Evaluation of Transfer Impressions for Osseointegrated Implants at Various Angulations

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The accuracy of impressions that transfer the relationship of the implant to the metal framework of the prosthesis continues to be a problem. This study was designed to evaluate the accuracy of the transfer process under variable conditions with regard to implant analog angulations, impression materials, and techniques. Replicas (n = 60) of a metal matrix (control) containing four implants at 90º, 80º, 75º, and 65º in relation to the horizontal surface were obtained by using three impression techniques: T1—indirect technique with conical copings in closed trays; T2—direct technique with square copings in open trays; and T3—square copings splinted with autopolymerizing acrylic resin; and four elastomers: "P"—polysulfide; "I"—polyether; "A"—addition silicone; and "Z"—condensation silicone. The values of the implant analog angulations were assessed by a profilometer to the nearest 0.017º, then submitted to analysis of variance for comparisons at significance of 5% ($P < .05$*). For implant analog at 90º, the material "A" associated with T2 and material "Z" with T3 behaved differently (*$P < .05$*) from all groups. At 80º, all materials behaved differently (*$P < .01$*) with T1. At 75º, when T1 was associated, materials "P" and "A" showed similar behavior, as well as materials "I" and "Z"; however, "P" and "A" were different from "I" and "Z" (*$P < .01$*). When T3 was associated, all experimental groups behaved differently among them (*$P < .01$*). At 65º, the materials "P" and "Z" behaved differently (*$P < .01$*) from the control group with T1, T2, and T3; the materials "I" and "A" behaved differently from the control group (*$P < .01$*) when T1 and T2, respectively, were associated. The more perpendicular the implant analog angulation is in relation to the horizontal surface, the more accurate the impression. The best materials were material "I" and "A" and the most satisfactory technique was technique 3. (Implant Dent 2004;13:358–366)*

Key Words: dental implants, prostheses, dental impression materials, techniques

One of the major concerns in implant-retained prostheses is with regard to the accuracy of impressions. This plays an essential role in prosthesis–implant adaptation. An accurate working cast for prosthesis components that have optimal adaptation depends on the impression material as well as the transfer techniques. Furthermore, problems related to investing, casting, alloy properties, and clinician skill should not be neglected.

According to Waskewicz et al.[1] and Lorenzoni et al.,[2] the original implant position and orientation must be reproduced in the working cast so that best prosthesis fit may be achieved without interfering in the path of prosthesis placement.

Indeed, the impression of implant-retained prosthetic components accounts for providing the transfer of the implant positions from the oral cavity to the working cast.[3] However, not only are there a great variety of prosthetic components (conical and square), but also many impression techniques designed for each type of component, demanding an investigation into the quality of these procedures so that the most desirable technique may be indicated or perhaps even a new approach may be developed.

As far as impression materials and techniques are concerned, the splinting of square copings for a transfer impression to ensure desirable results regardless of the kind of impression materials has been recorded in the literature.[4–6] However, some authors[7–9] found no statistically significant difference for transfer impressions using splinted or isolated copings. The splinting material and technique used may also be different, including light-cure composite,[10] direct splinting in the impression tray with autopolymer-

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izing acrylic resin,[11] and roughening of square copings by coating adhesive in the tray.[12] Besides, different implant angulations in relation to the alveolar ridge may also influence the accuracy of the impression. The magnitude of this effect is still unclear.

The purpose of this study was to evaluate the effect of various implant angulations on the accuracy of implant impression transfers. The parameters studied included different impression transfer techniques and materials.

Materials and Methods

For this study, a 3.5 × 0 × 0-cm metal matrix block was fabricated using anodized aluminum, in which four implants of 3.75 × 0 mm (Conexão; Conexão Prothesis Systems Ltda., São Paulo, Brazil) were fixed and kept at 90º, 80º, 75º, and 65º in relation to the horizontal matrix surface. Then, 60 impression trays were customized using autopolymerizing acrylic resin (Classico), which had 3 mm of undercut. The matrix base and its implants served as the control group (M).

Sixty impressions were made and evaluated by matching three different transfer impression techniques, namely, technique 1—indirect technique with conical copings in closed trays; technique 2—direct technique with square copings in open trays; and technique 3—square copings splinted with autopolymerizing acrylic resin (Duralay; Reliance Dental Mfg. Co., Worth, IL) with four different impression elastomers: polysulfide (Permlastic Regular; Kerr Corp., Orange, NJ), polyether (Impregum F; ESPE Dental, Medizin, Germany), addition silicone (Imprint II with high viscosity; 3M Dental Products, St. Paul, MN), and condensation silicone (Zetaplus/Oranwash; Zhermark S.p.A., Rovigo, Italy). All the materials were managed according to their respective manufacturers' recommendations and the specification number 19 of ADA.[13] The impressions were made in a controlled temperature environment (23°C ± 2°C) with relative humidity of 50% ± 10%. All impression materials were used after coating their respective adhesives in the impression trays, except Zetaplus/Oranwash, which was managed in association with a perforated impression tray because this material has a high density.

