ACP
AMERICAN COLLEGE OF PROSTHODONTISTS®

Accuracy of Impression Techniques for Impants. Part 2 – Comparison of Splinting Techniques

Humberto Gennari Filho, DDS, MS, PhD,[1] José Vitor Quinelli Mazaro, DDS, MS,[2] Eduardo Vedovatto, DDS, MS,[2] Wirley Gonçalves Assunção, DDS, MS, PhD,[3] & Paulo Henrique dos Santos, DDS, MS, PhD[3]

[1]Chairman, Professor, Department of Dental Materials and Prostheses, School of Dentistry at Aracatuba, São Paulo State University, São Paulo, Brazil
[2]Postgraduate Student with major in Dental Prostheses, School of Dentistry at Araçatuba, São Paulo State University, São Paulo, Brazil
[3]Assistant Professor, Department of Dental Materials and Prostheses, School of Dentistry at Aracatuba, São Paulo State University, São Paulo, Brazil

Keywords
Dental implants; prosthesis; impression technique.

Correspondence
Humberto Gennari Filho, Department of Dental Materials and Prostheses, School of Dentistry at Aracatuba, Sao Paulo State University (UNESP), José Bonifácio Street–No. 1193, Vila Mendonça, CEP 16015–050, Araçatuba, São Paulo, Brazil. E-mail: gennari@foa.unesp.br

Accepted May 21, 2007

doi: 10.1111/j.1532-849X.2008.00325.x

Abstract

Purpose: The aim of this study was to compare splinting techniques for impression copings of osseointegrated implants with different angulations.
Materials and Methods: Replicas ($N = 24$) of a metal matrix (control) containing two implants at 90° and 65° in relation to the horizontal surface were obtained by using four impression techniques: Technique 1 (T1), direct technique with square copings without union in open trays; Technique 2 (T2), square copings splinted with dental floss and autopolymerizing acrylic resin; Technique 3 (T3),square copings splinted with dental floss and autopolymerizing acrylic resin, sectioned and splinted again with autopolymerizing acrylic resin; Technique 4 (T4), square copings splinted with prefabricated acrylic resin bar. The impression material was polyether. The replicas were individually scanned to capture the images, which were assessed in a graphic computation program. The program allowed the angulation between the bases of the replicas and the reading screws to be measured. The images of the replicas were compared with the matrix image (control), and the differences in angulations from the control image were calculated. The analysis of variance and the Tukey test for comparisons ($p < 0.05$) were used for statistical analysis.
Results: All groups showed significant differences in the implant angulations in comparison with the control group ($p < 0.05$). Group T1 showed the highest difference (1.019°) followed by groups T2 (0.747°), T3 (0.516°), and T4 (0.325°), which showed the lowest angular alteration compared to the control group. There were significant differences between inclined and straight implants in all the groups, except in group T4.
Conclusions: Based on the results, the splinting of pick-up impression copings is indicated for osseointegrated implant impressions. The square copings splinted with a prefabricated acrylic resin bar presented the best results among the pick-up impression techniques evaluated in this study.

The passive fit of an implant-retained prosthesis is an important factor in rehabilitation success. The impression's accuracy is one of the factors that can interfere in the osseointegrated implant's treatment. Transfer of the precise position of implants to a master cast is a prerequisite for accurate and passive fit of the superstructure. Inaccurate frameworks can cause stress at the implant/bone interface.[1]

According to Assif et al,[2] passive fit can be achieved by obtaining an accurate impression either with transfer impression copings or with pick-up impression copings. Many authors describe impression techniques involving different impression materials,[3,4] different prosthetic copings (conical and square),[5] and different techniques for splinting the impression copings.[6]

When procedures using direct impression with square copings are required, the method and the material of splinting techniques must be investigated. Herbst et al[7] and Humphries et al[8] found no statistically significant difference in transfer impressions using splinted or isolated copings. Spector et al[9] indicated that splinting is unnecessary once the acrylic resin used for splinting the copings suffers polymerization shrinkage, which can cause some distortion, because splinting the pick-up transfer copings can take more clinical time. However, Assif et al[2] showed that the technique using acrylic resin to splint pick-up impression copings was significantly more accurate than the unsplinted technique. Although some previous investigations showed no difference between implant impression techniques with splinted or unsplinted pick-up impression copings, these studies evaluated only transfer impression techniques on parallel implants. Carr[10] suggested that the accuracy of transferred relationships in parallel implants could not be reproduced from the nonparallel implants. Another study showed that the most favorable implant position for transfer impressions was perpendicular in relation to the horizontal surface.[5] This way, the correct splinting technique may influence the reproduction of an accurate master cast when the implants exhibit nonparallel relationships.

