EGYPTIAN DENTAL JOURNAL
www.eda-egypt.org
Vol. 69, 573:581, January, 2023
Print ISSN 0070-9484 • Online ISSN 2090-2360
Fixed Prosthodontics and Dental Materials
Submit Date : 21-10-2022 • Accept Date : 28-11-2022 • Available online: 1-1-2023 • DOI : 10.21608/edj.2022.169745.2306

VALIDITY OF DIFFERENT IMPRESSION MATERIALS IN TERMS OF DIMENSIONAL ACCURACY FOR COMPLETELY EDENTULOUS MANDIBULAR RIDGES THROUGH EMPLOYING PHOTOANALYSIS TECHNIQUE

Mostafa Helmy Mostafa Ahmed*, Heba Khorshid* *and* Shady M. Elnaggar**

ABSTRACT

Objectives: To evaluate and compare the accuracy of four different impression materials utilized as final impressions taken in mandibular edentulous cases, employing the Photo analysis technique.

Materials and Methods: Ten patients were selected, with completely edentulous arches. For each patient, four different impressions mandibular impressions were obtained using four different impression materials namely, 1. Zn/O Eugenol, 2. Putty and Light PVS Rubber Base, 3. Silginat 4. Monophase. All four impressions were boxed, and all were poured using type IV dental stone. Casts were then photographed using a digital camera with fixed, repeatable specifications, and digital photographs were then introduced into computer software (Digimizer® Software V. 4.3.1). Two measurements were taken for each cast and compared.

Results: For each analysis method (photo analysis method using Digimizer® software, 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. The significant level was set at $P \leq 0.05$. Generally, there were no statistically significant differences in measurements between tested impression materials.

Conclusions: Zn/O and Eugenol have always been considered the most accurate final impression material utilized in edentulous cases. This study revealed that the more recent, Rubber Base, Silginat, and Monophase impression materials proved to possess equivalent accuracy measured by the Photoanalysis method.

KEYWORDS: Accuracy, Mandible, Edentulous, Impression, Photoanalysis method.

* Assistant Professor of Prosthodontics, Faculty of Dentistry, Cairo University
** Lecturer of Removable Prosthodontics Department, Faculty of Oral and Dental Medicine, Badr University in Cairo, Egypt.

INTRODUCTION

Impression materials that demonstrate accurate dimensional stability are obligatory to capture the fine details of the underlying supporting structures including bone and soft tissue [1-3]. The variance in the nature and quality of supporting oral structures necessitates the use of different impression materials and techniques to obtain the best outcomes of final delivered complete dentures [4].

Numerous causes were found to influence the precision of the final master casts acquired from a secondary impression; including accurate use of impression materials, the utilized impression technique, how, when, and materials used to pour the casts. [5]

Special tray produces a consistent and uniform thickness of impression material which improves the final accuracy of the master cast. [6,7] Furthermore, special trays materials should have certain requirements such as high dimensional stability over time and not permanently deformation during and after the impression-taking process and when removed from the patient's mouth, [8] It is also crucial that the impression materials be strongly adhered to the special tray, predominantly on impression removal from the patient's mouth. [9] Applying a tray adhesive is performed routinely to help adhere the impression material to the tray and hence distribute the polymerization shrinkage evenly throughout the material. [10]

Elastomeric impression materials were first introduced in the late 1950s and became of their superior dimensional stability and tear resistance associated in comparison with hydrocolloid materials used at that time [11]. There are four different types of elastomeric impression materials used in dentistry: polysulfide, condensation polyvinyl siloxane, addition polyvinyl siloxane, and polyether One of the most widely used, accurate, and dimensionally stable impression materials reported in the literature is the Addition PVS or Polyvinyl siloxane impression materials [12]. This is because of its high tear strength, good elastic properties, outstanding deformation recovery on removal, and short working and setting time [13]. Furthermore, this impression material has less polymerization shrinkage than condensation polyvinyl siloxane [13,14].

Polysulfide is a somewhat unpopular impression material because of its disagreeable scent, long setting time, and the fact that it is messy to handle. Polyether impression materials have sufficient tear resistance but have high elastic modulus and become relatively rigid when set. [11, 13, 14] Furthermore, moisture contamination of the polyether may result in expansion and reduction in dimensional accuracy. [15]

Four different types of viscosities or consistencies are available in addition to polyvinyl siloxane impression materials to suit different needs; the light body has the lowest viscosity; the medium body which is commonly used as a monophase material or single-viscosity technique; the heavy body has a higher viscosity and is generally placed in the impression tray to support the light body material; Putty has high filler content and is usually combined with a light body silicone during the impression procedure, known as the putty-wash technique [16-19].