A standardized pressure of 5 kg was exerted over each tray during the impression procedures. This was enough to force the excess material to flow out and to maintain the pressure constant throughout the working time. The impression/matrix set was placed in distilled water at 36°C ± 1°C during the polymerization time of each material. The impression/matrix set was separated.

In technique 1 (conical copings), the impression/matrix set was separated with the help of a metallic puller screwed into the metal matrix base. Then, the conical copings were unscrewed from the matrix and fitted to the implant analogs and immediately replaced in each respective notch left in the impression. Sixty minutes later, to provide the matrix replicas, dental stone type IV (Herostonel Vigodent Inc., Rio de Janeiro, Brazil) was manipulated with a vacuum machine, with a powder/water ratio of 30 g/7 mL, recommended by the manufacturer and then poured under constant vibration. When set (120 minutes after pouring), the impression was separated from the cast.

In techniques 2 (square copings) and 3 (splinted square copings), the screws of the copings were removed with a screwdriver, and then the impression/matrix set was separated with the help of a puller screwed to the base of the metal matrix. Once the impression had been obtained, implant analogs were adapted and screwed into the copings, which remained inside the impression in both techniques 2 and 3. Sixty minutes afterward, replicas were obtained following the proceedings described previously (Fig. 1).

After providing all the replicas, they were grouped into 12 experimental groups according to the studied impression materials and techniques. In each experimental group, there were five replicas for a total of 60 replicas when all experimental groups were pooled. Briefly, these 12 experimental groups have the following description:

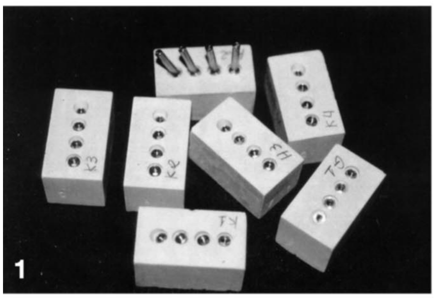
Group 1P: Association of conical coping technique and Regular Permlastic.
Group 1I: Association of conical coping technique and Impregum F.
Group 1A: Association of conical coping technique and Imprint II.
Group 1Z: Association of conical coping and Zetaplus/Oranwash.
Group 2P: Association of square coping technique and Regular Permlastic.
Group 2I: Association of square coping technique and Impregum F.
Group 2A: Association of square coping technique and Imprint II.
Group 2Z: Association of square coping technique and Zetaplus/Oranwash.
Group 3P: Association of splinted square coping technique and Regular Permlastic.
Group 3I: Association of splinted square coping technique and Impregum F.
Group 3A: Association of splinted square coping technique and Imprint II.
Group 3Z: Association of splinted square coping technique and Zetaplus/Oranwash.

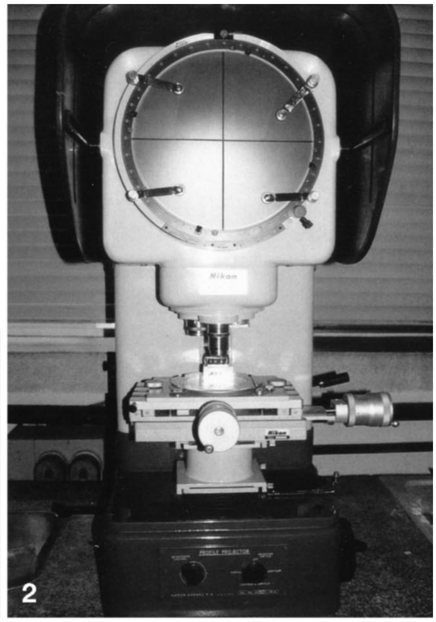
Readings

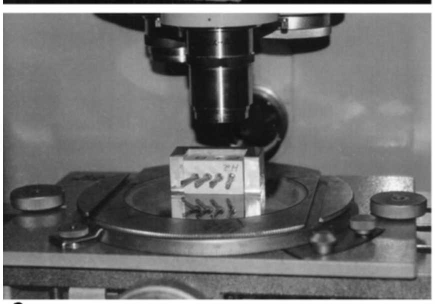
After the samples had been obtained, possible changes in the angulation of the implant analogs were assessed by means of a profilometer (Nikon; Nikon Corp., Tokyo, Japan) (Fig. 2) and compared with the control specimen (M). Previously, a metal device that served as support for the matrix and its replicas was designed and fabricated, and then centralized and cemented over the glass base of the profilometer support table.