Thus, the purpose of this study was to compare splinting techniques for impression copings of osseointegrated implants with different angulations.

Materials and methods

For this study, a $3.5 \times 2 \times 2\text{-cm}^3$ metal matrix block was made of anodized aluminum in which two 3.75-mm diameter, 10.0-mm length implants (Conexão, Conexão Prosthesis Systems Ltda., São Paulo, Brazil) were fixed and kept at 90° and 65° angulation in relation to the horizontal matrix surface. Impression trays were customized using autopolymerizing acrylic resin (Jet, Classico Dental Products Ltd, São Paulo, Brazil), with a 3-mm undercut allowing uniform thickness to lodge the impression material. This metal matrix served as the control group.

Twenty-four impressions were made and evaluated by matching four transfer impression techniques, which are as follows: Technique 1 (T1), direct technique without connection of the square copings and open trays (Fig 1); Technique 2 (T2), square copings splinted with dental floss and autopolymerizing acrylic resin (Duralay, Reliance Dental Mfg. Co., Worth, IL) (Fig 2); Technique 3 (T3), square copings splinted with dental floss and autopolymerizing acrylic resin (Duralay), sectioned and splinted again with autopolymerizing acrylic resin (Fig 3); Technique 4 (T4), square copings splinted with prefabricated autopolymerizing acrylic resin bar (Duralay) (Fig 4). The impression material used was polyether (Impregum F, 3M ESPE Dental, Medizin, Germany), after coating its respective adhesive in the impression trays. All materials were managed according to their respective manufacturer's recommendations.

An 11 lb metal block was put over each tray during the impression procedures to standardize pressure.[5] This was enough to allow the excess material to flow out and maintain the pressure constant throughout the working time.

In all techniques, the screws of the pick-up transfer copings were removed with a screwdriver; then the impression/matrix set was separated with the help of a handle device screwed to the metal matrix base. After the impression, implant analogs were adapted and screwed into the copings, which remained inside the impression in all techniques. After 60 minutes, to provide matrix replicas, type IV dental stone (Herostone Vigodent, Inc., Rio de Janeiro, Brazil) was manipulated with a vacuum machine, with a powder/water ratio of 30g/7ml (as recommended by the manufacturer) and then poured under constant vibration. When set (120 minutes after pouring), the impression was separated from the cast.

After fabrication, all replicas were randomly divided into four experimental groups according to the studied impression techniques. Each experimental group had 6 replicas, for a total of 24 replicas.

Figure 1 Technique 1: pick-up impression copings embedded in the metal matrix, without connection.

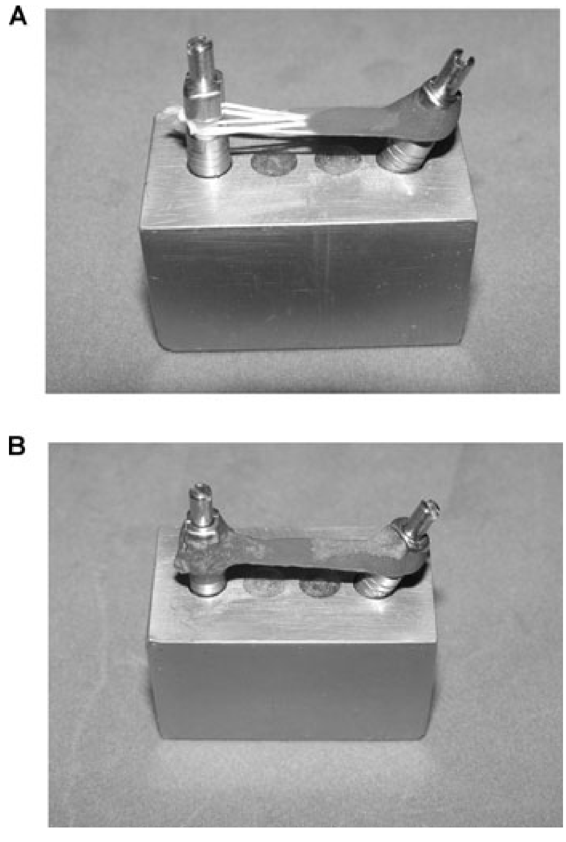

Figure 2 (A) Technique 2: framework with dental floss. (B) Technique 2: pick-up impression copings splinted with autopolymerizing acrylic resin.

