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Original Article

Assessment of Completely Edentulous Mandibular Final Impressions Obtained from Discrete Impression Materials in Terms of Dimensional Accuracy Using Extra-Oral Digital Scanning

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Abstract

Objectives: To evaluate and compare the accuracy of four different impression materials utilized in final impressions taking in mandibular edentulous cases using the Extra-oral digital scanning of impressions with EXOCAD software. Materials and Methods: Twenty middle-aged patients were selected, with completely edentulous arches. For each patient, four different mandibular final impressions were obtained using four different impression materials namely, 1. Zn/O Eugenol, 2. Rubber Base single-step, 3. Silginat 4. Monophase impression materials. All four impressions were scanned using an Extra-oral scanner (Medit T710 Extra-oral laboratory Scanner). Two measurements were taken for each virtual cast and compared. Results: One-way ANOVA test and Tukey's post hoc test for multiple comparisons of measurements were used. Generally, there were no statistically significant differences in measurements. Conclusions: Zn/O and Eugenol have always been considered the gold standard of secondary impression materials for completely edentulous ridges. This study concluded that the more recent Rubber Base, Silginat, and Monophase impression materials proved to possess equivalent accuracy.

Keywords: Accuracy, Mandible, Edentulous, Impression, Exocad

I. INTRODUCTION

The precision of different impression materials is one of the most significant factors in predicting the outcome of the final delivered complete denture. The difference in the compressibility of supporting oral mucosa and underlying bone dictates the use of different impression materials and techniques to obtain the best outcomes. [(1)]

Many factors were found to impact the accuracy of the master casts obtained from a definitive impression. [(2)] The usage of a special tray has an extensive effect by producing a uniform and standardized thickness of impression material which in turn improves the master's cast final accuracy. [(3, 4)] Additionally, materials used to fabricate special trays must have specific requirements involving; must not exhibit any permanent deformation during and after the impression-taking process and when retrieved from the patient's mouth and possess dimensionally stability over time. [(5)]

When removing the impression from the patient's mouth, the impression material needs to be firmly attached to the unique tray.[(6)]

Before taking impressions, it is customary to use a tray adhesive to assist bind the impression material to the tray, which helps

spread the shrinkage caused by polymerization throughout the material uniformly. [7-9]

One of the most accurate and dimensionally stable impression materials reported in the literature is PVS or Polyvinyl siloxane impression materials. [10] Additionally, there is a direct correlation between the consistency or viscosity of the impression substance and the amount of pressure used to create the impression. [11] In general, there are two categories of impression materials: those that produce low pressure, such as light-body polysulfide and light-body vinyl polysiloxane, and those that produce high pressure, such as irreversible hydrocolloid-silicon material and medium-body vinyl polysiloxane. [12] The greater the consistency or the viscosity of the material, the greater the pressure applied on the residual ridge during impression taking. [13]

It was also reported that addition silicone has higher dimensional stability. [14] This stability is due to the absence of volatile substances which on evaporation can cause significant shrinkage. [15] Its stability is close to Polyether except that moisture contamination of polyether may result in expansion and reduction in dimensional loss of accuracy. [16,17]

Nowadays, numerous software is available in the market that is used in designing and analyzing dimensional stability final impression and complete dentures such as the Exocad software (Exocad GmbH, Germany), DWOS full denture (Dental wings by Straumann, Germany), 3Shape (3Shape, Copenhagen, Denmark), Avadent software (Global Dental Science Scottsdale, AZ, USA), and BlueSky software (BlueSky Bio) systems. [18-20]

II. MATERIALS AND METHODS

At Cairo University's Faculty of Oral and Dental Medicine, twelve middle-aged patients were chosen from the outpatient clinic of the prosthodontics department. Patients with fully edentulous maxillary and mandibular ridges, with firm adherent overlaying mucosa, and systemically devoid of any diseases and demonstrating the typical maxillo-mandibular connection (Class I Angle categorization), Figure (1).

All patients were knowledgeable about the treatment plan and asked for approval on it with written consent forms according to the ethical principles stated in human studies approved by the ethical committee department-Cairo university & signed by the patient himself.

Two special trays for every single patient were constructed from self-cure acrylic resin on the primary cast; to be utilized with 1. Zn/O Eugenol, 2. Rubber Base materials. Meanwhile, a specialized type of prefabricated stock trays (with a measuring gauge for appropriate tray selection), Figure (2) was to be utilized with the other two impression materials: Silginat & Monophase impression materials.