MATERIALS AND METHODS

Ten patients were selected from the outpatient clinic of the Prosthodontics Department, Faculty of Oral and Dental Medicine, Cairo University. Patients exhibited Completely Edentulous Maxillary and Mandibular ridges showing the normal maxillo-mandibular relationship (Class I Angle classification), with well-developed ridge, normal bone anatomy with firm attached overlying mucosa, and systemically free from any medical conditions. ***(Fig 1)***

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. Putty and Light PVS Rubber Base materials. Meanwhile, a specialized type of prefabricated stock trays (with a measuring gauge for appropriate tray selection) ***(Fig 2)*** is to be utilized with the other two impression materials: Silginat & Monophase impression materials.

For each patient, four different mandibular impressions were obtained using four different impression materials namely, 1. Zn/O Eugenol*, 2. Rubber Base single-step**, 3. Silginat*** 4. Monophase**** impression materials.

Zn/O Eugenol impression Material:

Special trays were constructed from self-cure acrylic resin, border molding was made using green stick compound, and the final impression was made with zinc oxide and eugenol impression material. The impression was then left to set according to the manufacturer's instructions. ***(Fig 3)***

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. ***(Fig 4)***

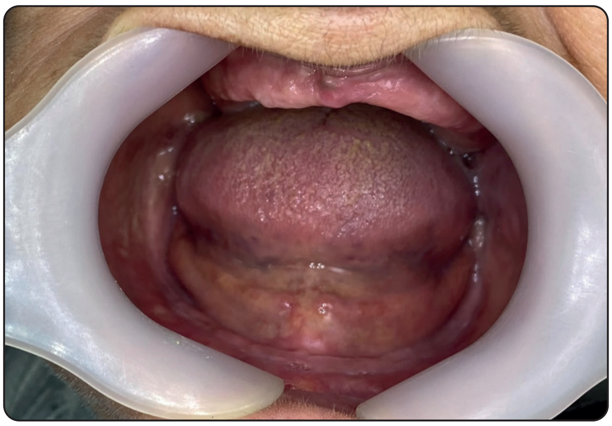

Fig (1): Patient with completely edentulous arches.

Fig. (2): Specially designed measuring gauge.

Fig. (3): Zn/O Eugenol impression material

Fig. (4): Rubber base impression material.

*Cavex, Holland.
**Panasil, Katzenbach, Germany.
*** Silginat, Katzenbach, Germany.
**** Identium, Katzenbach, Germany.

Silginat impression Material:

A specialized type of prefabricated stock trays was selected (with the aid of a measuring gauge for appropriate tray selection), and an impression using Silginat (impression material, in 5:1 Automixer cartridge, was performed. The impression was then left to set according to the manufacturer's instructions. ***(Fig 5)***

Monophase impression Material:

A specialized type of prefabricated stock trays 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. ***(Fig 6)***

(Fig (5): Silginat (5:1) Auto-mixer cartridge.

All four impressions were taken on the same day for each patient. Impressions were boxed and all poured at the same time, using the same type IV dental stone, utilizing a vacuum mixer, at the same room temperature. The dental stone was left to set according to the manufacturer's instructions. After pouring master casts, standardized bases were used with the same dimensions to facilitate a comparative study and to avoid any bias during the study.

Casts were then photographed using a digital camera placed on a camera stand at the same distance and angle from the casts with fixed, repeatable specifications ***(Fig 7)***. The digital photographs were then introduced into computer software. Digimizer® Software V. 4.3.1. Two measurements were obtained from each cast poured from each impression (line extending from anterior line angle of standardized base to contra-lateral retromolar pad and vice-versa).

Using Digimizer® Software V. 4.3.1 the length of these lines from the anterior line angle to each hamular notch was measured. Also, the perimeter of the triangle formed by connecting the standardized anterior line angle and the two retromolar pads were calculated in pixels, as showed in ***Fig. (8-11)***. To facilitate comparative study, mean of the two lines

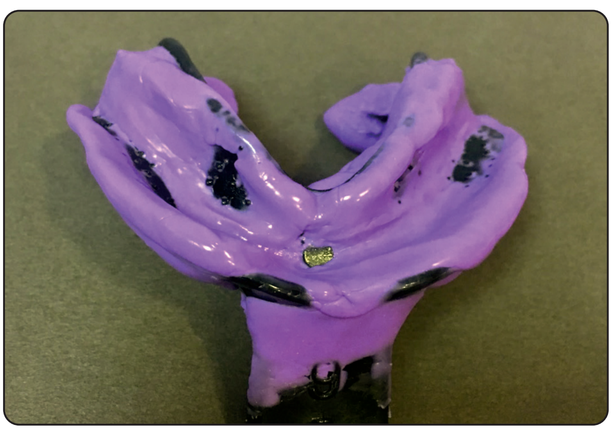

Fig. (6): Mandibular monophase impression material.