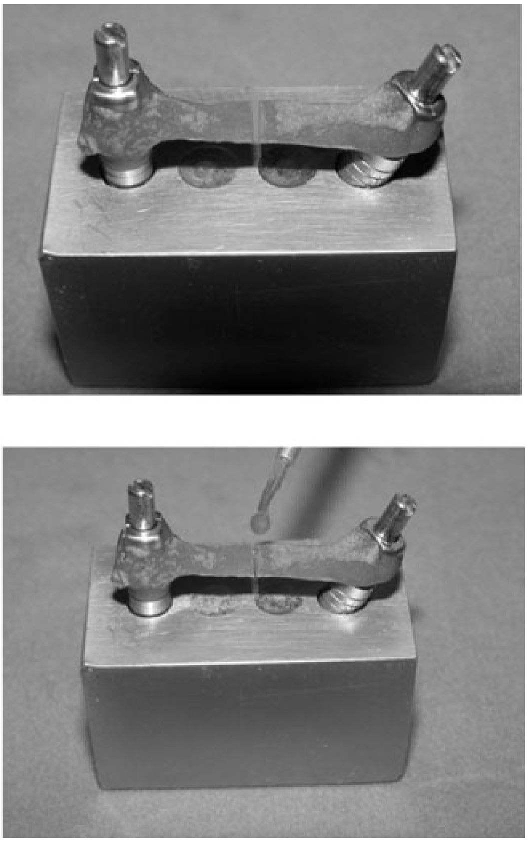

Figure 3 (A) Technique 3: sectioned bar. (B) Technique 3: connection with Duralay acrylic resin.

Measurements

After obtaining the specimens, possible changes in the angulation of the implant analogs were assessed through the use of AutoCad software (AutoCad 2000, Autodesk, Inc, San Rafael, CA) and were compared with the control specimen.

Previously, reading screws were screwed into the replicas (Fig 5) and matrix analogs to allow the axis extension of the analog to be visualized relating to the matrix base after the scanning procedure. The digitalization was performed individually with a scanner (SCAN JET 6100C, Hewlett Packard Company, Palo Alto, CA). The standard scanner area of 60×55 mm^2 was used to delimit the image, with the aim of standardizing the image size and resolution (600 dpi). The images were exported to AutoCad 2000 software and submitted to the same analysis conditions. The variations in implant analog angulations were assessed using the *Angular Dimension* command of the AutoCad 2000 software, starting with the analysis of the internal angles formed between the reading screw and the horizontal surface of the matrix (Fig 6). The samples were measured three times on different days by two calibrated operators, with the objective of reducing operator error. The data were submitted to two-way analysis of variance (ANOVA) and Tukey test ($p < 0.05$).

Figure 4 Technique 4: square copings splinted with prefabricated bar.

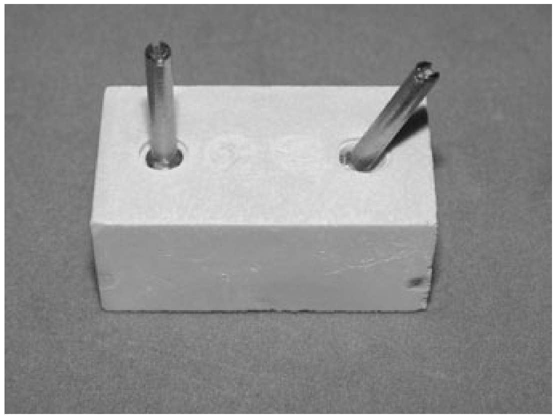

Figure 5 Replica with reading screws.

Results

The mean values of each group were described in terms of differences at a significance level of 5%.

