One clinical visit for a multiple implant restoration master cast fabrication

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The making of a one-piece, long-span, implant-supported prosthesis with conventional procedures frequently has difficulties associated with the accuracy of fit. This article presents a clinical and laboratory procedure for making an accurate implant working cast that facilitates fabrication of the casting on the master cast. The procedure demonstrates the process of sectioning and rejoining of the resin between the transfer copings and then pouring the impression by first joining the analogs alone with impression plaster, sectioning it, and rejoining it again to stabilize the analogs, and finally, using dental stone to pour the impression. Clinical, radiographic, and laboratory (optical microscope) measurements for one clinical implant restoration confirm the accuracy of fit of this one prosthesis made with this procedure. Its advantage is that it can allow fabrication of the final casting on the cast, thereby eliminating the clinical time necessary to obtain repetitive solder indexes, and thus minimizing inconvenience to the patient. (J Prosthet Dent 1997;78:550-3.)

As implant dentistry continues to evolve, it is more widely recognized that implant restorations require different procedures compared with traditional crown and bridge prosthodontics.[1-4] In particular, when restoring multiple unit implant-supported restorations, presoldering (metal framework only) or postsoldering (after porcelain application) procedures are required because of errors in the transfer of the relationship of the implants to the working cast. Errors that result from the transfer of implant position during the impression procedures often make it necessary to section and solder metal frameworks repeatedly.[1,5,6] This problem is particularly important with implant-supported prosthesis because, in contrast to natural teeth where the periodontal ligament allows tooth movement of 28 μm[6] in a vertical direction, and in a horizontal direction 56 to 73 μm in posterior teeth and 69 to 108 μm in anterior incisor teeth,[7] an implant can only move 2 to 3 μm[6] vertically and 12 to 66 μm in a labiolingual direction, because of lack of a periodontal ligament.[8,9] Thus the relational accuracy of the implant-supported restoration to adjacent implant abutments must be greater. Because of this, the inaccuracy of the casting in an implant-supported prosthesis with the conventional lost wax casting procedures to cast one-piece, full-arch implant frameworks is both imprecise and inaccurate as judged against the passive fit requirement.[4] The consequences of a lack of fit include micromovement that may break the cement-implant attachment and, with a screw-in prosthesis, loosening of the coping screw.[10] When the prosthesis is loosened from the implant interface, physiologic masticatory stresses are magnified at that interface and can result in displacement or screw fracture. Therefore, to achieve a close fit of the prosthesis to the implant, implant-supported crowns are made individually and soldered together from intraoral transfers to minimize framework distortion.[10-13] There are two significant sources of error in framework distortion: One is the shrinkage of the resin material (curing contraction is 0.6% linear)[14] used to join the implants impression coping at the time the master impression is obtained, and the second is expansion that takes place during setting of the dental stone (type III, setting expansion is 0.3%)[14] used for the master cast.

Phillips et al.[15] studied the accuracy of implant impressions obtained with three types of transfer copings, tapered copings, square copings, and square copings splinted with acrylic resin. He found that square and square/resin coping techniques showed no significant difference. However, Assif et al.[16] compared three impression procedures relative to the accuracy in a laboratory cast. The first procedure used autopolymerizing acrylic resin to splint the transfer copings. The second involved splinting the transfer copings directly to an acrylic resin custom tray. In the third, only impression material was used to orient the transfer copings. The procedure that uses acrylic resin to splint transfer copings in the impression material was significantly more accurate than the two other procedures.

This report describes a clinical and laboratory procedure for fabricating an accurate implant working cast. It uses the process of sectioning and rejoining of the resin between the transfer copings and then the master cast is made: pouring the impression by first, joining the analogs alone with impression plaster (setting expansion is 0.06%),[17] sectioning the plaster connection, and rejoining it again to stabilize the analogs, then using stone for

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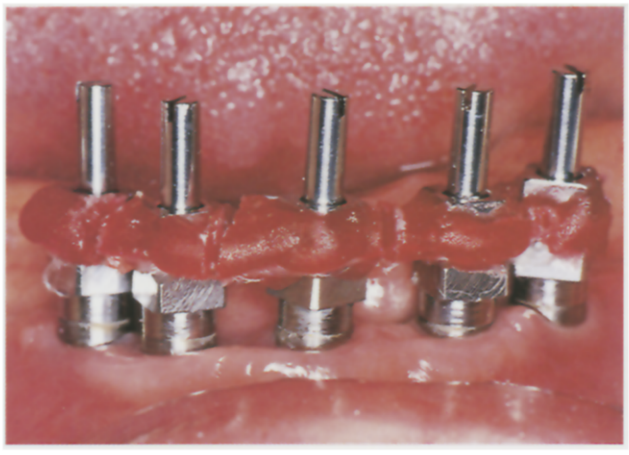

Fig. 1. Intraoral view of acrylic resin sectioned between each transfer coping in five-unit Brånemark mandibular high-water design fixed prosthesis.