For each patient, four different impressions mandibular impressions were obtained using four different impression materials namely, Zn/O Eugenol (Cavex, Holland), Rubber Base single-step (Panasil, Katzenbach, Germany), Silginat (Silginat, Katzenbach, Germany), Monophase (Identium, Katzenbach, Germany) impression materials.

A. Zn/O Eugenol Impression Material

The self-curing acrylic resin was used to create special trays, the green stick compound was used to create border moulding, and zinc oxide and eugenol impression substance were used to create the final impression. After that, the impression was allowed to dry as recommended by the manufacturer, Figure (3).

B. Rubber Bases Putty and Light P.V.S Impression Material

Special trays were constructed from self-cure acrylic resin on the primary cast with a spacer; adhesive material was painted on the special tray. Border molding was made with putty consistency P.V.S, followed by a wash impression using light consistency P.V.S. The impression was then left to set according to the manufacturer's instructions, Figure (4).

C. Silginat Impression Material

A specialized type of prefabricated stock trays (Polycarbonate stock trays-ASA

DENTAL, S.p.A, ITALY) was selected (with the aid of a measuring gauge for appropriate tray selection), and an impression was made using Silginat (a silicon-alginate impression medium). After that, the impression was allowed to dry as recommended by the manufacturer, Figure (5).

D. Monophase Impression Material

A specialized type of prefabricated stock trays (Polycarbonate stock trays-ASA DENTAL, S.p.A, ITALY) was selected (with the aid of a measuring gauge for appropriate tray selection), impression using Monophase Poly-ether impression material was performed. The impression was then left to set according to the manufacturer's instructions, Figure (6).

For each patient, all four impressions were taken on the same day. The previously taken impressions were scanned using an Extra-oral digital scanner (IMedit T710 Extraoral laboratory Scanner). and Digital 3D casts were generated on the IMedit software program on the computer. STL files of each cast were exported from the IMedit software and imported into the Exocad® software. Two measurements were obtained from each digital cast (with a line extending from the anterior line angle of the standardized base to contra-lateral retromolar pad and vice-versa).

A geometric centre of the cast was reproduced from the intersection of these two lines. Using Exocad® software, the length of these lines from the geographic centre to each retromolar pad was measured. Similarly, the surface area of the triangle formed by connecting the geographic center and the two retromolar pads were calculated in pixels. To facilitate a comparative study, the mean of the two lines was calculated in length determination for further analysis, Figures (6-10).

E. Sample Size Determination

A continuous response variable from separate control and experimental individuals was planned for the study, with one control subject for every experimental subject. In a prior study, responses within each subject group had a standard deviation of 16 and were regularly distributed. To be able to reject the null hypothesis that the population means of the experimental and control groups are equal with probability (power) 0.8, assuming that the true difference between the experimental and control means is 28.6. The likelihood of a Type I error in this test of the null hypothesis is 0.05.

F. Statistical Analysis

SPSS 20®, GraphPad Prism®, and Microsoft Excel 2016 were used for statistical analysis. the means and standard deviations (SD) of the data. Using the following formula, digital measurement data in (dpi) were converted from pixels to millimeters.

1 mm = 3.7795275591 pixel (X)