Fig. (7): Mandibular Final photographed cast.

was calculated in length determination for further analysis.

RESULTS

Sample size determination:

The statistical analysis for sample size determination for two-sided confidence intervals with unknown standard deviation revealed that a sample size of 7 objects produces a two-sided 95% confidence interval with a distance from the mean to the limits equal to 0.925 when the estimated standard deviation is 1.000. Thus, the sample size used in the present study was set to 10 objects per group.

Statistical Analysis:

Statistical analysis was performed with SPSS 20®, Graph Pad Prism®, and Microsoft Excel 2016.

Data presented as means and standard deviation (SD) values. Digital measurement values in (dpi) had been transformed from pixels to mm using the following formula

1 mm = 3.7795275591 pixel (X)

For each analysis of the photo analysis method using Digimizer® software, a 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. The significant level was set at $P \leq 0.05$.

Angular measurements were estimated for the studied mandibular impression materials (Zn/O Eugenol, Rubber Base, Silginat, Monophase). Photo analysis using Digimizer software, angular measurements revealed (77.35), (81.71), (79.29), and (78.11) degrees, as listed in ***Table (1)*** and shown in ***Fig. (12)***. 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.

TABLE (1): M; Mean, SD; Standard deviation, P; Probability Level

	Photo Analysis Method	
	Angle °	
	M	**SD**
Zn/O Eugenol	77.35^{a}	1.54
Rubber Base	81.71^{b}	1.08
Silginat	79.29^{a}	1.87
Monophase	78.1^{a}	1.47
P-value	0.00**	

Means with same superscript letter in the same column were insignificant different. Means with different superscript letter in the same column were significant different **significant difference

Perimeter measurements were estimated for studied mandibular impression materials (Zn/O Eugenol, Rubber Base, Silginat, Monophase). Photo analysis using Digimizer software, perimeter measurements revealed (708.29), (649.22), (720.55), and (711.75) mm, as listed in ***Table (2)*** and shown in ***Fig. (13)***.

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.

TABLE (2): M; Mean, SD; Standard deviation, P; Probability Level

	Photo Analysis Method	
	Perimeter (mm)	
	M	**SD**
Zn/O Eugenol	708.29^{a}	216.96
Rubber Base	649.22^{a}	198.86
Silginat	720.55^{a}	220.71
Monophase	711.75^{a}	218.02
P-value	0.8735*	

Means with same superscript letter in the same column were insignificant different *Insignificant difference

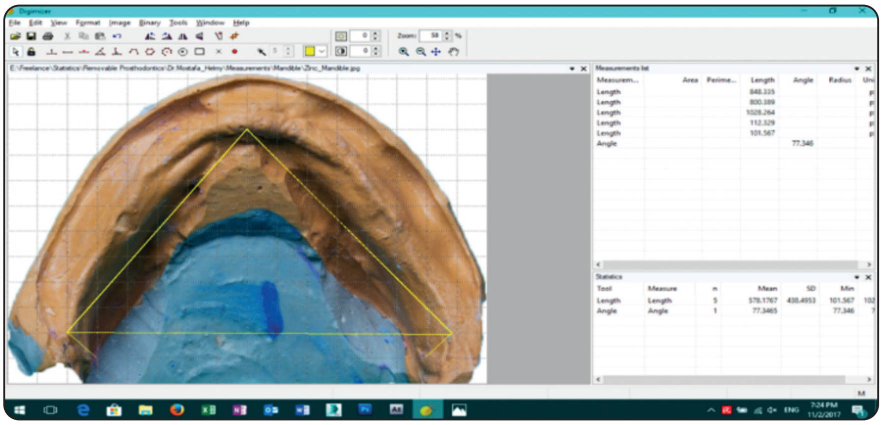

Fig. (8): Digimizer Zn/O Eugenol Photo Analysis.

