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Accuracy of angulated implant position transfer by two types of impression trays using splinted open tray technique

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Abstract

Background and Objectives: Accurate impression taking is a prerequisite for achieving passive fit between the implant and superstructure. This study sought to assess the accuracy of impressions taken from 15° and 25° angulated implants by two plastic and metal stock trays using the splinted open tray technique. Materials and Methods: This in vitro experimental study was conducted on 20 gypsum casts. An acrylic model was fabricated with a first premolar to first premolar edentulous area and second premolar and first, second and third molar teeth present in both sides. Two implants were placed vertically at the site of lateral incisors. At the site of first premolars, one implant with 15° angulation and another one with 25° angulation relative to the midline were inserted. Ten plastic and 10 metal stock trays were used for open tray impression taking with addition silicon impression material at the site of copings. Casts were poured and coded. Measurements were made using coordinate measuring machine (CMM). The data were analyzed using t-test (for normally distributed data) and non-parametric tests (for non-normally distributed data).

Results: The A1 distance was 7.253±0.053mm in plastic and 7.249±0.42mm in metal tray group. These values were 9.807±0.026mm and 9.802±0.009mm, respectively for A2, 34.483±0.132 and 34.462±0.112, respectively for A3, 28.210±0.1332 and 28.193±0.011, respectively for A4 and 52.709±0.032 and 52.717±0.041, respectively for A5. These differences were not statistically significant (P>0.05).

Conclusion: Both plastic and metal stock trays are accurate for position transfer of parallel and angulated implants in splinted open tray technique.

Keywords: dental implants, splinted open tray technique, metal and plastic stock trays, impression accuracy

Introduction

Passive fit of implant prosthesis is a prerequisite for osseointegration.[1,2] In contrast to natural teeth, dental implants do not benefit from the cushioning effect of periodontal fibers and thus, they cannot well adapt to the superstructure. Misfit of implant prosthesis causes strain in components and eventually leads to biological and mechanical complications.[3,4] Thus, precise and strict prosthetic processes are required to achieve passive fit. Precise impression taking is a fundamental step in this process. Conventionally, both open tray and closed tray techniques are used for implant impression taking.[5] Regarding the open tray technique, several studies have compared the accuracy of splinted and non-splinted impression copings.[6] Some studies did not find a significant difference between the two techniques[7,8] while most studies supported the use of splinted technique.[9–11] The accuracy of implant cast depends on the type of impression material, implant impression technique, implant angulation, type of connection and accuracy of model and die material.[12] Incorrect angulation of implants may be corrected with prosthetic restoration; however, non-parallel implants and presence of undercuts create an unfavorable path of insertion, which can cause distortion of impression material during removal and yield an inaccurate master cast, especially in cases with multiple implants.[13] Several studies have shown that divergent or convergent implants adversely affect the accuracy of impressions compared to parallel implants.[11–15] However, some studies did not find a correlation between accuracy of impressions and angulation of implants.[16,17] Dimensional changes are mainly due to the shrinkage of the impression material (because of polymerization reactions and production of volatile byproducts), load applied during impression taking, technique of impression and type of impression material. Type of impression tray also affects the impression accuracy especially in cases with angulated implants.[18] Implant impressions are taken using stock trays, which are available in metal and plastic forms and special trays, which are custom-made for each patient. The hardness of plastic stock trays is questionable especially when used with high-viscosity impression materials.[19] Several techniques have been recommended to achieve passive fit; however, a consensus on a unique protocol has not been reached. Impression materials and techniques have been extensively evaluated. However, studies on the effect of hardness of stock trays on the impression accuracy are scarce. Some researchers believe that by advances made in impression materials, type of tray determines the impression accuracy while some others have reported that type of tray has no effect on impression accuracy.[20] Del' Acqua et al.[19] in 2012 showed that metal stock trays had higher hardness and yielded more favorable results for taking implant impressions with high-viscosity impression material compared to plastic stock trays.[19] Damodara et al, in 2010 found no significant difference in linear measurements made on casts fabricated using different trays.[21] This study sought to assess the accuracy of impressions taken from 15° and 25° angulated implants by two plastic and metal stock trays using the splinted open tray technique. The null hypothesis was that the type of stock tray would have no significant effect on the impression accuracy of angulated implants.

