	18	20	185
		F7	16	18	21	185
7	G	G1	22	28	30	364
		G2	24	29	30	360
		G3	23	29	31	362
		G4	24	30	31	359
		G5	23	28	30	360
		G6	22	26	29	362
		G7	24	30	32	358

Flow of test samples at 30 s after load application, 1 min after load application and after setting

Table 2 Mean flow of zinc oxide eugenol impression paste test samples 30 s after load application

Group	Mean flow (mm)	SD
A	15.14	0.690
B	16.00	0.577
C	15.71	0.756
D	16.29	0.756
E	16.29	0.756
F	16.43	0.535
G	23.14	0.900

Table 3 Statistical analysis (post hoc test) for flow of zinc oxide eugenol impression paste test samples 30 s after load application

Group (i)	Group (j)	*P*	
G	A	0.000	Significant
	B	0.000	Significant
	C	0.000	Significant
	D	0.000	Significant
	E	0.000	Significant
	F	0.000	Significant

$P > 0.05$, insignificant; $P < 0.05$, significant

Table 4 Mean flow of zinc oxide eugenol impression paste test samples 1 min after load application

Group	Mean flow (mm)	SD
A	18.42	0.530
B	19.43	0.535
C	19.14	1.069
D	19.71	0.756
E	20.43	0.787
F	18.86	0.690
G	28.57	1.397

than Group A, B, C, D, E and F. Thus Group G shows maximum flow at 30 s after load application (Table 3).

The flow of zinc oxide eugenol impression paste after 1 min of load application for Group A to Group G was

Table 5 Statistical analysis (post hoc test) for flow of zinc oxide eugenol impression paste test samples 1 min after load application

Group (i)	Group (j)	*P*	
G	A	0.000	Significant
	B	0.000	Significant
	C	0.000	Significant
	D	0.000	Significant
	E	0.001	Significant
	F	0.000	Significant

$P > 0.05$, insignificant; $P < 0.05$, significant

Table 6 Mean flow of zinc oxide eugenol impression paste test samples at final set

Group	Mean flow (mm)	SD
A	20.43	0.787
B	20.29	0.951
C	20.86	1.069
D	21.43	0.976
E	23.43	0.976
F	20.43	0.976
G	30.43	0.976

19.35 ± 0.350, 19.43 ± 0.535, 19.14 ± 1.069, 19.71 ± 0.756, 20.43 ± 0.787, 18.86 ± 0.690, 28.57 ± 1.397 mm respectively. Maximum flow was seen in Group G followed by E, D, B A, C and F in descending order respectively (Table 4).

On statistical analysis (Post hoc test) flow at 1 min after load application for Group G was significantly different than Group A, B, C, D, E and F. Thus Group G shows maximum flow at 1 min after load application (Table 5).

The flow of zinc oxide eugenol impression paste after final set for Group A to Group G was 20.43 ± 0.787, 20.29 ± 0.951, 20.86 ± 1.069, 21.43 ± 0.976, 23.43 ± 0.976, 20.43 ± 0.976, 30.43 ± 0.976 mm respectively. Maximum flow was seen in Group G followed by E, D, C, F, A and B in descending order respectively (Table 6).

On statistical analysis (Post hoc test) flow at 1 min after final setting for Group G was significantly different than Group A, B, C, D, E and F. Thus Group G shows maximum flow (Table 7).

Discussion

In the present era, with increasing life span, there is an increased responsibility on dental practitioners to provide a good quality of prosthesis for patients who, for a variety of reasons have been rendered edentulous [7].

Table 7 Statistical analysis (post hoc test) for flow of zinc oxide eugenol impression paste test samples at final set

Group (i)	Group (j)	*P*	
G	A	0.000	Significant
	B	0.000	Significant
	C	0.000	Significant
	D	0.000	Significant
	E	0.000	Significant
	F	0.000	Significant

$P > 0.05$, insignificant; $P < 0.05$, significant

The fit and retention of a denture is dependent on the intimate adaptation of its base to the underlying soft tissue. This adaption is accomplished by making the base from a cast that reproduces the topography of the oral tissues. The cast must be produced from an impression that registers the underlying soft tissues accurately [8].

The production of an accurate master impression is regarded as an important milestone in the fabrication of the complete dentures, and depends upon the skills of the clinician as well as the appropriate selection and handling of suitable impression material [7].

Making impressions of the edentulous areas is exacting and challenges the clinical skill of most dentists. Philosophy differs, but it would be safe to assume that, most dentists would like to record the supporting soft tissues in a state of rest and with greatest degree of accuracy.

A degree of deformation of the denture bearing mucosa results while making an impression. Woelfel has graphically demonstrated that tissues covering an edentulous ridge can be displaced by an impression procedure [1, 2].