Figure (1) Edentulous Maxillary and Mandibular ridges

Figure (2): Specially designed stock trays with a measuring gauge

Figure (3): Zn/O Eugenol impression material

Figure (4): Rubber Bases Putty and Light P.V.S impression material

Figure (5): Silginat impression material

Figure (6): Monophase impression material

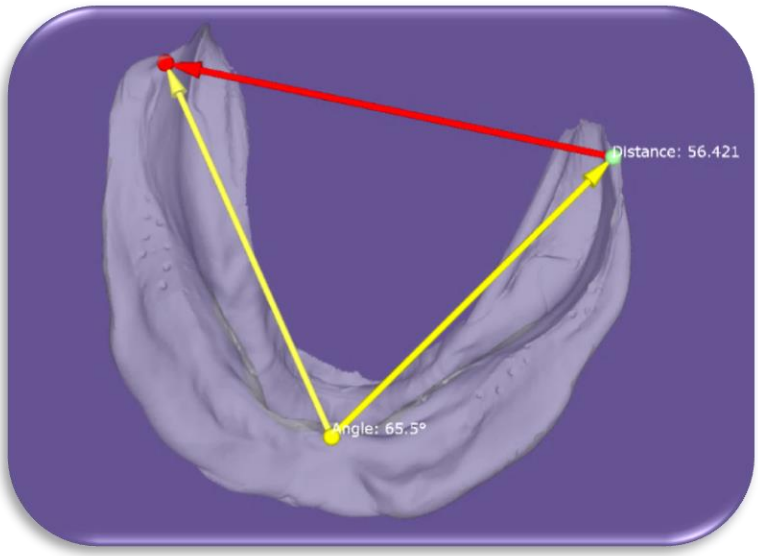

Figure (7): Monophase photo analysis

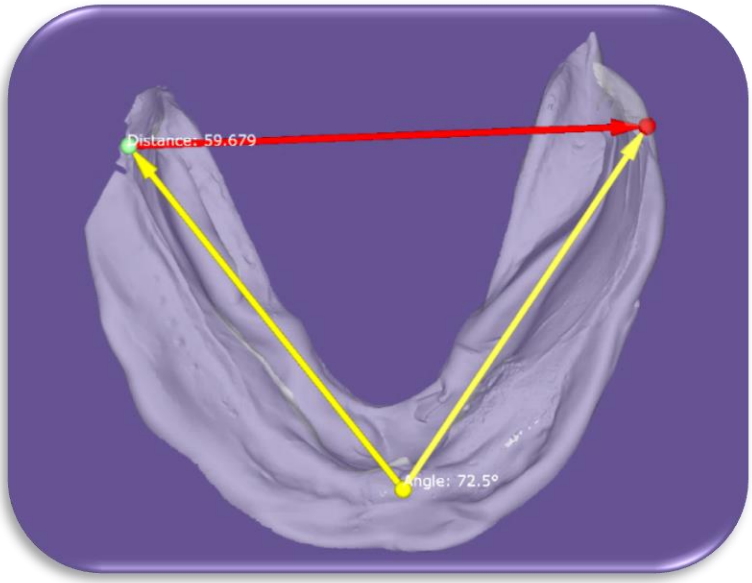

Figure (8): Rubber Base photo analysis

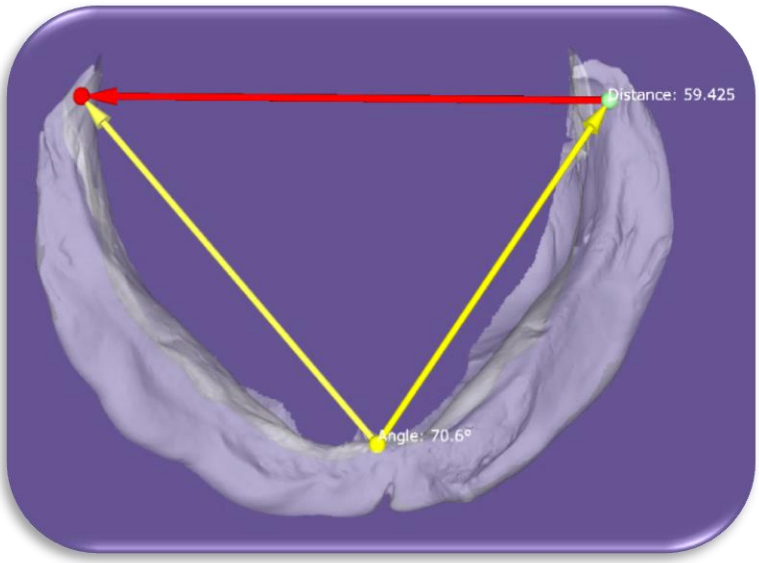

Figure (9): Silginat photo analysis

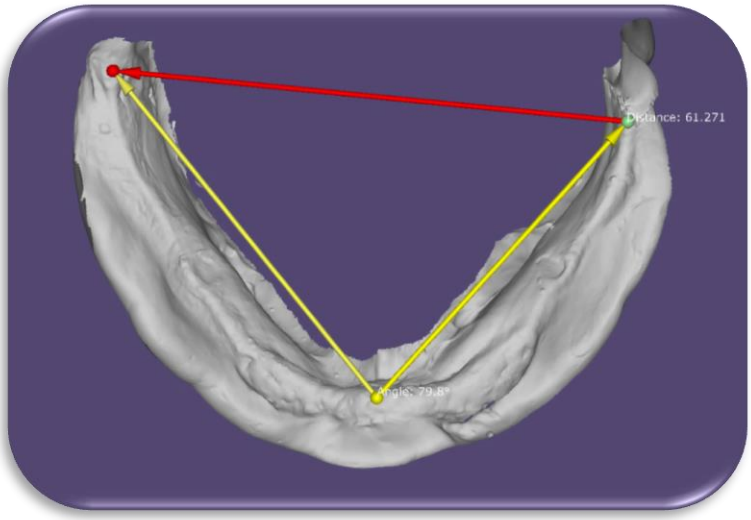

Figure (10): Zn/O Eugenol photo analysis

III. RESULTS

Regarding mandibular impressions, angular measurements were estimated for studied impression materials (Zn/O Eugenol, Rubber Base, Silginat, Monophase). For the scanning method using Exocad software, angular measurements revealed (79.8), (70.6), (72.5), and (65.5) degrees, as listed in table (1) and shown in Table (1). Using one-way analysis of variance (ANOVA) was performed to evaluate the level of significance between impression types followed by Tukey`s post hoc test for multiple comparisons, it was revealed that there was a significant difference between different impression types regarding mandibular angular measurements as P-value < 0.05 except for Rubber Base and Silginat which was insignificant as P-value > 0.05, as listed in Table (1).