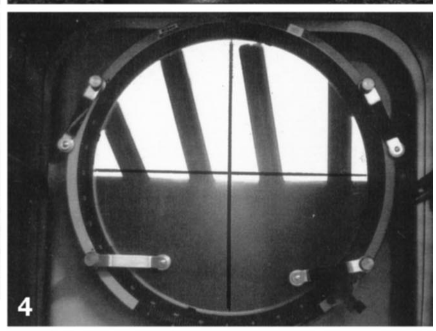
Replicas with referential components were placed and fitted to the metal device. Then the lateral features of their images were magnified and projected on the circular screen of the profilometer. The circular screen was circumscribed by two circumferential protractors, one measuring to the nearest 1° and the other to the nearest 1 minute. By adjusting both protractors to the orientation of a XY Cartesian plane, the observer could have a reading to the nearest 1 minute. After the readings, all values were standardized in degrees; that is, the readings were performed to the nearest 0.017°.

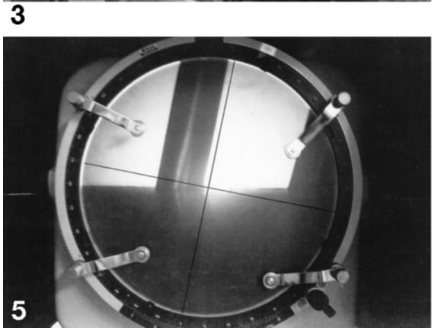
By visualizing the image displayed on the screen, the profilometer











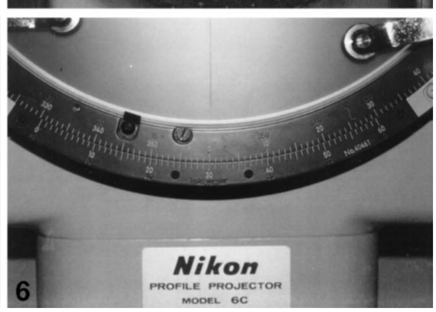


Fig. 1. Some experimental subjects.
Fig. 2. Frontal view of the Profilemeter used to perform results reading.
Fig. 3. The Profilemeter screen, which displays the readings.
Fig. 4. The view of the graduated Profilemeter screen and the angulation of a referential component in relation to the "X" axis.
Fig. 5. The view of the Profilemeter after it was rotated and parallel to the "Y" axis in relation to the implant referential component, which allows the angulation value to be recorded.
Fig. 6. Approximate view of the reading screen in the initial position for the readings −330° 30′ corresponds to the angulation of 90°.

support table could be moved horizontally (sideways, forward, and backward) and vertically to focus at the angle formed between the referential components connected to the implant analogs of each replica in relation to the horizontal surface of the matrix (Fig. 3). First, the support table was moved backward and forward until the surface of the matrix became parallel to the X axis (Fig. 4). Then it was moved sideways to centralize the area to be assessed until the long axis of the referential component became parallel to the Y axis of the Cartesian plane (Fig. 5). Next, readings provided by the y axis were recorded.

For example, the angulations values read for the implants at 90°, 80°, 75°, and 65° in relation to the matrix horizontal surface were at, 330°30′ (Fig. 6), 320°20′, 315°30′, and 305°30′, respectively, in the Cartesian plane. One observer performed all readings randomly and out of sequence. For each implant analog, five readings were performed, totaling 20 readings for each replica, 100 readings for each experimental group, and 1200 readings for all experimental groups. Additionally, five readings were performed in each of four implants of the metal matrix.

The data obtained from the readings were recorded and summarized in tables. Their means, standard deviations, and mean deviations were calculated, then submitted to the analysis of variance with two variables (impression technique and material) at significance of 5% ($P < .05$). After differences had been detected among the groups, the *post hoc* Tukey test was applied. Furthermore, the readings provided from all implant analogs at 90° served as parameters for comparisons with the readings obtained from other implant analog angulations, as well as the dispersion within each experimental group to evaluate the homogeneity of the behavior of each material associated with different techniques.

Results

The mean, the mean deviation, and the standard deviation of each experimental and control group can be seen in Tables 1 to 4. The results were described in terms of differences at significance of 5% and 1% and in terms of dispersion, that is, the magnitude of the changes among the specimens of the same group. The greater the dispersion value, the more heterogeneous the behavior of the impression material.

