

Comparative Evaluation Of Dimensional Accuracy And Surface Detail Reproduction Of Eugenol Vs Eugenol Free Zinc Oxide Impression Paste: An Invitro Study

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ABSTRACT

Purpose: Surface detail reproduction and dimensional accuracy of secondary impression plays a major role in success of complete denture fabrication. Lack of precision in the duplication process will eventually have a hostile effect on the adaptation of the final restoration. Most commonly used final impression material is zinc oxide eugenol paste. Conventional pastes contain eugenol and eugenol free pastes are available too. This in vitro study was planned to evaluate and compare the dimensional accuracy and surface detail reproduction of zinc oxide eugenol and eugenol free impression materials.

Materials and Methods: Three different zinc oxide eugenol impression pastes DPI, Denzomix, Neogenate (Septodont) and two eugenol free impression pastes Cavex outline and Image were used to make samples. Total of 100 samples with 20 samples for each group were made. A standardized stainless steels die, similar to that described in ANSI/ADA Specification No. 19 was used. The die was scored with three horizontal and two vertical lines of 0.02 mm width and used for impression making.

Results: Statistically significant difference [$P < 0.001$] was found in dimensional accuracy with least dimensional error was found in Cavex outline (0.281mm) and Septodont (0.285mm) followed by Denzomix (0.386mm), DPI (0.497mm) and Image (0.748mm). Maximum surface detail reproduction was shown by Septodont (95%) followed by Cavex outline (85%), Denzomix (80%), DPI (60%), Image (55%) [$p = 0.01$].

Conclusion: The most dimensionally accurate material is Cavex-Outline which is zinc oxide eugenol free material and best surface detail reproduction was shown by Septodont.

Keywords: complete denture, surface detail reproduction, secondary impression, zinc oxide eugenol, dimensional accuracy.

INTRODUCTION

Impression making either primary or secondary is a vital step in complete denture fabrication. In today's era where digital impressions have taken over till there is scope for conventional impressions in several parts of the world and also their accuracy is still questionable therefore the need to find out the most accurate non eugenol impression material is still not studied(1).

Dimensional accuracy and Surface detail reproduction of secondary impression plays a major role in success of complete denture fabrication. The inaccuracies in the replication process will ultimately have an adverse effect on the fitting of final version of the restoration. An imprecise impression is majorly the cause of such ill-fitting prosthesis (1).

Although various secondary impression materials are available, the gold standard for complete denture final impression materials is zinc oxide eugenol paste because of its free-flowing nature, longer working time, accurate recording of tissue details and dimensional stability (2, 3, 4, 5).

Eugenol has been widely used in dental products such as impression pastes, periodontal dressings, cements, filling materials, endodontic sealers, and dry socket dressings for many years and is considered non-carcinogenic and non-mutagenic and safe by the Food and Drug Administration(6). On the other hand many studies report

about the cytotoxicity of eugenol from low-grade local reactions to the rare, but serious, anaphylactic reaction. However, there have been rare reports of hypersensitivity reaction to eugenol (7). Due to this, some companies have introduced zinc oxide eugenol free pastes in the market and they have been widely used by dental practitioners too. Companies also claim of the appropriate consistency of the pastes and good detail reproduction (8). However, there is no literature available on these materials and their properties in comparison to each other and with the conventional eugenol carrying pastes, therefore existed a need for this study.

This in-vitro study was carried out with the aim of comparison of dimensional accuracy and surface detail reproduction of zinc oxide eugenol and eugenol free impression materials and the null hypotheses of the study was that there is no difference in dimensional accuracy and surface detail reproduction properties among eugenol and eugenol free impression materials.

MATERIALS AND METHODOLOGY

Three different zinc oxide eugenol impression pastes DPI (Dental Products of India), Denzomix (Mixodent), Neogenate (Septodont) and two zinc oxide eugenol free impression pastes Cavex outline (Cavex) and Image (Prime Dental) were used to make samples.



