10.5005/jp-journals-10024-1311

ORIGINAL RESEARCH

the Journal of CONTEMPORARY DENTAL PRACTICE
at www.thejcdp.com

Evaluation and Comparison of Dimensional Accuracy of Newly Introduced Elastomeric Impression Material using 3D Laser Scanners: An *in vitro* Study

Amrita Pandita, Teerthesh Jain, Naveen S Yadav, SMA Feroz, Pradeep, Akankasha Diwedi

ABSTRACT

Aim: Aim of the present study was to comparatively evaluate dimensional accuracy of newely introduced elastomeric impression material after repeated pours at different time intervals.

Materials and methods: In the present study a total of 20 (10 + 10) impressions of master model were made from vinyl polyether silicone and vinyl polysiloxane impression material. Each impression was repeatedly poured at 1, 24 hours and 14 days. Therefore, a total of 60 casts were obtained. Casts obtained were scanned with three-dimensional (3D) laser scanner and measurements were done.

Results: Vinyl polyether silicone produced overall undersized dies, with greatest change being 0.14% only after 14 days. Vinyl polysiloxane produced smaller dies after 1 and 24 hours and larger dies after 14 days, differing from master model by only 0.07% for the smallest die and to 0.02% for the largest die.

Conclusion: All the deviations measured from the master model with both the impression materials were within a clinically acceptable range.

Clinical significance: In a typical fixed prosthodontic treatment accuracy of prosthesis is critical as it determines the success, failure and the prognosis of treatment including abutments. This is mainly dependent upon fit of prosthesis which in turn is dependent on dimensional accuracy of dies, poured from elastomeric impressions.

Keywords: Accuracy, Elastomers, Repeat pours, Impression, 3D laser scanner.

How to cite this article: Pandita A, Jain T, Yadav NS, Feroz SMA, Pradeep, Diwedi A. Evaluation and Comparison of Dimensional Accuracy of Newly Introduced Elastomeric Impression Material using 3D Laser Scanners: An *in vitro* Study. J Contemp Dent Pract 2013;14(2):265-268.

Source of support: Nil

Conflict of interest: None declared

INTRODUCTION

Impression is the most important procedural step in dentistry which will impress not only the professionals but also the patient by accurate replacement of dento-orofacial structures. One of the most critical aspects of dentistry is the accuracy of the fit of the crowns or bridges or any other prosthesis. To achieve this accuracy, precision must be maintained from the impression to the casting procedure. The accurate replication of tooth preparation and their arch position requires impression materials with no distortion.

The elastomeric impression materials have certain advantages. One being able to repeatedly pour the impression which led to their increased usage in the field of dentistry. New generation of elastomeric impression materials vinyl polyether silicone have been introduced. These elastomeric impression materials are combination of polyether and vinyl polysiloxane. These materials have intrinsic hydrophilicity. They have reported to be most accurate in dimensional stability; surface reproduction and impressions can be poured repeatedly.

Dimensional accuracy of impression with repeat pours is of interest clinically, because duplicate models are desired. Studies have shown that second poured dies deviated more from the master die than the first poured die and introduction of new impression materials makes continuing research on this subject even more necessary.[1]

So, the present study was intended to evaluate and compare the dimensional accuracy as well as dimensional accuracy after repeated pours of recently introduced vinyl polyether silicone and commonly used vinyl polysiloxane elastomeric impression materials using three-dimensional (3D) laser scanners.

MATERIALS AND METHODS

Preparation of the Master Model

In the present study full arch-shaped master model was used as this configuration would be more clinically relevant in the evaluation of an impression material. A maxillary dentulous model with typodont teeth was modified by removing the right central incisor, right first molar and left first molar and replaced by extracted natural teeth. Reference marks were engraved on the orthodontic bands with industrial lasers and were cemented on to the flattened occlusal surface of natural teeth which served as reference mark for accurate measurements.