Regarding mandibular impressions, perimeter measurements were estimated for studied impression materials (Zn/O Eugenol, Rubber Base, Silginat, Monophase). For the scanning method using Exocad software, angular measurements revealed (156.119), (162.637), (154.901), and (161.295) mm, as listed in the table (1) and shown in Figure (11). Using one-way analysis of variance (ANOVA) was performed to evaluate the level of significance between impression types followed by Tukey`s post hoc test for multiple comparisons, it was revealed that there was an insignificant difference between different impression types regarding mandibular perimeter measurements, as listed in Table (1).

Table (1): Multiple Comparisons of Dimensional Accuracy of Different Impression Materials of Completely Mandibular Ridge

	Angular Measurement		**Perimeter Measurement**	
	Angle º		**Perimeter (mm)**	
	M	**SD**	**M**	**SD**
Zn/O Eugenol	79.8[a]	1.07	156.119[a]	47.82
Rubber Base	70.6[b]	1.65	162.637[a]	49.82
Silginat	72.5[b]	1.81	154.90[a]	47.45
Monophase	65.5[c]	1.91	161.295[a]	49.41
P-value	0.00*		0.9903 (ns)	

M; Mean, SD; Standard deviation, P; Probability Level
Means with same superscript letter in the same column were insignificantly different.
Means with different superscript letters in the same column were significantly different.
****Significant difference***
Ns; Insignificant Difference