Comparing the readings obtained from variable angulations (90°, 80°, 75°, and 65°) using different impression materials and techniques from those of control group (M), it was observed that:

For implants perpendicular to the matrix horizontal surface (90°), there were no significant differences among different materials using technique 1

Table 1. Means, Mean Deviation, and Standard Deviation From the Experimental Groups and the Control Group of Implants at 90° in Relation to the Surface

	T1			T2			T3		
90°	Means	MD*	SD†	Means	MD	SD	Means	MD	SD
P	330.496	0.010	0.190	330.557	0.071	0.473	330.635	0.149	0.288
I	330.323	−0.163	0.302	330.410	−0.076	0.119	330.353	−0.133	0.058
A	330.303	−0.183	0.360	330.082	−0.404	0.630	330.341	−0.145	0.163
Z	330.508	0.022	0.491	330.328	−0.158	0.344	330.804	0.318	0.334
M	330.486		0.044	330.486		0.044	330.486		0.044

* MD, mean deviation: difference between the mean of experimental subject and the mean of the control subject.

† SD, standard deviation: the degree of dispersion of the values.

(T1). For technique 2 (T2), material "A" (Imprint II) presented a lower average in comparison to the others, and it was significantly different in relation to materials "P" (Regular Permlastic), "I" (Impregum F), and to the control group. There were no differences among materials "P," "I," and "Z" (Zetaplus/Oranwash) and the control group. With regard to the dispersion values, material "A" also showed the greatest variation in the series, followed by materials "P" and "Z". For technique 3 (T3), the means of "P," "I," and "A" were similar to that of the control group, whereas the mean of material "Z" was significantly different from the control group and the other materials. Furthermore, material "Z" presented the greatest dispersion and material "I" presented the least dispersion and it was similar to that of the control group. Among different techniques, T3 presented the most homogeneous dispersion.

For implants at 80° in relation to the matrix horizontal surface, for T1, significant differences were observed among different material groups ($P < .01$), although materials "A" and "Z" showed similar mean values to that of the control group. In terms of dispersion values, material "Z" (for T1) was the most dispersed in relation to the others. For T2, there were no significant differences among different materials or between each material and the control group. In this situation, all means were similar to that of the control group; however, materials "P" and "Z" showed much higher dispersion values than those observed in groups "I" and "A." For T3, there were no significant difference among materials "P," "I," and "A." There was no difference between the experimental groups and the control group, but material "I" showed the most similar average to the control group and the least dispersion values. The greatest dispersion values were shown by material "Z." To summarize, T3 presented the least dispersions, regardless of the techniques, and material "I" showed the most homogeneous behavior (less dispersion).

For implants at 75° in relation to the matrix horizontal surface, for T1, materials "P" and "A," and "I" and "Z" showed a similar mean; however, differences were evidenced at significance of 1% when the values of "P" and "A" were compared with those of "I" and "Z." In relation to the control group, there were no significant differences when this group was compared with the others; its mean average was equidistant from that of "P" and "A," and "I" and "Z." In terms of dispersion, it was observed that materials "I," "A," and "Z" had similar behavior (standard deviation [SD] $\cong$ 0.52). However, this value was 10 times higher than that observed in the control group (SD $\cong$ 0.058). For T2, there were no significant differences among experimental groups and the control group. It was different when material "P" was compared with materials "I" and "Z." The mean values of materials "I" and "A" were the most similar to that of the control group. All dispersion values obtained from experimental groups were significantly greater than that of the control group, and material "A" showed the least dispersion among the experimental subjects. For T3, the control group did not show significant difference in comparison with the experimental groups, but the difference occurred among the experimental subjects at significance of 1%. The means of "P," "I," and "A" were close to that of the control group. It was also noted that these materials showed similar dispersions, which were much lower than that presented by "Z," that is, the material "Z" showed great dispersions regardless of the techniques used.

For implants at 65° in relation to the matrix horizontal surface, for T1, "P," "I," and "Z" differed significantly at 1% from the control group, but did not differ among them. The material "A" had the most desirable mean value, similar to that of the control group. Dispersions were not signifi-

Table 2. Means, Mean Deviation (MD), and Standard Deviation (SD) From the Experimental Groups and the Control Group of Implants at 80° in Relation to the Surface

	T1			T2			T3		
80°	Means	MD	SD	Means	MD	SD	Means	MD	SD
P	319.991	−0.493	0.327	320.557	0.073	0.564	320.389	−0.095	0.252
I	320.182	−0.302	0.296	320.236	−0.248	0.112	320.458	−0.026	0.168
A	320.296	−0.188	0.271	320.367	−0.117	0.230	320.219	−0.265	0.201
Z	320.506	0.022	0.754	320.415	−0.069	0.541	320.567	0.083	0.388
M	320.484		0.047	320.484		0.047	320.484		0.047