Impression Making

A perforated metal stock tray was used for making impressions. A total of 20 (10 + 10) impressions were obtained for both the impression materials using putty-wash 2 step technique with 2 mm relief. On the stock tray, tray adhesive supplied by the impression material manufacturer was thinly and evenly applied over the inner surface of the tray and extending approximately 2 mm on the outer surface along the periphery of the tray. The adhesive was allowed to dry before the impressions were made. A 2 mm thick vacuum formed plastic (Bioplast) was adapted to the stone cast by using sta-vacuum former machine to provide a uniform 2 mm space for the wash impression material. The elastomeric impression materials were proportioned and mixed according to the manufacturers specifications. The putty impression was initially made on the master model with the spacer placed on the tooth and it was allowed to set for 10 minutes. Spacer was removed and excess material was trimmed from the impression and sluiceways 2 mm wide in predetermined locations to extend alongside and around each preparation were made with a scalpel to allow the low-viscosity material to flow. Standardized amount of wash material was added to the putty impressions and each impression was reseated until firm contact was made within the periphery of the tray. The trays were held for 12 minutes from the starting of mixing, and the final impressions were allowed to set on the master model. The manufacturers setting time was doubled to compensate for impression fabrication at room temperature instead of the mouth temperature. All impressions were stored at room temperature, 25°C. After 1 hour, 24 hours and 14 days, these impressions were repeatedly poured with high strength stone (Type IV, Kalrock).[2]

Testing of Samples for Dimensional Accuracy Using 3D Laser Scanner

The stone master casts were digitized with the laser scanner to produce an image of the casts. Images from the digitizer were processed with special software 3D Scan Surf (Scan surf 3D Digital Corporation CT) into a 3D meshwork image of the casts (Fig. 1). The images of the casts were then exported to the 3D Surface Viewer software. The image of the master die was superimposed with one of the images of the casts made from the impression. This was repeated for all 24 casts poured up in the vinyl polyether silicone impression material, and all the 24 casts poured up in the polyvinyl siloxane impression material. The difference between the reference points was calculated.[3]

RESULTS

In analyzing the results of the variables considered in the present research work the following statistical method were applied: Descriptive statistics, one-way ANOVA Scheffe post hoc test. All the statistical methods were carried out through the SPSS for Windows (version 16.0).

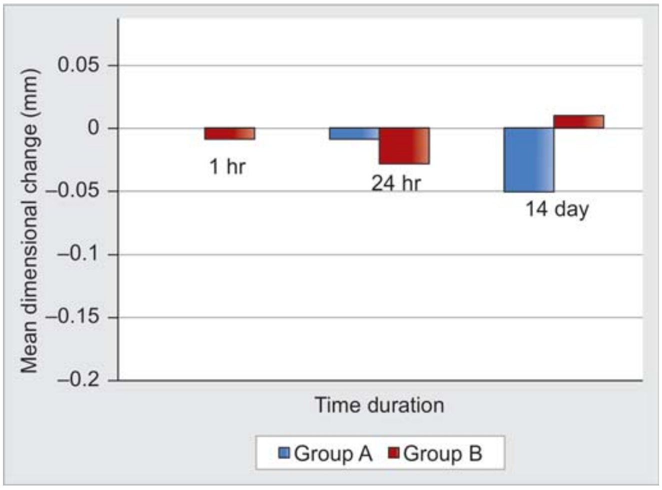
In the present study casts made from vinyl polyether silicone impressions at 1 hour, 24 hours and 14 days of interval showed deviation of 0.02, 0.05 and 0.14% respectively (Graph 1). Also the casts made from vinyl polysiloxane impressions at 1 and 24 hours of interval showed deviation of 0.04 and 0.07% (Graph 2). But after 14 days there was deviation of 0.02% from the master model (Graph 3).

DISCUSSION

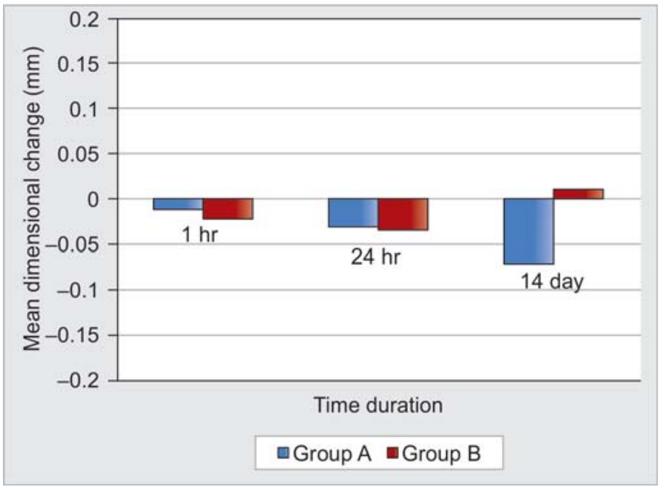
Reasons for distortion could be continued polymerization of impressions leading to shrinkage. Also, as vinyl polyether silicone contains polyether group, there could be absorption of water and leaching out of water soluble plasticizers; thus, leading to further shrinkage of impressions. In case of vinyl polysiloxane impressions after 1 and 24 hours, deviation of the casts from the master model could be due to continued polymerization shrinkage and after 14 days there is slight expansion because putty material is more viscous form of elastomers which shows slightly greater stress relaxation than fluid materials.[4] Studies have also shown that there are stresses generated by retrieval of multiple pours from a stiff-putty system.[5] Tray adhesive was not in as close proximity to the surface of the abutment as in a custom tray. Therefore, it can be said that impression setting contraction was not influenced by adhesive layer restriction. This could cause a decrease in horizontal mould space and thus producing undersized dies.[6]