Regarding the readings obtained from variable angulations (90° and 65°) using different impression techniques in

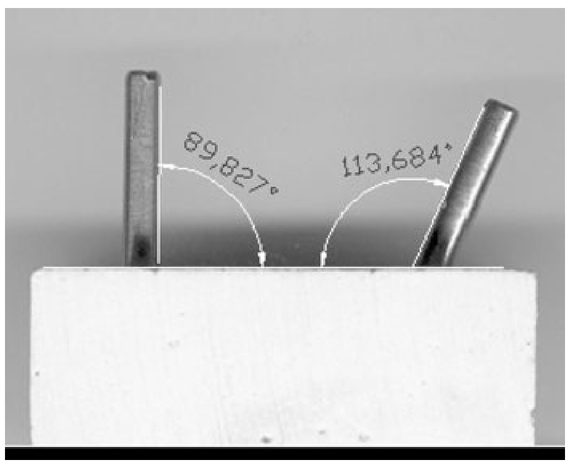

Figure 6 Angular measurements through the AutoCad software.

comparison with those of the matrix, it was observed that all impression techniques showed significant differences in the implant angulations compared with the control group ($p < 0.05$). The highest difference was obtained for T1 (1.019°), followed by T2 (0.747°). The difference was not statistically significant between these two groups. T4 showed the smallest means (0.325°) in the angulation of the implant analogs in comparison with the matrix (Table 1).

Comparing the readings obtained from variable angulations, there were significant differences ($p < 0.05$), regardless of the impression technique (Table 2). The inclined implant analogs presented higher alterations than straight implant analogs.

Table 3 illustrates the interaction between implant angulation and impression techniques. For straight implants (90°), the highest difference was obtained for T1, followed by groups T4, T3, and T2. The different angulations among these groups were not statistically significant ($p > 0.05$). When compared to the matrix, there were statistically significant differences for all groups ($p < 0.05$).

For inclined implants, T1 presented the highest differences for the matrix (1.710°), followed by T2 (1.276°). There was no statistical difference between these two techniques. The difference between T3 (0.772°) and T4 (0.331°) was not statistically significant. There was a statistically significant difference among all techniques studied when compared to the matrix ($p < 0.05$).

When the straight and inclined implants were compared to each technique type, it was observed that the inclined implants always presented higher mean values of difference in the angulation. There were statistically significant differences for all groups, except for T4, in which there were no significant differences ($p > 0.05$) in the angulation of the inclined (0.331°) and straight (0.320°) implant analogs.

Table 1 Difference in angulation among all the impression techniques, regardless of the implant inclination*

Impression technique	Difference in angulation (standard deviation)	
T1	1.019° (0.783°)	a
T2	0.747° (0.718°)	a b
T3	0.516° (0.412°)	b
T4	0.325° (0.237°)	b
Matrix (control)	0°	c

*Mean values are significantly different when followed by different letters ($p < 0.05$).

Table 2 Differences in angulation between straight (90°) and inclined (65°) implants regardless of the impression technique*

Implant position	Difference in angulation (standard deviation)	
Inclined (65°)	0.817° (0.734°)	a
Straight (90°)	0.282° (0.203°)	b

*Mean values are significantly different when followed by different letters ($p < 0.05$).

Table 3 Means (standard deviations) of the angulation and different techniques

Impression technique	Implant position					
	Straight (90°)			Inclined (65°)		
T1	0.329°	(0.187°)	A a	1.710°	(0.415°)	B a
T2	0.218°	(0.198°)	A a	1.276°	(0.651°)	B ab
T3	0.260°	(0.237°)	A a	0.772°	(0.401°)	B bc
T4	0.320°	(0.221°)	A a	0.331°	(0.272°)	A c
Matrix (control)	0°		A b	0°		A d

Means followed by different letters differ from each other at a significant level ($p < 0.05$). Capital letters indicate comparison between rows and small letters between columns.

Discussion

Nonpassive fit of a prosthesis is often a critical contributing factor in the prosthesis' failure.[11]Imprecise structure fit can have both mechanical and biological consequences resulting in complications. Fracture of implants and superstructure components, bone loss, and infectious processes can occur when the functional load is unequally distributed.[7,12] The accuracy of the master model can control and minimize the degree of imperfection in denture fabrication.[13,14] A factor that can contribute to the imprecise transfer of impression copings is a deficient splinting technique. Theoretically, this splinting technique is done to prevent the copings from becoming dislodged during impression making and during tray removal.[5]

Among the transfer impression techniques evaluated, the greatest alterations were verified when the union between transfers was not planned (T1), leaving them passive of movement, which may increase or decrease according to the material used. Many studies show that it is necessary to splint the impression copings to ensure accurate transferring of implant position during impression procedures.[5,6,15,16]

Regarding the transfer impression techniques used, T4 (square copings splinted with prefabricated acrylic resin bar) showed the best results, followed by T3. This result is in accordance with the one obtained by Dumbrigue et al,[17] in which it was observed that the use of prefabricated acrylic resin bars for splinting square copings can decrease the polymerization shrinkage of the acrylic resin and increase system stability.