Materials and methods

An epoxy resin model (Moravia, Boyman Boya) with an edentulous area from the first premolar to first premolar teeth and second premolar and first, second and third molar teeth present in both sides was fabricated. Four parallel holes, 4.5mm in diameter and 12mm in length, were drilled in the first premolar and lateral incisor sites of the model using a milling machine (K9, Kavo, Berlin, Germany). Branemark system implants (TMMK IV TiUnite, Nobel Biocare, Gothenburg, Sweden) were placed in drilled holes using a surveyor and fixed in place using auto-polymerizing acrylic resin (Acropars, Marlic Co., Tehran, Iran); 1 mm of the implant platform remained out of the acrylic resin. The implants were inserted vertically at the site of lateral incisors. At the site of first premolars, one implant with 15° angulation and another one with 25° angulation were placed. Plastic and metal stock trays were chosen for taking impressions with addition silicon impression material (Figure 1).

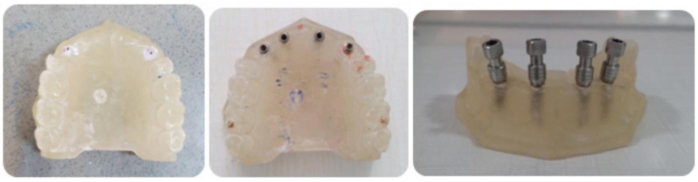

Figure 1 The sequence of fabrication of standard model.

Figure 2 Metal and plastic trays.

Figure 3 Splinting of impression copings.

Ten plastic stock trays (Morelli plastic stock tray no. 7, Dental Morelli Ltda) and 10 metal stock trays (Tecnodent metal stock tray no. I-4, Tecnodent Indústriae Comércio Ltda) were used. Four holes were created in the stock trays to allow access to the coping screws for the splinted impression technique (Figures 2) (Figure 3). The fitting surfaces of all implant components were cleaned with isopropyl alcohol before each connection procedure. Correct seating of the impression copings was verified visually and by use of a probe (no. 5, Duflex, SS White) throughout the impression and pouring procedures.

For open tray impressions, a 7 mm hole was made at the site of each implant. One-step putty/wash technique was used for impression taking in all the samples according to the manufacturer's instructions (Panasil; Kettenbach Dental, Eschenburg, Germany). The stock trays were painted with polyvinyl siloxane adhesive (VPS Tray Adhesive; 3M ESPE, Seefeld, Germany) 15 minutes prior to impression taking. Tray adhesive for polyvinyl siloxane (3M/ESPE) was applied only on the plastic stock trays, because the metal stock tray had enough holes to retain the impression material.[19] The impression/model set was immersed in distilled water at 36°C±1°C during polymerization while a standard 5 kg weight was placed over the tray. After five minutes, the impression was separated from the model. A direct impression of each model was made using the impression coping from its corresponding implant system. All the abutment analogs (held with a hemostatic forceps) were then fit to the impression copings using 10 Ncm torque. This procedure was performed for the purpose of standardization. The impression copings were fastened on the implants with 10Ncm torque, as recommended by Vigolo et al.,[22] and Inturregui et al.[23] Once the impression was taken, the guide pins were loosened and the tray was separated from the model. The implant analogs were fitted to the impression copings and the guide pins were tightened using 10Ncm torque. A total of 20 impressions, consisting of 10 open-tray with plastic stock trays and 10 with metal stock trays were made. After 60minutes, the impressions were boxed and poured with type IV die stone (Herostone, Vigodent Inc, Rio de Janeiro, Brazil) with a powder-to-water ratio of 30g/7mL, according to the manufacturer's instructions. After 120minutes, the impressions were removed from the stone casts. After setting, the casts were trimmed and coded. Five distances were measured on 20 casts as follows (Figure 4):

A1: Distance between the most anterior and most posterior analogs

A2: Distance between the internal margins of right and left anterior analogs

A3: Distance between the external margins of right and left posterior analogs

A4: Distance between the internal margins of right and left posterior analogs

A5: Distance between the distobuccal cusps of right and left molars

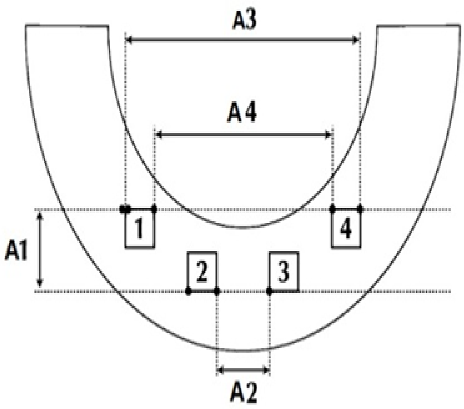

Figure 4 schematic views of measured distances.