In the present study putty consistency was used with vinyl polysiloxane and heavy body with vinyl polyether silicone. Therefore, putty being more viscous will have greater stress relaxation. This could be the reason for slight expansion of vinyl polysiloxane after 14th day pour as compared with the vinyl polyether silicone.

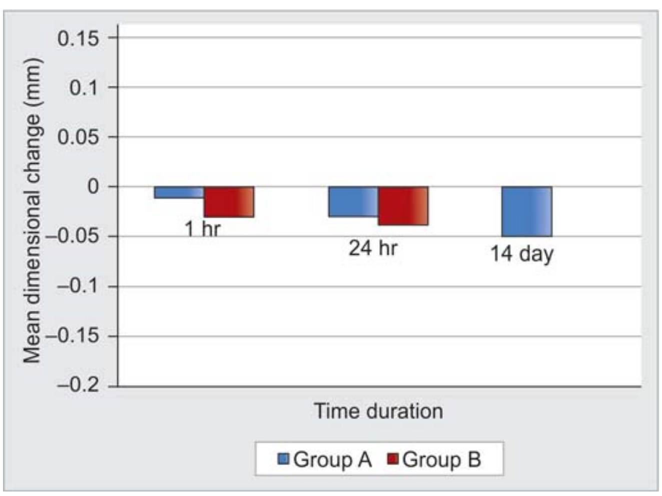
Also, undercuts in the master model were not blocked prior making impressions. Similar findings were reported with Johnson and Craig who concluded that the dies with



Graph 1: Comparison of mean cross arch dimensional of vinyl polyether silicone (group A) and vinyl polysiloxane (group B) impression materials at various time intervals



Graph 2: Comparison of anteroposterior (AB) dimensional change of vinyl polyether silicone (group A) and vinyl polysiloxane (group B) impression materials at various time intervals



Graph 3: Comparison of mean anteroposterior (CA) dimensional change of vinyl polyether silicone (group A) and vinyl polysiloxane (group B) impression materials at various time intervals

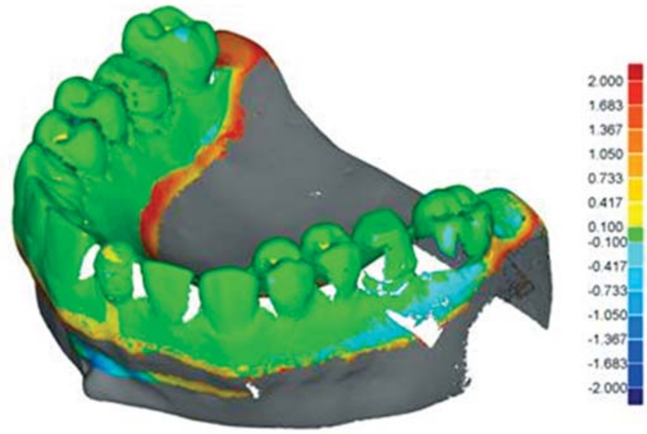


Fig. 1: 3D comparison

undercut were smaller than the standard, because the impression material was compressed in this region on removal, which resulted in permanent deformation of the material. They also concluded that vinyl polysiloxane appear to exhibit better recovery in such situations than do polyether impression materials.[7]

Setting expansion of the die material is shown to be of importance, but should be approximately similar in all cases. This was controlled by standardized pouring procedure, W/P ratio, mixing and amount of material.[8]

In clinical practice, the die should ideally be of the same dimension as of the preparation. But there are no standards for increasing die size over any time period and there is no standard for maximum inaccuracy for clinical acceptability. Impressions producing dies which are larger than the original preparation will subsequently produce castings which slip over the preparation easily, but they will exhibit greater margin openings due to concurrent shortening of the dies. Provision of small occlusal relief on the dies may be useful when constructing crowns on such dies whose diameters are increased by repeated pouring of the impression, since, such relief may compensate for shortening of the die. Dies which are produced from impressions which get smaller with time are not likely to produce crowns which fit acceptably unless compensation is made in other aspects of the casting procedure.[5]