Fig 1 Materials used in the study

Sample Description: Total 100 samples with 20 samples for each group were made. Sample size was obtained by using N master software (version 2.0) (9). The formulas used for sample size calculation are described here:

$$n_0 = \frac{Z^2 pq}{e^2} \quad n = \frac{n_0}{1 + \frac{(n_0 - 1)}{N}}$$

Where z = 1.96 at 95% Confidence interval, P and q are percentage of success and failure which is 50%, E is level of precision which is 5%, n0 = 385. n = 19.1 and N=20. Final sample size was 100. (20 per group * 5 groups) A standardized stainless steels die, similar to that described in ANSI/ADA Specification No. 19 was used to make samples. It consisted of three components: the test block, the mold and the metal riser. (Fig-2) It was scored with three horizontal and two vertical lines of 0.02 mm width and used for impression making. The horizontal lines were labelled as A, B and C. Two cross-points at the intersection of the horizontal lines with two vertical lines are marked XY and X'Y' served as the beginning and end points of measurement for dimensional accuracy (10). (Fig -3)



Fig.2 Stainless steel dies standardised

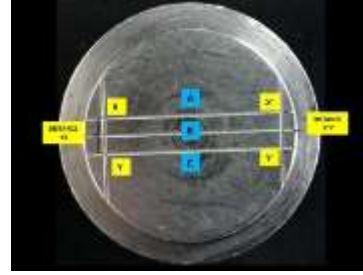


Fig.3 Distance XY and X'Y' on Die

A fine mist of artificial saliva was applied to the die surface before the impression material was applied. Equal lengths of the base and accelerator paste of test materials were dispensed 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 dispensed on to the die surface. A polyethylene sheet and a rigid flat metal plate was placed on top of the moulds to contain the material and a mass of 300 grams was added on the rigid metal plate to standardize pressure on the impression material during forming and setting (Fig 4). After the start of mixing at 1.5 minutes, applied impression material with the dies was transferred into a water bath (Fig.5), the temperature for which was maintained at 32 ± 2 °C for the recommended time by the manufacturer for removing the impression material from the mouth to simulate the aqueous oral environment as recommended by ADA/ANSI specification No.19 (11.12)



Fig.4 300 grams weight placed while setting of material



Fig.5 Die transferred into a water bath



Fig.6 Samples of different materials

The specimens were allowed to set according to manufacturer's recommended setting time. The samples which were smooth and free of voids or pits were included in the study. (Fig-6) The samples which were broken or contained major voids or pits on their impression surface were excluded from the study. After fabricating the samples Dimensional accuracy and Surface detail reproduction were measured by following methods.

Measuring dimensional accuracy: A single investigator who was unaware about the materials, measured the length of line B between cross points X and Y for each impression. These measurements were made three times to the nearest 0.001 mm at original magnification 10x using a measuring microscope. The three measured lengths were averaged and compared with the instrument of line B on the metal die used to make the impression. The percentage change from the metal die was computed. AutoCAD software was used to measure the distance on the specimens for measuring dimensional accuracy and surface detail reproduction (Fig. 7).

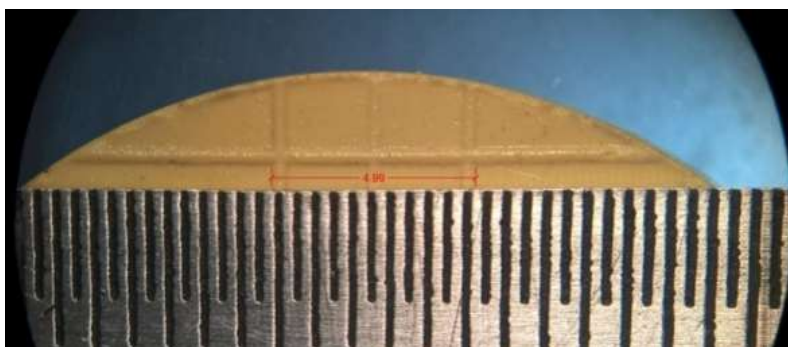


Fig. 7 Distance XY and X'Y' measured using AutoCad software for each sample

Measuring surface detail reproduction: All three lines were assessed for each specimen. The criteria for the impression to be satisfactory was if minimum of two of the three horizontal lines were replicated without any break in between the cross points. The remaining were considered unsatisfactory (10). Measurements were done by a co investigator blinded to the study. The collected data was entered in the excel sheets, tabulated and subjected to statistical analysis.

RESULTS:

In this in-vitro study dimensional accuracy and surface detail reproduction of five different zinc oxide eugenol and eugenol free impression materials were evaluated. Data were collected from 100 samples and tabulated using Microsoft Excel 2010. Statistical analysis was performed using SPSS (SPSS Statistics software v23; IBM Corp). Significance level was set with $\alpha = 0.05$.