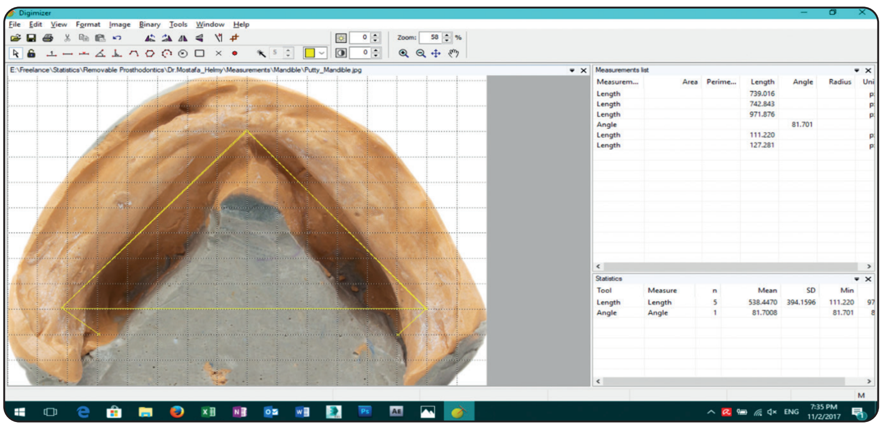

Fig. (9): Digimizer Rubber base Eugenol Photo Analysis.

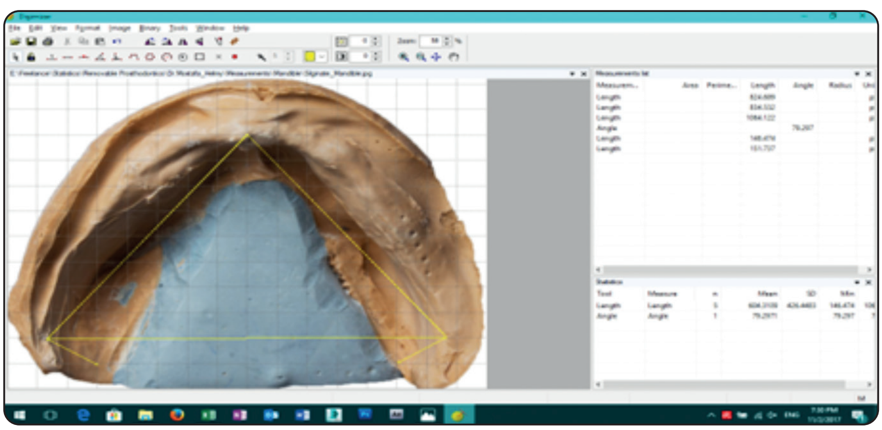

Fig. (10): Digimizer Silginat Photo Analysis.

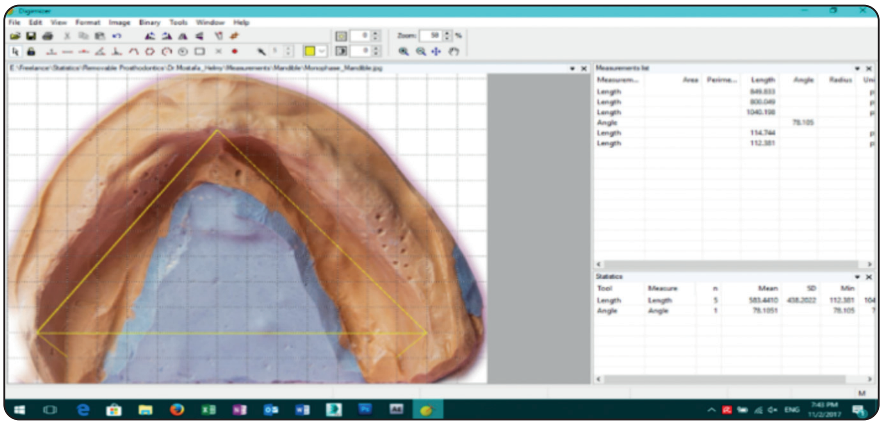

Fig. (11): Digimizer Monophase Photo Analysis.