The problem of deformation is multifarious and at least five factors can be identified: Pressure use to seat and hold an impression, the rheology (flow) of the impression material, the setting time and working time of impression material, The accuracy of impression material (both detail reproduction and dimensional accuracy) and the deformation and recovery of the denture bearing mucosa when a force is applied [9].

For several years it was believed that displacing the softer tissues into their supporting position (condensing them) would result in better distribution of occlusal forces to the basal seat. Clinical experience however eventually showed that displaced tissues attempts to return to its normal, unstrained position and moves the denture out of its intended position. This new position then results in deflective occlusal contacts. In addition, repeated displacing pressures upon the tissues cause, irritation, soreness and, finally atrophy [1].

Most Prosthodontists now agree that the denture bearing tissues should not be displaced by an impression material.

The gold standard for edentulous impression materials are zinc oxide eugenol paste [4]. Zinc oxide eugenol paste is the material of choice because it exerts very less pressure on the tissues and has good dimensional stability, adequate strength and record accurate tissue details .

Many researchers have concluded in their studies that zinc oxide eugenol paste causes least pressure on tissues among different impression materials [1, 2, 5, 6, 10].

A large number of zinc oxide eugenol 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.

For measurement of flow of zinc oxide eugenol impression paste different specification are given by American dental association no 16 (effective April 1962), the Australian standard no 18 (effective 1962), and British standards institution published BS 4284:1968.

The basis of these tests is to place a small volume of mixed material on a horizontal glass plate, followed by the application of a further glass plate and a load. The load is left in position for a given time and the diameter of the resulting disc of material is measured, giving an indication of the consistency and flow of the material.

ADA test used 0.5 ml mixed material and load applied is 500 g for 8.5 min. In Australian test 0.5 ml of mixed material is used and load applied is 1,500 g for 30 s.

In British standards test 0.5 ml mixed material is used and load is 1,500 g for 5 s.

In the present study the method used to measure flow was in accordance with the ADA specification no 16. Volume of material used was 0.5 ml and load applied was 500 g for 10 min. Similar method with some variations was used in past by various researchers [6, 11–16].

Two pieces of cellophane were placed between the paste and the two glass plates, to prevent the sticking of the paste to the plates as used by Asgarzadeh and Peyton [11] in their study.

In the present study the flow of zinc oxide eugenol impression paste after 30 s of load application for Group A to Group G was 15.14 ± 0.690, 16.00 ± 0.577, 15.71 ± 0.756, 16.29 ± 0.756, 16.29 ± 0.756, 16.43 ± 0.535, 23.14 ± 0.900 mm respectively. Maximum flow was seen in Group G followed by F, D, E, B, C and A in descending order respectively (Table 2). On statistical analysis (Post hoc test) flow at 30 s after load application for Group G was significantly different than other groups ($P < 0.05$). Thus Group G shows maximum flow at 30 s after load application (Table 3).

The flow of zinc oxide eugenol impression paste after 1 min of load application for Group A to Group G was 19.35 ± 0.350, 19.43 ± 0.535, 19.14 ± 1.069, 19.71 ± 0.756, 20.43 ± 0.787, 18.86 ± 0.690, 28.57 ± 1.397 mm respectively. Maximum flow was seen in Group G followed by E, D, B, A, C and F in descending order respectively (Table 4). On statistical analysis (Post hoc test) flow at 1 min after load application for Group G was significantly different than other groups ($P < 0.05$). Thus Group G shows maximum flow at 1 min after load application (Table 5).

The flow of zinc oxide eugenol impression paste after final set for Group A to Group G was 20.43 ± 0.787, 20.29 ± 0.951, 20.86 ± 1.069, 21.43 ± 0.976, 23.43 ± 0.976, 20.43 ± 0.976, 30.43 ± 0.976 mm respectively. Maximum flow was seen in Group G followed by E, D, C, F, A and B in descending order respectively (Table 6). On statistical analysis (Post hoc test) flow at final setting for Group G was significantly different than other groups ($P < 0.05$). Thus Group G shows maximum flow (Table 7).

Thus, it was found that maximum flow (23.14 ± 0.90 mm at 30 s, 28.57 ± 1.397 mm at 1 min and 30.43 ± 0.976 mm after setting) was seen in Group G (P.S.P.). The flow for Group G was significantly different than other groups.

According to ADA specification no. 16, zinc oxide eugenol impression pastes type I should exhibit flow between 30–50 mm. With regard to flow only Group G complied with ADA requirements (flow 30.43 ± 0.976 mm).

The cellophane sheets used between the glass plates possibly would have caused a decrease in flow of test material due to its rough surface. Thus only one material complied with ADA requirements.