Table 3. Means, Mean Deviation (MD), and Standard Deviation (SD) From the Experimental Groups and the Control Group of Implants at 75° in Relation to the Surface

	T1			T2			T3		
75°	Means	MD	SD	Means	MD	SD	Means	MD	SD
P	315.090	−0.166	0.246	315.549	0.293	0.442	315.192	−0.064	0.207
I	315.568	0.312	0.519	315.164	−0.092	0.410	315.101	−0.155	0.150
A	315.046	−0.210	0.548	315.254	−0.002	0.361	315.174	−0.082	0.216
Z	315.486	0.230	0.502	314.948	−0.308	0.516	315.602	0.346	0.574
M	315.256		0.058	315.256		0.058	315.256		0.058

cant among the experimental subjects, but they were significantly greater than that of the control group. For T2, the mean values of the materials "P," "A," and "Z" were significantly different from that of the control group, whereas material "I" showed a value similar to that of the control group. The material "I" presented more homogeneous behavior in relation to "P," "A," and "Z." For T3, materials "P" and "Z" were significantly different from the control group but were similar between them. Materials "I" and "A" were not different from the control group and both were similar. To summarize, for this angulation, the most homogeneous series occurred in T3.

For implants perpendicular to the horizontal surface, the best association in terms of average occurred in T1 using material "P," that is, the group 1P, and the second choice was T2 using material "I" (less dispersion).

For implants at 80° in relation to the horizontal surface, the mean value obtained from material "Z" in T1 (320.506) was similar to that of the control group (320.484); however, it showed great dispersion. For this sample set (T1 and Z), that is, group 1Z, one would expect that 95% of values would be within the interval 318.998 to 322.014 according to the normal distribution. In contrast, material "I" in T3, which also showed a very similar mean value to that of control group, simultaneously showed a lower standard deviation (T3 and I), whose interval was 320.122 to 320.794.

For implants at 75° in relation to the surface, the best association in terms of mean value was that of material "A" in T2, that is, group 2A. The second choice was the material "P" in T3, that is, group 3P.

For implants at 65° in relation to the surface, the best association in terms of mean value was material "I" in T3 (group 3I). The second choice was material "I" in T2 (less dispersion).

It was evident that in comparison to all experimental groups, the control group showed the least dispersion.

Discussion

Treatment using osseointegrated implants demands concern with several issues. Special attention should be given to the transmission of the load at the implant/bone interface, because they are biologically connected through the osseointegration process.

According to Cox and Zarb,[14] the lack of passive fit between prosthesis and implant may submit these components to strain and consequently result in their failure, fracture of the implant, or microfracture of the bone that surrounds the implant, and bone loss. Another consequence that may result from the lack of passive fit is the fracture of the screw that splints the crown to the abutment or to the implant. To achieve a structure with 100% passive fit to the abutment or directly to the implants is still quite impossible as a result of the number of variables involved in the prosthesis fabrication process. These include tolerance among the components of the implant systems, impression transfer procedures, investing, casting, and alloy properties as well as the materials for impressions.[2,15] Therefore, one must search for the best fit to minimize the sources of imperfection[16] so that the prosthesis/implant/bone system would require the minimum adaptation inherent to the implant-retained prosthesis approach. This should consequently provide periimplant health and improve the longevity of the finalized treatment.

Authors are unanimous[17–20] that there is a need for checking the fidelity of the cast obtained from the impression transfer, because this factor is important for providing a well-fitting prosthesis (and allowing this adaptation to be checked on the working cast itself). Therefore, it requires the desirable association of sound impression materials, with effective impression transfer techniques, to accurately register the implant position and its relationship with adjacent and antagonist teeth.

Table 4. Means, Mean Deviation (MD), and Standard Deviation (SD) From the Experimental Groups and the Control Group of Implants at 65° in Relation to the Surface

	T1			T2			T3		
65°	Means	MD	SD	Means	MD	SD	Means	MD	SD
P	306.818	0.938	0.328	306.407	0.527	0.710	306.470	0.590	0.232
I	306.625	0.745	0.675	305.764	−0.116	0.283	305.839	−0.041	0.413
A	306.144	0.264	0.424	307.354	1.474	0.537	306.036	0.156	0.252
Z	306.888	1.008	0.435	306.654	0.774	0.449	306.393	0.513	0.310
M	305.888		0.031	305.888		0.031	305.888		0.031

There is a great difference between the values obtained from mean average and dispersion (SD). Most of the time, the material shows good results in terms of average, but simultaneously it shows great dispersions. This means that these values have a large interval, and the extremities are very distant. This fact implies that the materials that show these characteristics do not behave homogeneously. In this research, it can be seen that material "Z" (Zetaplus/Oranwash) always showed great dispersion values, although it sometimes showed good mean values. This observation is consistent with that obtained by Wee.[21] Based on the results observed and the difficulty of manipulation, we do not indicate this material for implant impression transfer.

