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Accuracy of Interchangeable Implant Impression Systems: An In Vitro Pilot Study

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Purpose: *To evaluate the accuracy of impressions on changing the implant component (coping and abutment replica) between Brånemark and BIOMET 3i and between Straumann and Allfit.*

Materials and Methods: *Two master casts were constructed, one containing pair of Brånemark self-tap Mk II fixtures (Nobel Biocare) labeled Master cast I and the other containing pair of Straumann Standard plus implant, SLA fixtures (Straumann) labeled Master cast II. Ten impressions of each master cast were made by open tray technique using polyether impression material. Five out of 10 impressions made from master cast I contained Brånemark pair of coping and replica and the other 5 contained 3i (Implant Innovations). Five out of 10 impressions made from master cast II contained Straumann pair of copings and replica and the remaining 5 contained Allfit implants (Ihde Dental). Duplicated casts were prepared, and distances between copings were measured using traveling microscope and compared the distance in master casts.*

Result: *No significant difference was observed in mean value between 2 master casts and their duplicates.*

Conclusion: *The interchangeability of coping and abutment replica between Brånemark and BIOMET 3i and between Straumann and Allfit was found to be possible without compromising the quality of impressions. (Implant Dent 2015;24:1–6)*

Key Words: dental implant systems, impression accuracy, interchangeability, transfer coping

The introduction of the original implant system (Brånemark) was followed by several alternative systems (implant and components) closely resembling the original design and treatment protocol.[1–6] Fixation screws, laboratory components, and tools can be used interchangeably between Brånemark and BIOMET 3i and between Straumann and Allfit implant systems.[7]

Patients may present with implants already placed in the maxillae or mandible. This situation often presents serious problems because the restorative dentist may not know which type of implant was placed, unless he/she has access to the patient records. Incidents have been anecdotally cited in which different types of implants have been placed in the same mouth or even in the same arch. Therefore, in such cases, the availability of different implant components would be beneficial for the patient.

Lang et al[8] evaluated the fitness of precision between the Procera (Nobel Biocare Management AG, Zürich-Flughafen, Switzerland) custom abutment and various implant systems and found that the Procera abutment fits into the internal threading of the entire external hexagon implants studied. Jaarda et al[9] studied the geometry of 5 interchangeable prosthetic retaining screws (3i Implant Innovation-gold, Impla-Med-gold, Nobelpharma-gold, 3i Implant Innovation-titanium, and Implant Support Systems-titanium). They found significant differences between screws and concluded that interchanging prosthetic retaining screws might introduce unknown variables when treating patients. They also reported that the ultimate tensile strength of the 5 interchangeable prosthetic retaining screws were significantly different from the control screws, thereby suggesting that interchanging prosthetic retaining screws will influence their accuracy feature.[10] AU4

In a review of studies referring to success and failure in osseointegrated

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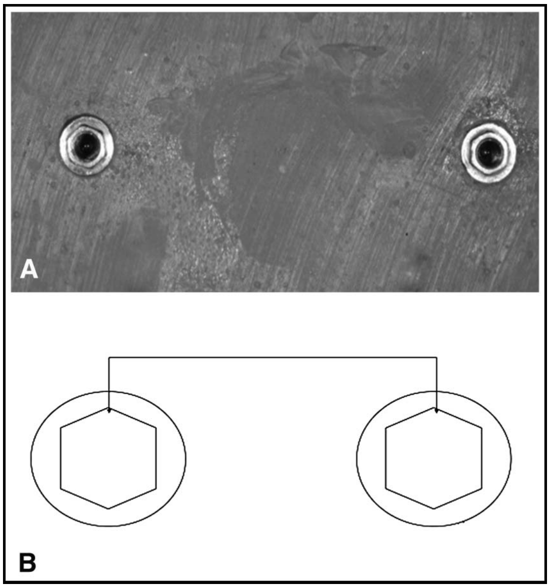

Fig. 1. A, Block, which contains a pair of Brånemark fixture (master cast I). **B**, The fixed points in the hexa that were used for measurement.