The three-dimensional position of the implant and the implant analog heads in x, y, and z axes were evaluated using a CMM (Cyclone II, Renishaw, Gloucestershire, UK) with an accuracy of 2.8µm. All measurements were made by a single calibrated operator blinded to the impression technique used. For each master model, the local coordinate axes were defined with several probe hits on each of the exposed vertical and horizontal surfaces. The respective stone surfaces on the cast models were also used to define the local coordinate axes. Placement of the machine probe in contact with several points on the platform of each implant on the reference models and each implant analog on the casts yielded an imaginary plane. A circle was drawn on this plane, and its center was defined, which allowed determination and recording of the three-dimensional position of the center of each implant or implant analog aperture (Figure 2). Each experimental cast was measured three times (the mean value was recorded), and the distances from the reference point on the center of the superior surface were compared with the master model (Figure 5). The data were collected and analyzed using t-test for normally distributed data and non-parametric tests for non-normally distributed data.

Figure 5 Cast fabrication and measurements.

Results

This study was conducted on two types of plastic and metal stock trays, 20 casts and four implants. A1, A2, A3, A4 and A5 distances were measured. According to the independent t-test, the measured A1 distance was 7.245±0.053mm in plastic tray and 7.249±0.042mm in the metal tray technique. The measured A2 distance was 9.807±0.026mm in plastic tray and 9.802±0.009mm in the metal tray technique. The measured A3 distance was 34.483±0.132mm in plastic tray and 34.462±0.112mm in the metal tray technique. The measured A4 distance was 28.21±0.132mm in plastic tray and 28.193±0.11mm in the metal tray technique and 52.709±0.032 and 52.717±0.041, respectively for A5. The actual distances on the acrylic model were as follows:

A1=7.245, A2=9.806, A3=34.487, A4=28.204 and A5=52.658. According to independent t-test, the mean change in A1 distance was 0.017mm by use of plastic tray and 0.135mm by use of metal tray (P=0.863). The mean change in A2 distance was 0.008 by use of plastic tray and 0.003 by use of metal tray (P=0.608). The mean change in A3 distance was 0.041mm by use of plastic tray and 0.035mm by use of metal tray (P=0.608). The mean change in A4 distance was 0.041mm by use of plastic tray and 0.035mm by use of metal tray (P=0.653). and the mean change in A5 distance was 0.01mm by use of plastic tray and 0.013mm by use of metal tray (P=0.641). Results of t-test indicated that these differences were not statistically significant (P>0.05). A summary of the results is given in Table 1.

Table 1 The mean dimensinal change values (σf) with 95% confidence interval

Group	Distance	Mean SD (mm)	Minimum (mm)	Maximum (mm)	P_ value
A1	Plastic trays (n=10)	7.253	7.156	7.308	0.863
	Metal trays (n=10)	9.807	9.762	9.865	
A2	Plastic trays (n=10)	34.48	34.4	34.84	0.608
	Metal trays (n=10)	28.21	28.13	28.57	
A3	Plastic trays (n=10)	52.7	52.64	52.76	0.608
	Metal trays (n=10)	7.249	7.167	7.313	
A4	Plastic trays (n=10)	9.802	9.787	9.822	0.653
	Metal trays (n=10)	34.46	34.4	34.77	
A5	Plastic trays	28.19	28.13	28.13	0.641
	Metal trays	52.71	52.63	52.76	