In summary, those materials that showed desirable results in terms of averages and dispersion were Impregum F and Imprint II with high viscosity. With regard to the technique used for the impression transfer, technique 3 showed the best results (square coping splinted with autopolymerizing acrylic resin Duralay using open tray).

Another important observation was that the control group showed significantly lower dispersion when compared with different situations (T1, T2, and T3), except for group 3I when the implant was perpendicular to the surface. This implies that satisfactory association between techniques and impression materials for providing accuracy is still unavailable. This fact associated with other difficulties found with regard to alloy properties, investing and casting, would be the obstacles for achieving passive fit between the metal prosthetic framework and the implant. Our results enhance the findings of Mazzeto,[22] who evaluated the dimensional stability of the elastomers (addition and condensation silicone, polysulfide, and polyether) and concluded that all these materials showed significant dimensional changes.

It was observed that the most favorable implant position for the impression transfer is the perpendicular one in relation to the horizontal surface, whereas the worst results were obtained from the implants at 65°. This fact deserves consideration because it may induce an angular discrepancy. According to Gyllenram,[15] the effects of angular misfit are aggravated as the degree of misfit increases. Thus, the horizontal misfit triples the angular discrepancy. In a good impression, there is a possibility of finding a discrepancy of 50 μm in any axis. Therefore, this study is in accordance with Waskewicz et al.[1] who stated that as a result of the impossibility of a 100% passive fit, it is recommended that the prosthesis be sectioned and soldered.

Conclusions

- Condensation silicone (Zetaplus/Oranwash) showed the worst result and may be considered contraindicated for the implant transfer impression.
- The best elastomer materials were polyether (Impregum F) and addition silicone (Imprint II with high viscosity).
- Polysulfide presented intermediate results.
- The less angulated the implant was the more accurate was the impression provided.
- The greatest dispersion occurred in implants at 65°.
- Technique T3 (square copings splinted with autopolymerizing acrylic resin (Duralay; Reliance Dental Mfg. Co.) presented the most homogeneous results in comparison to the others/
- The worst combination was technique 1 (indirect technique with conical copings in closed trays) with the implant at 65° in relation to the surface.
- In terms of dispersion, the combination between implant at 90° and technique 3 showed the most homogeneous behavior.
- Based on the data in the reviewed literature, an association between techniques and impression materials that may provide the required accuracy is still unavailable.

Disclosure

The authors claim to have no financial interest in any company or any of the products mentioned in this article.

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Abstract Translations [German, Spanish, Portugese, Japanese]

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Bewertung von Transferabdrücken für knochengewebsintegrierende Zahnimplantate bei unterschiedlichen Winkelstellungen