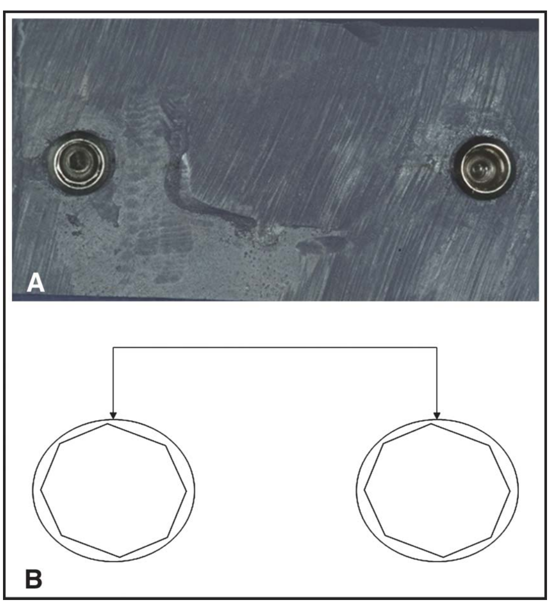

Fig. 2. A, Block, which contains a pair of Straumann fixture (master cast II). **B**, The fixed points in the octa that were used for measurement.

implant treatment published between 1981 and 1997, Goodacre et al[11] studied the mechanical and biological problems associated with dental implant treatment. The authors mentioned prostheses and abutment screw loosening, implant fracture and fracture of the metal framework, and the restorative material used as some of the mechanical problems associated with dental implant treatment. Misfit of components was cited as a possible cause of these complications. Although the causes for the failure of a prosthesis are multifactorial, it must be assumed that prosthesis misfit plays an important role in complications, such as screw loosening, screw fractures, plaque retention, etc.[12–16]

Therefore, care must be taken to minimize prosthesis misfit. There has been no clear consensus on the effect of interchanging the impression coping and replica between comparable implant systems on the accuracy of the impressions made.[17,18] Currently, there is no literature available on the use of alternative coping and abutment replica systems. The studies on interchangeability of abutments have showed inaccuracy at the implant-abutment interface. It was also noted that the potential for significant precision problems may be even greater than expected when all the elements are furnished by the same manufacturer.[17,19]

Hence, the aim of this *in vitro* pilot study was to evaluate the accuracy of impressions on changing the implant component (coping and abutment replica) between Brånemark and 3i and between Straumann and Allfit.

Materials and Methods

Two master casts were constructed. The first master cast contained a pair of 4 × 15 mm Brånemark self-tap Mk II fixtures (Nobel Biocare AB, Gothenburg, Sweden), and this master cast was assigned as "Master cast I." The second master cast contained a pair of 4.1 × 12 mm Straumann Standard plus implant, SLA fixtures (Straumann Institute, Waldenburg, Switzerland) and was assigned as "Master cast II."

Ten impressions of each master cast were made by open tray technique using a polyether impression material. Five out of the 10 impressions made from master cast I contained Brånemark pair of coping and replica, and the other 5 contained 3i (Implant Innovations Inc, West Palm Gardens, FL). Five out of the 10 impressions made from master cast II contained Straumann pair of copings and replica, and the remaining 5 contained Allfit implants (Ihde Dental AU5
AG, Switzerland) (Table 1). T1

Master Cast Model Design

Two blocks were constructed from chemical-cured ortho resin (Orthoresin; Dentsply, DeguDent GmbH, Postfach, Hanau, Germany). The material was mixed and then poured in customized flasks that had been previously fabricated. The material was allowed to set according to the manufacturer's instructions. After the setting, the blocks were taken out of the flasks and trimmed off the excess. Then, 2 points