DIMENSIONAL ACCURACY

Table 1: Mean and SD for Dimensional Accuracy of Impression Materials

Material	N	Mean distance XY and X'Y' on metal die	Mean distance XY and X'Y' on samples	Mean Dimensional Error (mm)	±SD (mm)	P value (unpaired t-test)
DPI	20	5.0mm	4.50	0.49	0.01	<0.001
Septodont	20	5.0mm	4.71	0.28	0.05	<0.001
Denzomix	20	5.0mm	4.61	0.38	0.10	<0.001
Cavex Outline	20	5.0mm	4.71	0.28	0.05	<0.001
Image	20	5.0mm	4.25	0.74	0.11	<0.001

P<0.001 indicates highly significant difference
SD is Standard deviation, mm millimetre

Mean and standard deviation of dimensional accuracy is seen in Table 1

Statistically significant difference ($p < 0.001$) was found in the mean dimensional accuracy of Zinc oxide eugenol & eugenol free impression materials upon using unpaired t-test between the impression materials and die measurements. Least dimensional error was found in and Cavex outline (0.281mm) and Septodont (0.285mm) followed by Denzomix (0.386mm), DPI (0.497mm) and Image (0.748mm). Statistically significant difference was found in dimensional accuracy of various impression materials with the standard die. Table 2 and Table 3 show Results of ANOVA and Post Hoc Test for intergroup comparison all five groups.

Table 2 : ANOVA for Dimensional Accuracy of ZOE impression Materials

Sum of Squares	Df	Mean Square	F	P
2.538266	4	0.634566	102.45	<.0001

Highly significant statistical difference ($P < 0.001$) was found in dimensional accuracy of various ZOE & eugenol free impression materials.

Table 3: Post Hoc Test for Intergroup Comparison

Between Groups	P value	Significance
DPI v/s Septodont	<0.01	Significant
DPI v/s Denzomix	<0.01	Significant
DPI v/s Cavex Outline	<0.01	Significant
DPI v/s Image	<0.01	Significant
Septodont v/s Denzomix	<0.01	Significant
Septodont v/s Cavex Outline	0.90	Non significant
Septodont v/s Image	<0.01	Significant
Denzomix v/s Cavex Outline	<0.01	Significant
Denzomix v/s Image	<0.01	Significant
Cavex Outline v/s Image	<0.01	Significant

However, post hoc test showed no significant statistical difference ($p > 0.05$) between eugenol free Cavex outline & Zinc oxide eugenol containing Septodont impression material. Rest all impression materials had statistically significant difference between them with respect to dimensional accuracy.

SURFACE DETAIL REPRODUCTION

Surface detail reproduction followed the similar order with maximum surface detail reproduction by Septodont (95%) followed by Cavex outline (85%), Denzomix (80%), DPI(60%), Image(55%) ($p = 0.01$). Frequency distribution of specimen for surface detail reproduction Table 4

DISCUSSION:

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 (13).

An impression material should be ideally viscous so that it can be retained in the impression tray and also should possess good flow to record all the details to make complete denture impressions. They should record and produce oral tissue details precisely and be stable dimensionally. The gold standard for edentulous impression materials is zinc oxide eugenol paste (14). Zinc oxide eugenol paste is the material of choice because it exerts very less pressure on the basal tissues, dimensional stability is good, satisfactory strength and ability to record accurate details.

A large number of zinc oxide eugenol pastes are available which are essentially similar in general properties but differ in their clinical behaviour. Deviations are noted from one product to another regarding setting times, consistency and flow and physical properties of set material. These required the appraisal of different physical characteristics of various products existing to help the profession in choosing and using these materials. Many researchers have concluded in their studies that zinc oxide eugenol paste causes least pressure on tissues among different impression materials (15, 16, 17, 18, 19)

Physical properties of various ZOE impression pastes have been studied in the past (20, 21). There is one recent study on flow property of ZOE impression pastes (4). It was found that very less literature is available comparing the dimensional accuracy and surface detail reproduction of zinc oxide eugenol with eugenol free impression paste which are important properties of a secondary impression material for complete denture impression.

In this in-vitro study stainless steel die standardized according to ADA specification No. 19 was designed for measuring dimensional accuracy and surface detail reproduction. Sample size determination using the data from research work of Katyayan P et al in 2011(9) was followed and a total sample size of 100 was achieved.

After the measurement of samples for Dimensional accuracy, it was found that Mean Dimensional Error was least for Cavex Outline which was 0.281mm followed by Septodont (0.285mm), Denzomix (0.386mm), DPI (0.497mm) and maximum error was found with Image which was 0.748mm.