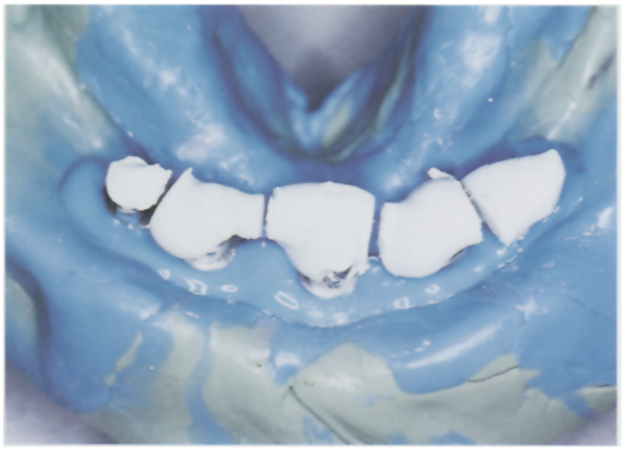

Fig. 2. Implant analogs fixed to impression copings in impression made with Reprosil. Implant analogs placed in each transfer coping have been connected with impression plaster that was consequently separated between each analog.

the rest of the cast. This procedure takes approximately 10 to 15 minutes. The advantage is that it can allow fabrication of the final casting on the stone cast, thereby eliminating the clinical time it takes for repetitive solder indexes and minimizing the inconveniences to the patient.

By controlling the effects of expansion and shrinkage of the materials associated with the impression procedure, this procedure provides an accurate cast on which the laboratory can join separate units and then solder them. This will provide a one-piece cast framework to the restorative dentist. However, this procedure does not address the investment and soldering errors.

CLINICAL PROCEDURE

1. Seat a square transfer coping on each implant and secure it with a long screw. Confirm the seating by radiography.
2. Weave dental floss among the square transfer copings and apply acrylic resin material (GC Corp., Tokyo, Japan) or light-cure composite with a brush or small spatula to join all transfer copings. The floss acts as a matrix for the resin.
3. Unscrew the transfer copings and remove them from the mouth. Section the resin between each transfer coping with a thin disk and reseat the transfer copings in the mouth (Fig. 1).
4. Join the spaces created with acrylic resin or light-cured composite again. (This reduces the effects of polymerization shrinkage.)
5. Make an impression with a polyvinyl siloxane material (Reprosil, Caulk, Milford, Del.) using an open top tray that allows access to the screws.
6. Unscrew the transfer copings and remove the impression containing the transfer copings from the patient's mouth.

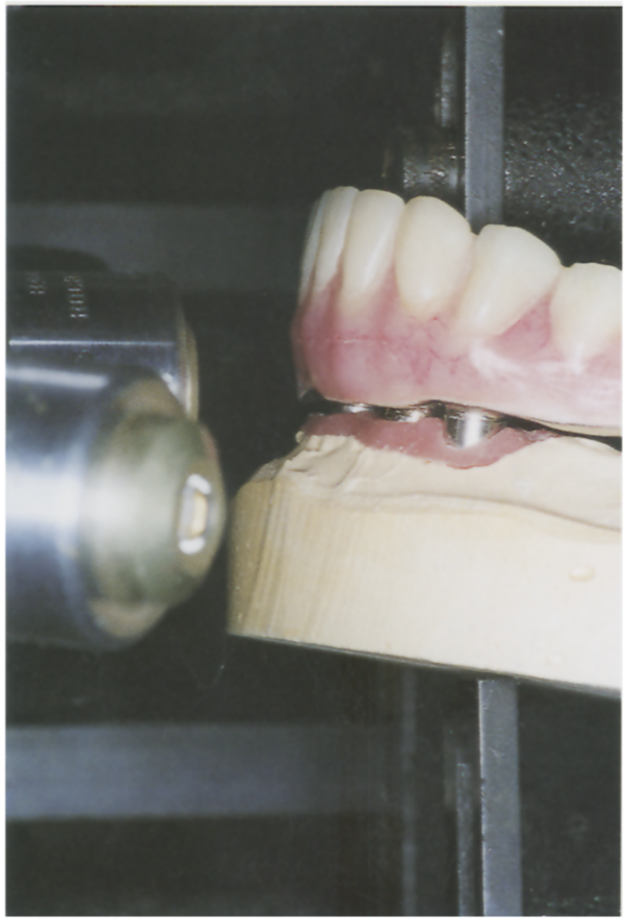

Fig. 3. Master cast mounted on optical microscope for measuring gap distance between implant head and prosthesis framework.