Discussion

Trays are divided into two groups of custom trays, which are made specifically for each patient and stock trays, which are available in different sizes and are made of plastic or metal.[19] Considering the extra time and cost of fabrication of custom trays, dentists prefer to use stock trays because they are easy to use and yield optimal results.[22] The obtained results confirmed the null hypothesis of this study. The results showed that both plastic and metal stock trays were suitable for taking impressions from parallel and angulated implants with polyvinyl siloxane impression material. The plastic and metal trays had similar accuracy. In contrast to the current study, Del' acqua et al.,[19] reported that the metal stock tray was more suitable for taking impressions from implants with high-viscosity impression material and yielded results superior to those of plastic stock trays. Such a difference in the results may be due to differences in the methodology of the two studies.[19] According to a systematic review in 2014, splinted impression technique was reported to be more accurate for partially and fully edentulous patients. The open tray technique was more accurate than the closed tray technique in fully edentulous patients.[24,25] It should be noted that favorable results depend on the type of stock tray. Masri et al.,[26] discussed that high viscosity impression materials have low flow, and decreased fluidity causes accumulation of stress when prefilled tray is placed on dental arch. If the tray is not hard enough, such stresses can cause distortion of plastic tray. When seated prefilled, plastic stock trays are susceptible to flexure and distortion.

Thus, plastic trays should not be used with high-viscosity impression materials.[27]

Cho &Chee[27] concluded that metal stock trays do not cause significant dimensional changes but plastic trays may cause significant dimensional alternations. Such a distortion is due to the flexibility of plastic trays. Thongthammachat et al. evaluated the effect of type of tray, impression material and time on dimensional accuracy of dental casts. They concluded that both plastic and metal stock and custom-made trays might yield accurate casts when impression materials with appropriate viscosity are used. In other words, type of tray had no significant effect on dimensional stability.[28] Based on the results of the current study, no significant difference was found in the accuracy of impressions taken with metal and plastic stock trays in splinted open tray technique. Damadaro et al.,[21] in a randomized clinical trial compared diagnostic casts in two groups of A and B. Group A included diagnostic casts of irreversible hydrocolloid impression material with perforated metal, perforated plastic and semi-rigid plastic trays. Group B included casts of polyvinyl siloxane impression material and custom-trays as the control group. They found significant differences in linear measurements made on casts between the two groups. They recommended taking diagnostic impressions using semi-rigid plastic trays instead of perforated metal trays.[21] According to a systematic review in 2014, implant impression accuracy was similar by use of polyether and polyvinyl siloxane impression materials.[24] Since type of impression material significantly affects the impression accuracy, we used polyvinyl siloxane elastomeric impression material. According to a systematic review in 2014, implant angulation >20° significantly affected the implant impression accuracy.[24] In the current study, impression accuracy in vertical, 15° and 25° angulated implants was equal in use of both plastic and metal trays in splinted open tray impression technique. Plastic and metal trays along with implants placed in three different angulations were used in this study. The CMM was used for measurements in the three dimensions, which is highly accurate. No significant differences were found between plastic and metal trays and implants placed in three angulations in terms of accuracy of impressions. Different methodologies of studies, design of experimental models, measured distances relative to reference points and impression technique complicate accurate comparison of the results of different studies. In vivo studies are required to increase the generalizability of the results to the clinical setting and find the most accurate, simple impression technique for dental implants.

Conclusion

Within the limitations of this study, the results showed no significant difference in the accuracy of impressions taken using plastic and metal stock trays with polyvinyl siloxane impression material. Thus, both plastic and metal stock trays are accurate for position transfer of parallel and angulated implants in splinted open tray technique.

Acknowledgments

None.

Conflict of interest

The author declares that there is no conflict of interest.