Cavex Outline is a two-paste system in which white paste is base component, contains metallic oxides of magnesium and zinc and a blue paste, consisting of fatty acid as the reactive agent(8). Setting reaction of the zinc oxide eugenol paste is chelation reaction while eugenol-free-zinc oxide paste is a saponification reaction, resulting

in the production of an insoluble soap. This reaction attains a stable equilibrium in a comparatively short period of time (22). This may explain the better dimensional stability of eugenol free zinc oxide paste.

Similar results were observed by Balthazar-Hart et al (22) They studied accuracy and dimensional stability of four interocclusal recording materials with the similar methodology (using ADA specification no 19 die). Materials were: zinc oxide eugenol paste, eugenol free paste, silicone putty and polyether. In this study eugenol-free zinc oxide paste was the only material which exhibited no statistically significant difference between the die scribes and those of the sample.

Unpaired t test showed statistically significant difference while comparing the samples with the die. ($P < 0.001$) Values in present study are greater than the values mentioned in study by Skinner W.E. et al. However, methodology for measuring dimensional accuracy is different in both studies. In present study the die according to ADA specification no 19 which is basically for the elastomeric impression material was used, while in Skinner's study six inches long brass trough was used ADA No. 16. Also, it has not mentioned about properties of dimensional accuracy and surface detail reproduction of the same material. So results could not be compared with ADA standards (23)

The text book of Phillips's science of dental materials has mentioned that "The dimensional stability of the impression pastes is quite satisfactory with the negligible shrinkage of $< 0.1\%$. This condition can be satisfied only if the tray material is dimensionally stable." (24) Whereas, in present methodology, tray was not used and that may be the reason for the difference in dimensional change. However, many studies have used similar methodology as described in present study (9, 11, 22)

Result of the ANOVA showed statistically significant difference ($P < 0.001$) in dimensional accuracy of various ZOE impression materials. And Post Hoc Test for intergroup Comparison showed that there was significant difference between groups ($P < 0.01$) except Cavex outline and Septodont ($P = 0.90$). This means that Cavex outline and Septodont are equal in terms of dimensional accuracy while, all other materials showed difference amongst each other.

For surface detail reproduction all three lines were assessed for each specimen. Production of three horizontal lines continuously between the cross points, was the indication that impression was satisfactory. This methodology was obtained from previous study on surface detail reproduction (10).

Septodont showed highest surface detail reproduction which satisfactorily recorded 19 samples out of 20 samples. (95%). Second was Cavex Outline which recorded 17 samples satisfactorily (85%) followed by Denzomix (80%), DPI (60%) and lastly Image (55%). Chi square value is 12.267, $p = 0.01$ which showed highly significant difference.

For the surface detail reproduction the best material was Septodont (with eugenol) followed by Cavex Outline (eugenol free). So, the results show that dimensional accuracy and surface detail reproduction are not solely depended upon eugenol content of the material.

Results of present study are contradictory with the result of one recent study on flow property of various zinc oxide eugenol and eugenol free impression materials. However this study has classified all impression materials under same category as Zinc oxide eugenol materials. PSP group showed highest flow followed by DPI, Image, Denzomix, Cavex, Neogenate (Septodont) and Pyrex in descending order (4).

The overall composition of each material should be known in detail as it affects the properties of pastes directly. The amount of filler such as silica, plasticizer such as vegetable or mineral oil in eugenol containing pastes and orthoethoxybenzoic acid or fatty acid in eugenol free pastes, accelerator such as CaCl_2 , amount of rosin and resinous balsam as they increase the flow and inert powders such as kaolin, talc, diatomaceous earth as they give body to the materials should be known percentage wise to compare the properties of materials (24). Method of manufacturing and storage are other important parameters which may affect the performance of the material.

Future scope of this study is to develop a more standardized methodology for measuring dimensional accuracy of zinc oxide eugenol and eugenol free paste which includes dimensionally stable tray to support the material. And comparison of various materials can be done after knowing detail composition of each material.

CONCLUSION:

On the basis of the result obtained following conclusions can be made:

1. The most dimensionally accurate material is Cavex-Outline which is zinc oxide eugenol free material while the second best material is Septodont which is zinc oxide eugenol containing material. The difference between both of them is statistically non-significant. For the surface detail reproduction the best material is Septodont followed by Cavex-Outline.
2. Within the limitation of this in-vitro study it can be concluded that dimensional accuracy and surface detail reproduction are not solely depended upon eugenol content of the material. Clinician can use eugenol free impression paste for better patient comfort.

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