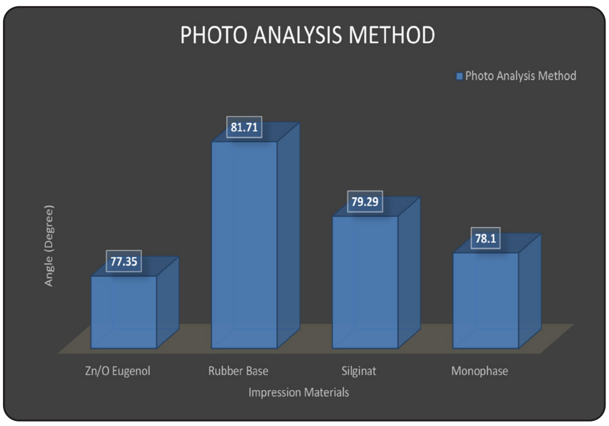

Fig. (12): Angular measurements for the studied mandibular impression materials.

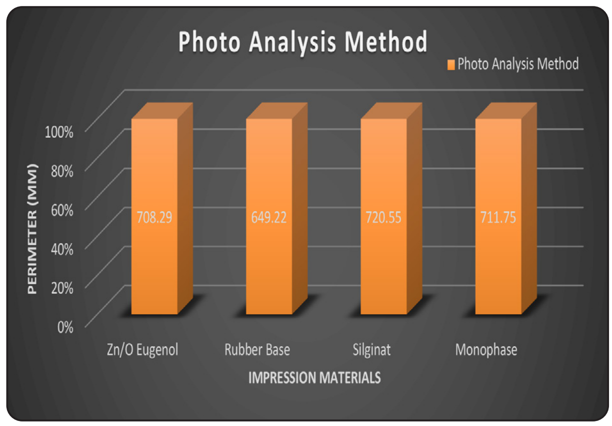

Fig. (13): Perimeter measurements for studied mandibular impression materials.

DISCUSSION

In the current study, the dimensional accuracy of four different impression materials was investigated on the poured extra hard stone IV casts providing a comparable expansion rate for all casts to avoid bias in the dimensional accuracy comparison of impressions which was following a study performed by Caputi S and Varvara [20].

Additionally, all impressions were poured with improved stone which is the hardest, strongest, and toughest product to prevent any fractures or scratches during impression removal and hence avoid any alterations in the measuring procedure as agreed upon by Thongthammachat et al. [2]. All impressions were poured in the same room temperature and humidity, at the same time, to avoid any atmospheric effects on the casts with Standardized base formers as formerly reported in these many studies. [2-6]

A standardized and fixed angulation and distance between the digital camera and the casts during the photo shooting session for all groups was performed which allowed the comparison of different groups properly under the same standards and conditions. Images were then analyzed using the Digimizer software for measuring the dimensional accuracy of the four different impression materials.

Digimizer Software was also employed in a study performed by Nejad et al. [21] which revealed that Digimizer could be a very useful tool for image analysis which can measure the spatial and physical contents of different photographs in different fields of science. The computerized 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 as done in most recent studies. [22]

The results of this study revealed that there were no statistically significant differences between the four impression materials regarding the mandibular angular and perimeter measurements. This study shows that the elastomeric synthetic impression materials (Putty and Light PVS 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 used in the fabrication of completely edentulous impressions as reported by Bitragunta et al. [10]

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. This was in accordance with a study performed 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. Another study harmonized with the findings in our study which reported that the monophase and putty-wash techniques were similarly accurate in capturing dental tissue details [24]. Silginat® which is one of the materials utilized in this study, is a medium-viscosity, polyvinyl siloxane (PVS) impression material with heavy body hardness when set with a low-tear resistance with a clean, easy, and reliable application [24]. The greater the percentage of fillers content, the greater the consistency or viscosity of the impression materials. For example, the light body undergoes the shear thinning effect because it has a lower filler percentage which makes it displace more under high shear stresses [24]. The findings of our current study were in adherence with several studies [25, 26] that concluded that the insignificant dimensional accuracy differences between the different polyvinyl siloxane materials were attributed to the variability in the composition of each brand name, primarily in the matrix-filler ratio, which can lead to variability in polymerization shrinkage and elastic recovery [25, 26].

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, Putty, and Light PVS 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.

Conflict of Interest

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

REFERENCES

1. Perakis N, Belser UC, Magne P. Final impressions: a review ofmaterial properties and description of a current technique. Int JPeriodontics Restorative Dent. 2004; 24:109-17.
2. Thongthammachat S, Moore BK, Barco MT, 2nd, Hovijitra S,Brown DT, Andres CJ. Dimensional accuracy of dental casts: influence of tray material, impression material, and time. JProsthodont. 2002; 11:98-108
3. Tjan AH, Whang SB, Tjan AH, Sarkissian R. Clinically oriented evaluation of the accuracy of commonly used impression materials. J Prosthet Dent. 1986; 56:4-8.