ZUSAMMENFASSUNG: ZIELSETZUNG: Weiterhin bleibt die Genauigkeit der Abdrücke zur Übertragung des exakten Verhältnisses von Implantat zum Metallaufbau der Prothese problematisch. Die vorliegende Studie zielte darauf ab, die Genauigkeit dieses Transferprozesses bei unterschiedlichen Bedingungsvorgaben zu bewerten. Als der Bewertung zu Grunde liegende Faktoren wurden die analogen Winkelbildungen des Implantats sowie die zum Zahnabdruck verwendeten Materialien und Vorgehensweisen angenommen. METHODEN UND MATERIALIEN: Es wurden Abdrücke (n=60) einer Metallstruktur (Kontrolle) vorgenommen, bei der vier Implantate zu jeweils 90°, 80°, 75° und 65° - gesehen im Verhältnis zur horizontalen Struktur - eingesetzt wurden. Zur Erstellung dieser Abdrücke wurden drei unterschiedliche Abdrucktechniken zum Einsatz gebracht: T1 als indirekte Technik mit konischen Abdruckkappen in geschlossenen Abdrucklöffeln; T2 als direkte Methode mit quadratischen Abdruckkappen in offenen Abdrucklöffeln; und abschlieβend T3 mit quadratischen Abdruckkappen unter Zuhilfenahme einer aus auto-polymerisierendem Harz bestehenden Schiene sowie vier Elastomeren: "P" - Polysulfid, "I" - Polyäther, "A" - Additivsilikon, und "Z" - Kondensationssilikon. Die Werte der analogen Winkelbildungen zu den einzelnen Implantaten wurden mittelst Profilometer bis auf 0,017° genau ermittelt und nachfolgend innerhalb der Varianzanalyse zum Vergleich bei maβgeblichen Abweichungen von 5% ($p<0,05$) vorgelegt. ERGEBNISSE: Für die zu 90° gewinkelten Implantate ergaben sich in allen Gruppen für sowohl Material "A" in Verbindung mit T2 wie auch für Material "Z" in Verbindung mit T3 unterschiedlicheErgebnisse ($p<0,05$). Bei 80° Neigung verhielten sich alle untersuchten Materialien in Verbindung mit T1 unterschiedlich ($p<0,01$). Bei 75° und einer Verwendung von T1 wiesen die Materialien "P" und "A" ähnliche Verhaltensweisen auf. Das Gleiche traf auf die Materialien "I" und "Z" zu, wobei sich das Verhalten dieser beiden Materialien wiederum von dem der Materialien "P" und "A" unterschied ($p<0,01$). Bei Einsatz von T3 verhielten sich alle Materialien durchgängig unterschiedlich ($p<0,01$). Bei 65° Winkelbildung unterschied sich das Verhalten der Materialien "P" und "Z" ($p<0,01$) von dem der Kontrollgruppe bei sowohl T1, T2 und auch T3. Entsprechend anders waren die Verhaltensweisen der Materialien "I" und "A" bei Verwendung von T1 und T2 als bei der Kontrollgruppe. SCHLUSSFOLGERUNGEN: Je rechtwinkliger die analoge Winkelung des Implantats im Verhältnis zur horizontalen Oberfläche, desto genauer wird das Abdruckergebnis. Als beste Materialien erwiesen sich die Materialien "I" und "A". Technik Nr. 3 wurde innerhalb dieser Versuchsreihe als beste Methode ermittelt.

SCHLÜSSELWÖRTER: Zahnimplantate, Prothesen, Materialien zur Verwendung bei Zahnabdrücken, Methoden

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Evaluación de las impresiones transferidas de implantes oseointegrados con distintas angulaciones

ABSTRACTO: PROPÓSITO: La precisión de las impresiones que transfieren la relación del implante con el armazón de metal de una prótesis continúa siendo un problema. Este estudio fue diseñado para evaluar la precisión del proceso de transferencia bajo distintas condiciones con respecto a las angulaciones analógicas del implante, materiales y técnicas de impresión. MÉTODOS Y MATERIALES: Se obtuvieron réplicas (n=60) de la matriz de metal (control) que contenían cuatro implantes a 90°, 80°, 75° y 65° con relación a la superficie horizontal usando tres técnicas de impresión, T1, técnica indirecta con puntas cónicas en bandejas cerradas; T2, técnica directa con puntas cuadradas en bandejas abiertas; y T3, puntas cuadradas divididas con resina acrílica autopolimerizante; y cuatro elastómeros, "P", polisulfato, "I", poliéster, "A" silicona de adición y "Z", silicona de condensación. Los valores de las angulaciones analógicas del implante fueron evaluadas por un calculador del perfil a los 0,017° más cercanos, luego presentados para el análisis de variación para obtener comparaciones con un grado de significancia del 5% ($p<0,05$). RESULTADOS: Para los implantes analógicos de 90°, el material "A" asociado con T2, y el material "Z" con T3 se comportaron de manera diferente ($p<0,05$) que el resto de todos los grupos. A los 80°, todos los materiales se comportaron de manera diferente ($p<0,01$)con T1. A los 75°, cuando se asoció con T1, los materiales "P" y "A" demostraron un comportamiento similar así como los materiales "I" y "Z", sin embargo, "P" y "A" fueron diferentes a "I" y "Z" ($p<0,01$); cuando se asoció T3, todos los grupos experimentales se comportaron de manera diferente ($p<0,01$). A los 65°, los materiales "P" y "Z" se comportaron de manera diferente ($p<0,01$) del grupo de control con T1, T2 y T3; los materiales "I" y "A" se comportaron de manera diferente del grupo de control ($p<0,01$) cuando se asociaron T1 y T2 respectivamente.CONCLUSIONES: Cuanto más perpendicular sea la angulación analógica del implante en relación a la superficie horizontal, más precisa es la impresión. Los mejores materiales fueron "I" y "A" y la técnica más satisfactoria fue la Técnica 3.

PALABRAS CLAVES: implantes dentales, prótesis, materiales para impresiones dentales, técnicas.