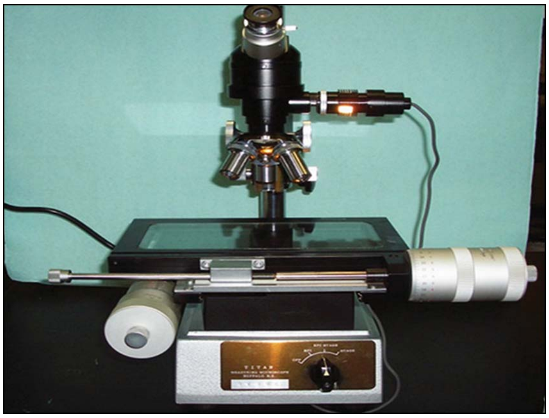

Fig. 3. Traveling microscope used for the measurement of distance between reference points.

were marked on each block with a specific distance. Two holes were made using a straight handpiece with a fissure bur at the marked points.

Two Brånemark fixtures (Nobel Biocare AB) and 2 Straumann fixtures (Straumann Institute, Waldenburg, Switzerland) were inserted and relined individually into the prepared holes. A Ney surveyor was used to confirm an exact path of insertion of the 2 fixtures. Master cast I contained 2 Brånemark F1 fixtures (Fig. 1, A), and master cast II contained 2 Straumann fixtures F2 (Fig. 2, A). Two reference points were selected, which represented the head of the helix in Brånemark system (Fig. 1, B) and the head of the octa of the Straumann system (Fig. 2, B). Measurements were taken using a traveling microscope (Titan, Buffalo, NY). Three readings were taken for each master model, and the average of the 3 readings were used as reference distance to which the distances on the duplicated models were compared.

Table 1. The Distance Between the Reference Points on Master Model 1 (Brånemark Fixtures, 30.011 mm) and Experimental Models (Brånemark and 3i Fixtures)

Model No.	Brånemark	3i
1	30.038	29.899
2	29.969	30.123
3	30.029	29.989
4	29.989	29.994
5	30.101	29.389
Mean	30.025	29.879
SD	0.051	0.285

Impression Tray Design

Impressions were made with an open tray technique using a custom tray. Copings were screwed into the fixtures using their specific screws. To standardize the torque at 10 N·cm, a calibrated torque controller was used. One layer of wax spacer was applied, covering the superior surface of the master cast without covering the coping and the cast stoppers. Then, 2 layers of wax spacer were wrapped around the copings. Chemically cured polymethyl methacrylate acrylic resin (Fastray; Harry J. Bosworth Company, Skokie, IL) was mixed and adapted over the wax spacer, and then the material was allowed to set according to the manufacturer's instructions. Holes were made over the copings (using a straight handpiece with a fissure bur), and the thickness of the flanges was reduced from the inner surface to allow the excess impression material to escape during the impression making. Ten custom trays were duplicated from each master cast. The duplication was made by using the silicon impression material in prefabricated flasks.

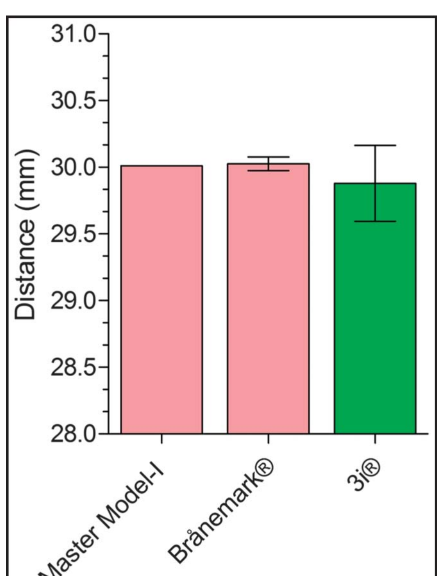

Fig. 4. Variation in distance between the reference points on Master model I (Brånemark fixtures) and experimental models.