LABORATORY PROCEDURES

1. Attach an implant analog to each impression coping embedded in polyvinyl siloxane impression material.
2. By using a brush or cement spatula, join the apical

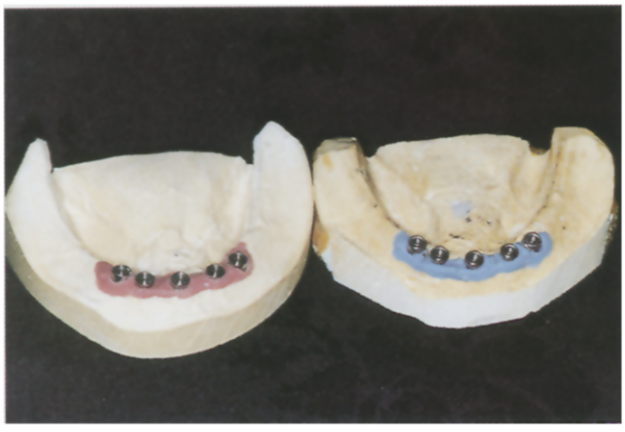

Fig. 4. *Left,* master cast made with conventional procedure. *Right,* master cast made using proposed procedures.

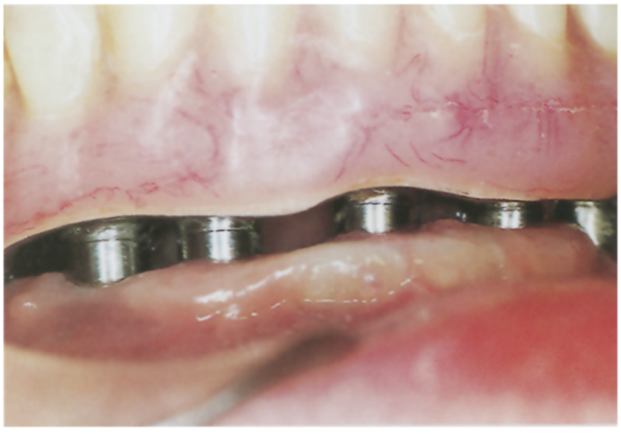

Fig. 5. Final prosthesis shows supragingival interface between abutments and superstructure with only one gold screw in place at left end of prosthesis.

portion of the analogs securely with impression plaster.

3. After the impression plaster sets, section each interproximal space with a thin disk. Soak it for a few minutes in slurry water and rinse it out. Then proceed to rejoin the separations with a second mix of impression plaster (Fig. 2). Rewet the plaster before adding the new mix, otherwise the joint will be weak because the set stone will dehydrate the new mix.
4. Box the impression and pour soft tissue model material around the coronal end of the analogs and then complete pouring of the impression with dental stone.

Accuracy of fit criteria

To demonstrate the accuracy of fit of the framework, the following steps were used for checking passivity of fit on a clinical case. The clinical criteria were (1) radiography, (2) tactile examination with a periodontal probe (Hu-Friedy, Chicago, Ill), (3) manual manipulation on distal ends of prosthesis, and (4) tightening one screw at a time.

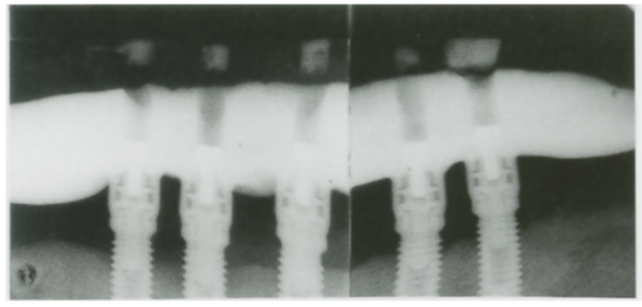

Fig. 6. Periapical radiograph of final implant-supported fixed prosthesis.