4. Van Waas AJ. (2011). Anatomy and procedure for making an impression for a removable complete denture. Ned Tijdschr Tandheelkd.118:555-560.

5. Cunningham DM: A study of the comparative accuracy of elastic impression materials utilizing partial denture impression. Thesis, Indiana University School of Dentistry, Indianapolis, IN, 1961

6. Rosenstiel SF, Land MF, Fujimoto J: Tissue management and impression making, in Rosenstiel SF, Land MF, Fujimoto J (eds): Comtemporary Fixed Prosthodontics, (ed 3). St Louis, MO, Mosby, 2001, pp 354-379

7. Rueda LJ, Sy-Mun˜oz JT, Naylor WP, et al: The effect of using custom or stock trays on the accuracy of gypsum casts. Int J Prosthodont 1996; 9:367-373

8. Wirz J, Jaeger K, Schmidli F: Light-polymerized material for custom impression trays. Int J Prosthodont 1990; 3:64-71

9. Goiato MC, Filho HG, Dos Santos DM, Barao VA, and Junior AC (2011). Insertion and follow-up of complete dentures: a literature review. Gerodontology. 28: 197-204.

10. Bitragunta pb, Purna S and Mallikarjun M (2011). Systematic Review of Complete Denture Impression Techniques. Indian J Dent Adv. 3: 673-680.

11. Wassell RW, Barker D, Walls AW. Crowns and other extra-coronal restorations: impression materials and technique. Br DentJ.2002;192:679-84, 687-690.

12. Ali K, Shenoy V and Rodrigues S (2010). Comparative evaluation of dimensional accuracy of casts made by repeated pouring of addition silicone impressions using 1) Two-step putty/light-body technique using stock tray and 2) One-step simultaneous dual viscosity technique using custom tray: An in vitro study. J. Nep. Dent. Assoc. 11: 32-39.

13. Daou. E.E (2010). The elastomers for complete denture impression: A review of the literature. The Saud Dent. J.22: 153-160

14. Massad JJ and Cagna DR (2007). Vinyl polysiloxane impression material in removable prosthodontics. Part 1: edentulous impressions. Compend. Contin. Educ. Dent. 28: 452-459.

15. Kanazawa M, Iwaki M, Arakida T, Minakuchi S. Digital impression, and jaw relation record for the fabrication of CAD/CAM custom tray. J Prosthodont Res 2018; 62:509-13.

16. O'Brien WJ. Dental materials and their selection. 3rd ed. NewMalden, UK: Quintessence Publishing Co; 2002, p. 90-112.

17. Shillingburg HT, Jr., Hatch RA, Keenan MP, Hemphill MW.Impression materials and techniques used for cast restorations ineight states. J Am Dent Assoc. 1980; 100:696-699.

18. Driscoll CF, Freilich MA, Guckes AD, Knoernschild KL, Mcgarry TJ. The glossary of prosthodontic terms. J Prosthet Dent 2017;117: e1-105.

19. Salinas TJ (2009). Treatment of edentulism: optimizing outcomes with tissue management and impression techniques. J Prosthodont. 18:97-105.

20. Caputi S and Varvara G (2008). Dimensional accuracy of resultant casts made by a monophase, one-step and twostep, and a novel two step putty/light-body impression technique: an in vitro study. J. Prosthet Dent. 99: 274-281.

21. Nejad N.S., Ali S.: Utilizing a Photo-Analysis Software for Content Identifying Method (CIM) Journal of Landscape Ecology (2015), 8: 32-55

22. Wang C, Shi YF, Xie PJ, Wu JH. Accuracy of digital complete dentures: A systematic review of in vitro studies. J Prosthet Dent 2020; 125:249-56.

23. Tarawneh FM, Panos PG and Athanasiou AE (2008). Three-dimensional assessment of dental casts' occlusal surfaces using two impression materials. J Oral Rehabil.35: 821-826.

24. Bansal PK. Comparison of dimensional accuracy using two elastomeric impression materials in fixed prosthodontics. PakOral Dent J. 2010; 30:537-544.

25. Carlo HL, Fonseca RB, Soares CJ, Correr AB, Correr-SobrinhoL, Sinhoreti MA. Inorganic particle analysis of dental impression elastomers. Braz Dent J. 2010; 21:520-527.

26. Ciesco JN, Malone WF, Sandrik JL, Mazur B. Comparison of elastomeric impression materials used in fixed prosthodontics. JProsthet Dent. 1981; 45:89-94.