Impression Protocol

Twenty impressions were made using polyether (Impregum Penta Soft; 3M ESPE) to transfer the copings from AU6 the fixture to the cast. Ten impressions were made from the first master cast (Brånemark system) out of which 5 impressions transferred Brånemark coping and replica (Nobel Biocare) and AU7 the other 5 transferred the interchangeable 3i coping and replica (Implant Innovation).

Similarly, for the second master cast (Straumann system), 5 impressions transferred Straumann coping and replica and the other 5 transferred the interchangeable Allfit coping and replica (BioMed Est; Ihde Dental AG). The impressions were made using a Pentamix mixing machine (Pentamix 2; 3M ESPE) to have a uniform mixing. The trays were loaded with impression material and allowed to set according to the manufacturer's instructions. Transfer copings were unscrewed and connected to abutment replica.

Cast Production Protocol

The impressions were poured with Royal boxing wax wrapped around each tray. The mix was prepared with dental stone (GC Fujirock EP, Japan) using a vacuum-mixing AU8 machine, and then poured using a vibrating machine (Vibromaster; Bego Bremer Goldshagerel will GmBA & Co., Bremen, Germany). The material was allowed to set according to the manufacturer's instructions. Then, the blocks were trimmed to refine the shape of the blocks.

Table 2. The Distance Between the Reference Points on Master Model 2 (Straumann Fixtures, 30.011 mm) and Experimental Models (Straumann and Allfit Fixtures)

Model No.	Straumann	Allfit
1	30.239	30.219
2	30.211	29.453
3	30.099	29.717
4	30.175	30.119
5	30.012	29.579
Mean	30.147	29.817
SD	0.092	0.336

Measurement Protocol

A traveling microscope (Titan) (Fig. 3) was used to measure the distance between the 2 reference points that were determined in the master cast. The measurements were taken by fixing the casts on the microscope, which allowed a controlled movement of the casts. Reference point for the measurements was fixed for each of the implant systems. The head of the hex in external hex implant system (Brånemark and 3I) and the head of the octa in the internal octa implant system (Straumann and Allfit) were used as the reference points. The values obtained for the master model I and II were then compared to the duplicated models. Three readings were taken for each duplicated cast. The average distance of the 3 readings were taken and compared with that of the master cast.

All statistical analysis was performed using One-Sample *t* test in SPSS program (version 10), and descriptive data analysis was used to report findings.

Results

The distance between the reference points is depicted in Tables 1 and 2. Both master Model I and II measured a distance of 30.011 mm. The dimensions for Master model I (Brånemark) and its duplicated models and 3i models are shown in Table 1 and Figure 4. The mean distance for Brånemark duplicated models was 30.025 ± 0.051 and 29.879 ± 0.285 for the 3i models. Although, the Brånemark duplicated models showed more accuracy, both systems were statistically not significant from the master model ($P > 0.05$).

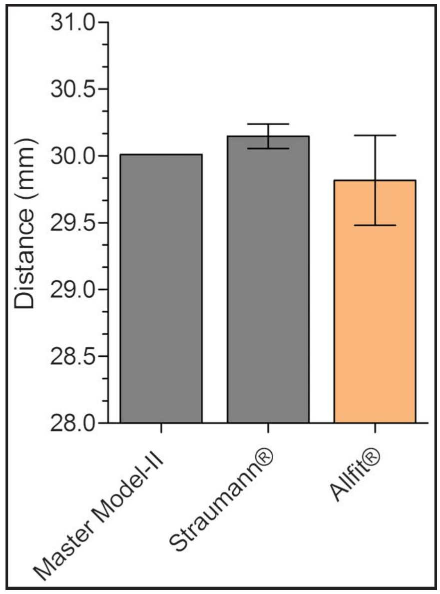

Fig. 5. Variation in distance between Master model I (ITI fixtures) and experimental models.