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Avaliação de Impressões de Transferência para Implantes Osseointegrados em Várias Angulações

RESUMO: PROPÓSITO: A exatidão de impressões que transferem o relacionamento do implante à estrutura metálica da prótese continua a ser um problema. Este estudo foi projetado para avaliar a exatidão do processo de transferência sob condições variáveis com relação a angulações de análogos de implante, materiais e técnicas de impressão. MÉTODOS & MATERIAIS: Réplicas (n=60) de uma matriz de metal (controle) contendo quatro implantes a 90°, 80°, 75° e 65° em relação à superfície horizontal foram obtidas empregando-se três técnicas de impressão, T1 –técnica indireta com cápsulas cônicas em moldeiras fechadas; T2 –técnica fechada com cápsulas quadradas em moldeiras abertas; e T3 –cápsulas quadradas ligadas com resina acrílica auto-polimerizante e quatro elastômeros, "P" –polissulfeto; "I" –poliéter, "A" –silicone de adição e "Z" –silicone de condensação. Os valores das angulações análogas de implante foram avaliados por um perfilômetro até o mais próximo 0,017°, então submetidos a análise de variãncia para comparações à significãncia de 5% ($p<0,05$). RESULTADOS: Para análogo de implante a 90°, o material "A" associado com T2, e o material "Z" com T3 comportaram-se diferentemente ($p<0,05$) de todos os grupos. A 80°, todos os materiais comportaram-se diferentemente ($p<0,01$) com T1. A 75°, quando T1 estava associado, os materiais "P" e "A" mostraram comportamento semelhante, bem como os materiais "T" e "Z", contudo, "P" e "A" foram diferentes de "I" e "Z" ($p<0,01$); quando T3 estava associado, todos os grupos experimentais comportaram-se diferentemente entre si ($p<0,01$). A 65°, os materiais "P" e "Z" comportaram-se diferentemente ($p<0,01$) do grupo de controle com T1, T2 e T3; os materiais "I" e "A" comportaram-se diferentemente do grupo de controle ($p<0,01$) quando T1 e T2, respectivamente, estavam associados. CONCLUS'ES: Quanto mais perpendicular for a angulação de análogo de implante em relação à superfície horizontal, mais exata será a impressão. Os melhores materiais foram "I" e "A" e a técnica mais satisfatória foi a Técnica 3.

PALAVRAS-CHAVE: Implantes dentários, próteses, materiais de impressão dentária, técnicas.

異なるangulationにおけるosseointegratedインプラントのtransfer impressionの評価

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概要：

目的：インプラントと補綴の金属フレームワークの位置関係をtransferさせるにあたり、印象の精度に問題が生じることがある。本研究はこのtransferプロセスの、インプラントアナログアンギュレーション、印象材料、技法の違いにもとづく異なる条件下での正確さを評価するために考えだされた。

素材と方法：水平面に対する傾きがそれぞれ90°、80°、75°、65°である4つのインプラントを含む金属製基質（対照実験材料）のレプリカ（n=60）が、T1 - クローズドトレイ内の円錐形copingによる間接法；T2 - オープントレイ内の方形copingによる直接法；T3 - auto-polymerizing型アクリルレジンをスプリントにした方形copingによる方法の3つのインプラント技法と、“P” - ポリサルファイド；“I” - ポリエーテル；“A” - additionシリコン；“Z” - condensationシリコンの4つのelastomerによって作成された。インプラントのアナログアンギュレーション値がprofilometerによって0.017°刻みで計測され、偏差が有意率5%（$p<0.05$）で分析された。

結果：90°のインプラントアナログ4種類では、材料“A”とT2の組み合わせ、材料“Z”とT3の組み合わせのふるまいが、その他すべてのグループと異なっていた（$p<0.05$）。80°では、すべての材料がT1で異なるふるまいを見せた（$p<0.01$）。75°では、材料“P”と“A”また材料“I”と“Z”がT1との組み合わせで同様のふるまいを見せたが、材料“P”、“A”と材料“I”、“Z”のふるまいは異なっていた（$p<0.01$）。T3との組み合わせでは、すべての実験グループがそれぞれ異なるふるまいを見せた（$p<0.01$）。65°では、材料“P”と“Z”がT1、T2、T3と組み合わされた対照実験群と異なるふるまいを見せ（$p<0.01$）、また材料“I”がT1と組み合わされた場合と“A”がT2と組み合わされた場合はどちらの材料も対照実験群と異なるふるまいを見せた（$p<0.01$）。

結論：インプラントアナログアンギュレーションは対水平面角が直角に近ければ近いほど、印象精度が向上する。最良の材料は“A”と“I”で、もっとも満足できる技法は技法3であった。

キーワード：デンタルインプラント、補綴、歯科印象材料、技法

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