Since, this study only examined the dimensional changes of an impression material and obviously does not incorporate all the variables involved in the process of constructing a casting, it cannot be deduced that the larger die production by vinyl polysiloxane would necessarily produce a better fitting casting than smaller die produced by vinyl polyether silicone.[9]

A study was done to assess the dimensional stability of eight impression materials over 12 weeks relevant to *in vitro* tribology studies. It was concluded that addition silicone and polyether impression materials tested in this study met the manufacturers' claim being dimensionally stable up to 2 weeks.[10]

In the present study 3D laser scanners were used to assess dimensional accuracy of models. Manual measuring devices are easy to use and readily available but are time consuming to use, permit error due to operator fatigue, and do not account for the dimensional changes that exist along a 3D surface.[11]

The properties of impression material in the clinical situation still differ from the laboratory testing conditions. Further investigations should incorporate more closely simulated clinical conditions.

CONCLUSION

According to ADA specification no.19 recommendations, a maximum negative change in dimension to be 0.50% after a minimum of 24 hours. All the deviations measured from the master model with both the impression materials were within a clinically acceptable range. Hence, it can be concluded that, because of excellent dimensional stability, both impression materials can be repeatedly poured for 2 weeks as there is no significant dimensional change overall.

Thus, elastomeric impression materials have established themselves as elastic impression materials that are capable of producing accurate dies with an excellent replication of surface detail.

CLINICAL SIGNIFICANCE

In a typical fixed prosthodontic treatment accuracy of prosthesis is critical as it determines the success, failure and the prognosis of treatment including abutments. This is mainly dependent upon fit of prosthesis which in turn is dependent on dimensional accuracy of dies, poured from elastomeric impressions.

REFERENCES

1. Luebke RJ, Scandrett FR, Kerber PE. The effect of delayed and second pours on elastomeric impression material accuracy. J Prosthet Dent 1979;41:517-20.
2. Piwowarczyk A, Ottl P, Büchler A, Lauer HC, Hoffmann A. In vitro study on the dimensional accuracy of selected materials for monophase elastic impression making. Int J Prosthodont 2002;15:168-74.
3. Shah S, Sundaram G, Bartlett D, Sherriff M. The use of a 3D laser scanner using superimpositional software to assess the accuracy of impression techniques. J Dent 2004; 32: 653-58.
4. Salem NS, Watts DC, Combe EC. Stress relaxation properties of elastomers. Dent Mater 1987;3:37-39.
5. Lacy AM, Bellman T, Fukui H, Jendresen MD. The time dependent accuracy of elastomeric impression material part II (condensation silicone). J Prosthet Dent 1981;45:329-33.
6. Boulton JL, Gage JP, Vicent PF, Basford KE. A laboratory study of dimensional changes for elastomeric impression materials for using in custom and stock trays. Aust Dent J 1996;41(6):398-404.
7. Idris B, Houston F, Claffey N. Comparison of the dimensional accuracy of one- and two-step techniques with the use of putty/wash addition silicone impression materials. J Prosthet Dent 1995;74:535-41.
8. Odman PA, Jernt TM. Accuracy of impression materials in a semiclinical model. Dent Mater 1988;4:64-67.
9. Marcinak CF, Draughn RA. Linear dimensional change in addition silicone impression material. J Prosthet Dent 1982;47:411-13.
10. Rodriguez JM, Bartlett DW. The dimensional stability of impression materials and its effect on in vitro tooth wear studies. Dent Mater 2011;27:253-58.
11. Tjhan AH, Whang SB, Tjan AH, Sarkissian R. Clinically oriented evaluation of accuracy of commonly used impression material. J Prosthet Dent 1986;53:784-90.

ABOUT THE AUTHORS

Amrita Pandita

Senior Lecturer, Department of Prosthodontics, Saraswati-Dhanwantari Dental College, Parbhani, Maharashtra, India

Teerthesh Jain (Corresponding Author)

Senior Lecturer, Department of Prosthodontics, People's Dental Academy, Bhopal, Madhya Pradesh, India, Phone: 9713392289 e-mail: dr.teerthesh.jain@gmail.com

Naveen S Yadav

Professor, Department of Prosthodontics, People's Dental Academy Bhopal, Madhya Pradesh, India

SMA Feroz

Senior Lecturer, Department of Prosthodontics, People's Dental Academy, Bhopal, Madhya Pradesh, India

Pradeep

Professor, Department of Prosthodontics, Manipal College of Dental Science, Manipal, Karnataka, India

Akankasha Diwedi

Postgraduate Student, Department of Prosthodontics, People's Dental Academy, Bhopal, Madhya Pradesh, India