Table 2 and Figure 5 present the distance between the reference points on the master model II and its duplicated Straumann and Allfit models. The Straumann models showed a mean distance of 30.147 ± 0.092. The mean distance for the Allfit duplicated models was 29.817 ± 0.336. Comparison of the distance with the master cast did not ravel any statistical significance ($P > 0.05$).

Discussion

The success of implant treatment results from biologic and mechanical factors.[20] A critical element in implant prosthodontics is to fabricate a suprastructure that fits accurately to the implants to avoid the increased risk of technical and biological complications.[21–23] An acceptable prosthesis requires optimal accuracy in all steps of fabrication. The implant-abutment joint, maintained by a retention force generated by the screw, is an essential biomechanical factor that withstands occlusal forces.[24]

The precision of the prosthesis depends on the accuracy of positioning the impression components and recording the implant position with the impression procedure.[7,25] The impression can be made either at the abutment level using a transfer coping and a pickup impression technique with the coping retained in the impression while it is removed from the mouth or at the implant level using 2 methods: the pickup method or the repositioning method, in which a tapered impression coping is retained on the implant and later removed from the mouth, reassembled with the implant analog, and replaced tightly into the impression.[26,27]

Clinical situations demand for brand switching and/or use of universal components in implant dentistry. Studies showed that the potential for precision problems were greater when all the elements are furnished by the same manufacturer.[17] In this study, we found that there was no significant difference in the accuracy of the impression and models by interchanging the coping and replica among the various implant systems studied. This observation is in agreement with similar studies, which attempted to change the abutments and screws.[17,28]

Precious metal alloys are preferred over base metals in implant restorations to avoid the potential for corrosion between dissimilar metals. It is assumed that corrosion of precious metals against titanium would likely be less than that seen with base metals, and byproducts of the corrosion process would be less likely to be toxic or allergenic than their base metal counterparts.[29]

The use of fixture-level impression technique was expected to record only the implant head position rather than both its position and dimensions. Both of these factors would suggest that the impression distortion was likely to have less effect as compared with the conventional fixed prosthodontic impressions.[30] Also, impression accuracy was increased by using custom trays because it has been shown that a difference in the thickness of elastomeric impression material in an impression tray could reduce its accuracy.[31,32] Another point of importance aimed at maximizing the accuracy of transferring the fixture and abutment/coping relation was the use of polyether impression material that has good dimensional stability and accuracy.[18,33]

The implant impression using impression copings requires a connection

to the implant or the abutment. After separating the impression, another connection between the impression coping and an implant analog is required to fabricate a definitive cast. Because the connection between 2 metal components may occur with various spatial relations at the micrometer level, the implant impression has an inherent discrepancy. This is considered as "machining tolerance" and reported that the measured tolerances ranged from 22 PM to 100 PM.[34] Hence, while interpreting the studies investigating the implant impression accuracy, the machining tolerance should be considered as one of factors affecting accuracy.[18] Hence, in this study also, we found negligible discrepancy when the impression coping of the same system or a similar system is used. In a systematic review, a linear discrepancy of 0.6 PM to 136 PM between the definitive cast and experimental model was considered as a consequence of machining tolerance.[18] The impression coping with different designs showed a different level of impression accuracy, and to increase the accuracy, the coping was extended or treated with airborne-particle abrasion and impression adhesive.[27,35]

Although our findings present no statistically significant differences in interchanged components, the observations clearly reinforce the advantages of using the same implant components. In general, based on the findings, it is recommended that the components of the same system be used for routine procedures. However, the use of components from alternative system can also be considered because it does not affect the accuracy.[12,18]

Conclusion

Within the limitation of this study, the Brånemark and Straumann master models, reference points on BIOMET 3i and Allfit duplicated models showed values with no statistically significant difference. Although it is desirable to use components such as coping and abutment replica from same system, the accuracy is not compromised by using components from identical systems. Because this study is done in an *in vitro* setup, it may be considered as a limitation.

Disclosure

The authors claim to have no financial interest, either directly or indirectly, in the products or information listed in the article.

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