The most favorable implant position for the impression transfer was the one perpendicular to the horizontal surface. Those results corroborate the findings of Assunção et al,[5] who studied transfer impressions for osseointegrated implants at various angulations and concluded that the most favorable implant position for an accurate transfer impression is when it is perpendicular to the surface (90°), while the worst results occur with more inclined implants (65°).

These factors, along with other difficulties found regarding alloy properties, investing, and casting, would be obstacles for achieving passive fit between the metal denture framework and the implant;[18,19] however, those errors can be minimized by selecting an impression transfer technique to promote smaller movement and better stabilization of the impression components.

Conclusions

Based on the results obtained, the following conclusions can be made:

(1) All replicas obtained with the impression transfer technique presented an angular difference in relation to the matrix.

(2) The angulated implants (65°) presented the highest differences in angulation when compared to the matrix.

(3) T1 (direct technique without union of the square copings and open trays) presented the highest differences in comparison to the matrix.

(4) T4 (square copings splinted with prefabricated bar) presented the best results among the impression transfer techniques evaluated.

References

1. Waskewicz GA, Ostrowski JS, Parks VJ: Photoelastic analysis of stress distribution transmitted from a fixed prosthesis attached to osseointegrated implants. Int J Oral Maxillofac Implants 1994;9:405-411
2. Assif D, Marshak B, Schimidt A: Accuracy of implant impression techniques. Intl J Oral Maxillofac Implants 1996;11:216-222
3. Lorenzoni M, Pertl C, Penkner K, et al: Comparison of the transfer precision of three different impression materials in combination with transfer caps for the Frialit-2 system. J Oral Rehabil 2000;27:629-638
4. Assif D, Fenton A, Zarb G, et al: Comparative accuracy of implant impression procedures. Int J Periodontics Restorative Dent 1992;12:112-121
5. Assunção WG, Gennari Filho H, Zaniquelli O: Evaluation of transfer impressions for osseointegrated implants at various angulations. Implant Dent 2004;13:358-366
6. Assif D, Nissan J, Varsano I, et al: Accuracy of implant splinted techniques: effect of splinting material. Int J Oral Maxillofac Implants 1999;14:885-888
7. Herbst D, Nel JC, Driessen CH, et al: Evaluation of impression accuracy for osseointegrated implant supported superstructures. J Prosthet Dent 2000;83:555-561
8. Humphries RM, Yaman P, Bloem TJ: The accuracy of implants master casts constructed from transfer impressions. Int J Oral Maxillofac Implants 1990;5:331-336
9. Spector MR, Donovan TE, Nicholls JI: An evaluation of impression techniques for osseointegrated implants. J Prosthet Dent 1990;63:444-447
10. Carr BA: Comparison of impression techniques for a two-implant 15-degree divergent model. Int J Maxillofac Implants 1992;7:468-475
11. Branemark PI: Prótesis Tejido-integrados: La Osseointegración en la Odontologia Clínica. Berlin, Quintessenz, 1987, pp. 251-257
12. Fenton AH, Assif FD, Zarb GA, et al: The accuracy of implant impression procedures. J Dent Res 1991;70:399
13. Assif D, Marshak B, Nissan J: A modified impression technique for implant-supported restoration. J Prosthet Dent 1994;71:589-591
14. Ivanhoe JR, Adrian ED, Krantz WA, et al: An impression technique for osseointegrated implants. J Prosthet Dent 1991;66:410-411
15. Daoudi MF, Setchell DJ, Searson LJ: A laboratory investigation of the repositioning impression coping technique at the implant level for single tooth implants. Eur J Prosthodont Restor Dent 2003;11:23-28
16. Vigolo P, Majzoub Z, Cordioli G: Evaluation of the accuracy of three techniques used for multiple implant abutment impressions. J Prosthet Dent 2003;89:186-192
17. Dumbrigue HB, Gurun DC, Javid NS: Prefabricated acrylic resin bars for splinting implant transfer copings. J Prosthet Dent 2000;84:108-118
18. Vigolo P, Majzoub Z, Cordioli G: In vitro comparison of master casts accuracy to single-tooth implant replacement. J Prosthet Dent 2000;83:562-566
19. Gulbransen HJ: How do you test a cast framework fit for a full-arch fixed implant-supported prosthesis? Int J Oral Maxillofac Implants 1994;9:470-474