The positives of this study is that the P.S.P. has the maximum flow at various time intervals and after final set of material.

Summary

Zinc oxide eugenol impression paste was taken as test material because it is most commonly used to make the final impression for fabrication of the complete denture prosthesis. Seven groups of commercially available zinc oxide eugenol impression pastes were evaluated for flow property.

For evaluating flow property, 0.5 ml volume of mixed material of each group was placed on a horizontal glass plate, followed by the application of a further glass plate (70 g) and a load (500 g). The load was left in position for 10 min. The diameter of the resulting disc of material was measured, after 30 s and 1 min of load application and also once the material sets.

The result revealed the following observations;

1. Flow of zinc oxide eugenol impression paste test samples 30 s after load application was maximum for the Group G (23.14 mm) and minimum for Group A (15.14 mm).
2. Flow of zinc oxide eugenol impression paste test samples 1 min after load application was maximum for the Group G (28.57 mm) and minimum for Group A (18.42 mm).
3. Flow of zinc oxide eugenol impression paste test samples at final set was maximum for Group G (30.43 mm) and minimum for Group A (20.43 mm).

Conclusion

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

1. Flow of zinc oxide eugenol impression paste test samples after 30 s and 1 min of load application, and after final set was maximum for P.S.P. (Group G).
2. Flow of zinc oxide eugenol impression paste test samples after 30 s and 1 min of load application, and after final set was minimum for PYREX (Group A).
3. With respect to flow only P.S.P. (Group G) complied with ADA requirements.
4. Setting time of zinc oxide eugenol impression paste test samples was highest for P.S.P. (Group G).

Within limits of the present study and on the basis of the result, it may be concluded that if a material has the better flow property, it will record the tissue details more accurately and thus will be more dimensionally accurate.

Acknowledgments Authors would like to thanks to Late Dr. H. R. Dayaker, Ex Principal, Proffessor and Head of the Department, Department of Prosthodontics, Darshan Dental College and Hospital, Udaipur, Rajasthan. Its because of his constant support and motivation I was able to finish my dissertation work. Sir though you are no more between us but your words of guidance are still with me. Thanks for everything.

References

1. Frank RP (1969) Analysis of pressure produced during maxillary edentulous impression procedure. J Prosthet Dent 22:400–412
2. Frank RP (1970) Controlling pressure during complete denture impressions. Dent Clinic North Am 14:453–469
3. Robert J (1957) Clark, Phillips R.W. Flow studies of certain dental impression materials. J Pros Dent 7:259–266
4. Reinitz R.J. From plaster to polyvinyls. A reviews of dental impression materials
5. Balthazar Y, Sandrik JL, Malone WFP, Mazur B, Hart T (1981) Accuracy and dimensional stability of four interocclusal recording materials. J Prosthet Dent 45:586–591
6. Michalakis KX, Pissiotis A, Anastasiadou V, Kapari D (2004) An experimental study on particular physical properties of several interocclusal recording media. J Prosthodont 13:42–46
7. Al-ahmar AO, Lynch CD, Locke M, Youngson CC (2008) Quality of master impressions and related materials for fabrication of complete dentures in the UK. J Oral Rehabil 35:111–115
8. Pratten DH, Novetsky M (1991) Detail reproduction of soft tissue. J Prosthet Dent 65:188–191
9. Koran A (1980) Impression procedure for recording the denture bearing mucosa. Dent Clinic North Am 24:97–111
10. Chai J, Dennis K, Leong Pang IC (1994) An investigation of the rhelogical properties of several interocclusal registration materials. J Prosthdont 3:134–137
11. Asgarzadeh K, Peyton FA (1954) Physical properties of the corrective impression paste. J Prosthet Dent 4:555–567
12. Myers GE, Peyton FA (1961) Physical properties of the zinc oxide eugenol impression pastes. J Dent Res 40:39–48
13. Tyas MJ, Wilson HJ (1970) Properties of zinc oxide eugenol impression pastes. Brit Dent J 129:461–465
14. Kumagai K, Tamiya N, Lwamoto K, Taniguchi Y, Takeda H, Kikuzuki K (1989) Factors affecting the setting time of zinc oxide eugenol impression materials-the influence of humidity and temperature to the reaction velocity. Nihon Hotetsu Shika Gakkai Zasshi 1:127–132
15. Gomes WL, Santos JF, Muench A (1990) Consistency of zinc oxide eugenol impression materials. Rev Odontol Univ Sao Paulo 3:197–199
16. American Dental Association (1964) No. 16 for dental impression paste-zinc oxide-eugenol type. Guide to dental material, 2nd edn. American Dental Association, Chicago