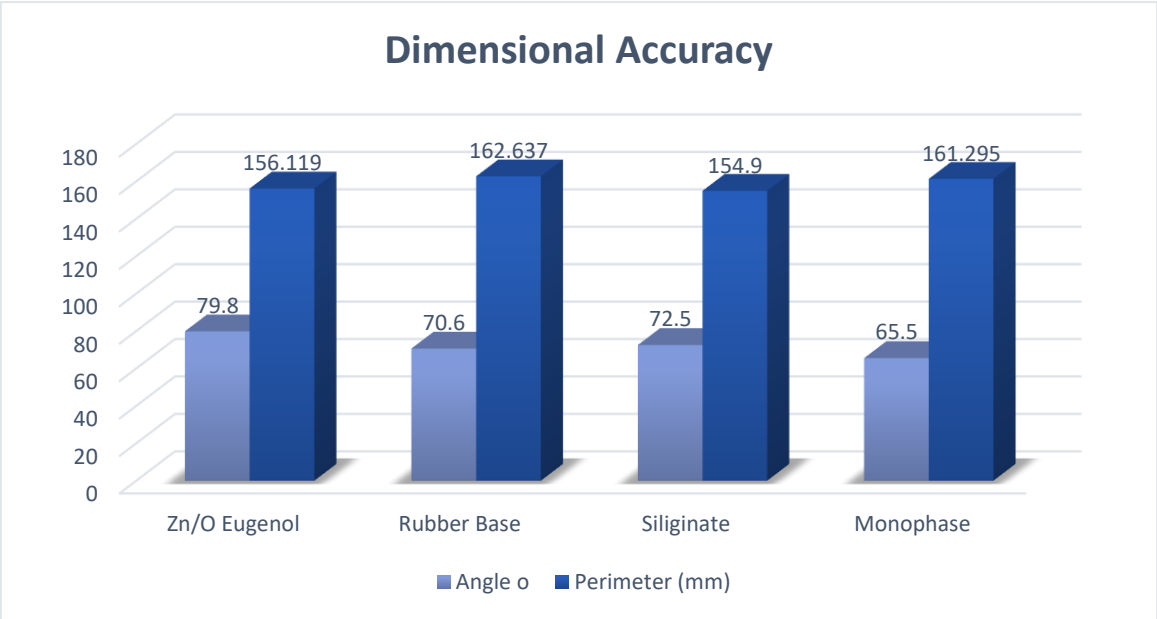

Figure (11): Bar Chart revealing Multiple Comparisons of Dimensional Accuracy of Different Impression Materials of Completely Edentulous Mandibular Ridge

IV. Discussion

Middle-aged patients were selected, as changes that might happen for the patient within this age range are not extreme and therefore the consistency and standardization of the results were assured. Moreover, patients at this age are mostly co-operative, having proper neuromuscular coordination. Age may impair the central processing of the nerve impulses and obstruct the activity of muscles & consequently elder people are usually presented with weak neuromuscular control. [21,22]

Patients were selected from both sexes as the difference in sex will have no effect on the impression accuracy.

Patients were selected free from systemic diseases which could affect denture retention (e.g., Parkinson's disease, hemiplegia, or any abnormalities in the temporomandibular joint), as these might result in inappropriate impression making, due to improper neuromuscular control. [23]

Patients having healthy firm muco-periosteum & without any signs of inflammation or flabbiness covering the edentulous ridge, prevent any impression tray movement over the redundant tissues during impression procedures, which could affect impression accuracy. [24-26]

In the present study, we've utilized Polycarbonate stock trays with Silginat & Monophase impression materials for the simplicity of the technique and less chair-side time. While, using custom-made acrylic resin tray with Zn/O Eugenol & Rubber Base in the traditional manner.

In the current study, the dimensional accuracy of four different impression materials was investigated by digitally scanning the impressions taken from each patient. Digitally scanned impressions were automatically virtually transformed into Digital STL files of the master casts obtained from the four different impression materials taken. Analysis of the STL files of the master casts was performed using the Exocad® software as described in detail in the results section.

The computerized virtual analysis technique used in this study renders easier data collection, expression, reproduction, and exports a range of valuable data that can be easily stored, retrieved, and reproduced accurately whenever needed. [16]

Exocad® software is one of the various available software in the market that is used in

designing and analyzing dimensional stability of final impressions and complete dentures and has been used in many studies for this purpose. (18)

The results of this study showed that there were no statistically significant differences between the dimensional accuracy of the four impression materials. It has been revealed in this study that the newer, more recent impression materials (Rubber Base, Silginat, and Monophase impression materials) utilized in this study showed no statistical difference in terms of dimensional stability and accuracy between them and Zn/o Eugenol which is considered the gold standard material to be used in the fabrication of completely edentulous impressions as reported by Bitragunta et al. (7)

This study concluded that the recent, Rubber Base, Silginat, and Monophase impression materials proved to possess equivalent accuracy but are more feasible, easier, and cleaner to use in comparison with Zn/O eugenol. This was following a study by Caputi et al. (20) and Tarawneh et al. (21) who also concluded that rubber base produced highly accurate, standardized final impression with reproducible and reliable results.

V. CONCLUSION

Zn/O and Eugenol have always been considered the gold standard of secondary impression materials utilized for obtaining highly accurate final impressions for completely edentulous patients. This study concluded that the more recent, Rubber Base, Silginat, and Monophase impression materials proved to possess equivalent accuracy but are more feasible, easier, and cleaner to use in comparison with Zn/O eugenol.

VI. CONFLICT OF INTEREST

This clinical study was self-funded by the authors, with no conflict of interest.

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