References

1. Guichet DL, Caputo AA, Choi H, et al. Passivity of fit and marginal opening in screw- or cement-retained implant fixed partial denture designs. *Int J Oral Maxillofac Implants*. 2000;15(2):239–246.
2. Karl M, Taylor TD, Wichmann MG, et al. *In vivo* stress behavior in cemented and screw-retained five-unit implant FPDs. *J Prosthodont*. 2006;15(1):20–24.
3. Jemt T. *In vivo* measurements of precision of fit involving implant-supported prostheses in the edentulous jaw. *Int J Oral Maxillofac Implants*. 1996;11(2):151–158.
4. Jemt T, Rubenstein JE, Carlsson L, et al. Measuring fit at the implant prosthodontic interface. J Prosthet Dent. 1996;75(3):314–325.
5. Nakhaei M, Madani AS, Moraditalab A, et al. Three-dimensional accuracy of different impression techniques for dental implants. Dent Res J (Isfahan). 2015;12(5):431–437.
6. Alexander Hazboun GB, Masri R, Romberg E, et al. Effect of implant angulation and impression technique on impressions of NobelActive implants. *J Prosthet Dent*. 2015;113(5):425–431.
7. Herbst D, Nel JC, Driessen CH, et al. Evaluation of impression accuracy for osseointegrated implant supported superstructures. *J Prosthet Dent*. 2000;83(5):555–561.
8. Choi JH, Lim YJ, Yim SH, et al. Evaluation of the accuracy of implant-level impression techniques for internal-connection implant prostheses in parallel and divergent models. *Int J Oral Maxillofac Implants*. 2007;22(5):761–768.
9. Naconecy MM, Teixeira ER, Shinkai RS, et al. Evaluation of the accuracy of 3 transfer techniques for implant-supported prostheses with multiple abutments. *Int J Oral Maxillofac Implants*. 2004;19(2):192–198.
10. Cabral LM, Guedes CG. Comparative analysis of 4 impression techniques for implants. *Implant Dent*. 2007;16(2):187–194.
11. Filho HG, Mazaro JV, Vedovatto E, et al. Accuracy of impression techniques for implants. Part 2- comparison of splinting techniques. *J Prosthodont*. 2009;18(2):172–6.
12. Wee AG. Comparison of impression materials for direct multi-implant impressions. *J Prosthet Dent*. 2000;83(3):323–331.
13. Jörgensen KD. A new method of recording the elastic recovery of dental impression materials. *Scand J Dent Res*. 1976;84(3):175–182.
14. Assuncao WG, Filho HG, Zaniquelli O. Evaluation of transfer impressions for osseointegrated implants at various angulations. *Implant Dent*. 2004;13(4):358–366.
15. Mpikos P, Kafantaris N, Tortopidis D, et al. The effect of impression technique and implant angulation on the impression accuracy of external- and internal-connection implants. *Int J Oral Maxillofac Implants*. 2012;27(6):1422–1428.
16. Conrad HJ, Pesun IJ, DeLong R, et al. Accuracy of two impression techniques with angulated implants. *J Prosthet Dent*. 2007;97(6):349–356.
17. Carr AB. Comparison of impression techniques for a two-implant 15-degree divergent model. *Int J Oral Maxillofac Implants*. 1992;7(4):468–75.
18. Seyedan K, Sazegara H, Kalalipour M. Dimensional Accuracy of Polyether and Poly Vinyl Siloxane Materials for Different Implant Impression Technique. *Research J of Applied Sciences*. 2008;3(3):257–263.
19. Del'acqua MA, de Avila ÉD, Amaral ÂL, et al. Comparison of the accuracy of plastic and metal stock trays for implant impressions. *Int J Oral Maxillofac Implants*. 2012;27(3):544–5550.
20. Choi JH, Lim YJ, Yim SH, et al. Evaluation of the accuracy of implant-level impression techniques for internal-connection implant prostheses in parallel and divergent models. I*nt J Oral Maxillofac Implants*. 2007;22(5):761–768.
21. Damodara EK, Litaker MS, Rahemtulla F, et al. A randomized clinical trial to compare diagnostic casts made using plastic and metal trays. *J Prosthet Dent*. 2010;104(6):364–371.
22. Vigolo P, Majzoub Z, Cordioli G. *In vitro* comparison of master

cast accuracy for single-tooth implant replacement. *J Prosthet Dent*. 2000;83:562−566.

23. Inturregui JA, Aquilino SA, Ryther JS, et al. Evaluation of three impression techniques for osseointegrated oral implants. *J Prosthet Dent*. 1993;69(5):503−509.
24. Papaspyridakos P, Chen CJ, Gallucci GO, et al. Accuracy of implant impressions for partially and completely edentulous patients: a systematic review. *Int J Oral Maxillofac Implants*. 2014;29(4):836−845.
25. Christensen GJ. Now is the time to change to custom impression trays. *J Am Dent Assoc.* 1994;125(5):619−620.
26. Masri R, Driscoll CF, Burkhardt J, et al. Pressure generated on a simulated oral analog by impression materials in custom trays of different designs. *J Prosthodont*. 2002;11(3):155−160.
27. Cho GC, Chee WW. Distortion of disposable plastic stock trays when used with putty vinyl polysiloxane impression materials. *J Prosthet Dent*. 2004;92(4):354−358.
28. Thongthammachat S, Moore BK, Barco MT, et al. Dimensional accuracy of dental casts: influence of tray material, impression material, and time. *J Prosthodont*. 2002;11(2):98−108.

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