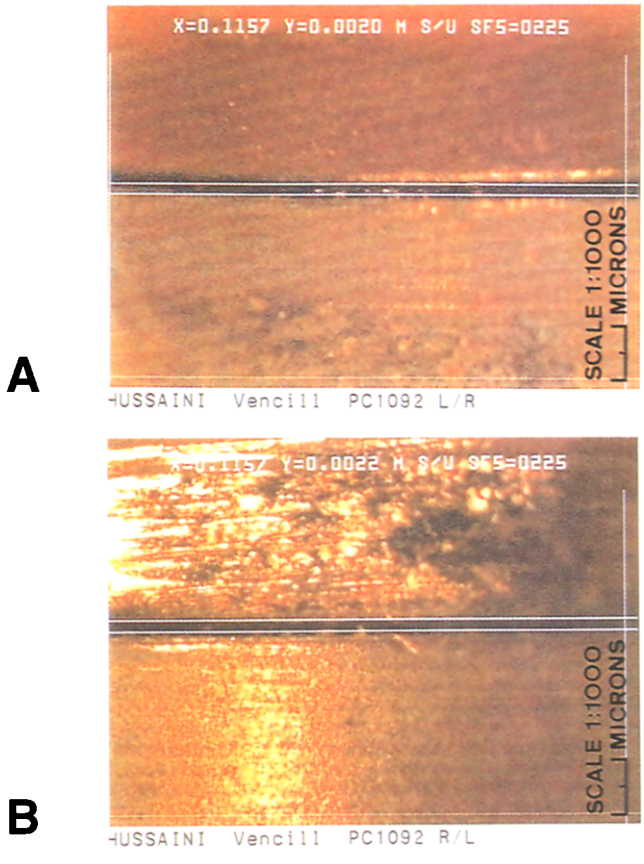

Fig. 7. Photomicrograph shows abutment/framework interface gap in Y-axis. **A,** Left most distal implant 20 μm. **B,** Right most distal implant 22 μm.

For the laboratory criteria, and for comparison purposes, the same impression was used. One cast was made with the proposed procedure. The implant analogs were joined with impression plaster first, then were separated and rejoined. The impression was poured with type III dental stone. The other cast was made according to the conventional procedure, pouring type III dental stone without the impression plaster procedure. Under optical microscope (ACCO, Wilson Instruments Inc., New York, N.Y.), the gap in the Y-axis between the framework and the abutment replicas was measured (Fig. 3)

for both casts (Fig. 4) and the measurements were recorded in microns for each implant.

DISCUSSION

Even though the procedure that uses an open top tray and acrylic resin to splint the transfer copings is considered to be the most accurate method,[16] there is usually a detectable gap observed between the implant head and the prosthesis framework. For this reason, an intraoral soldering index needs to be made routinely.

Two master casts were fabricated with the same impression, which was made by using an open tray, luting the impression copings, sectioning them, and then rejoining them. The first master cast was fabricated by using the proposed procedure; the second master cast was fabricated pouring type III dental stone directly into the impression. The effect of the pouring procedure was examined by measuring the gap between the implant head and the prosthesis framework. On the first cast (proposed procedure), the gaps ranged from 20 to 36 μm (Fig. 5), whereas on the conventional cast, the gaps ranged from 82 and 139 μm, revealing a total difference of 400 μm when the differences at each site are added and totals subtracted from each other.

When an accurate working cast is made, the clinician can rely on instructing the laboratory to cast each unit separately and solder them using the master cast as an index. By using the proposed procedure, if the final casting fits the master model, the clinician should be confident that it will fit the patient's mouth. Because all presoldering procedures are performed in the laboratory with the master cast, only one visit is required for impression making, a second visit for casting try-in, and a third visit for delivery are necessary.

The goal of the prosthodontist is to achieve a passive fit prosthesis on the abutments (Figs. 6 and 7), along with optimal occlusal design and contact relationship of the occlusion. The rationale for using impression plaster (setting expansion 0.06%)[17] is its minimal setting expansion compared with type III dental stone (setting expansion 0.3%).[14] Setting time (impression plaster 4 minutes, dental stone 12 minutes)[14] also makes it more desirable. However, because of the minimal strength and low fracture resistance, the entire cast, including the exposed implant analogs and the impression plaster connection, are embedded in dental stone.

One of the differences between natural dentition and dental implants is the amount of movement they tolerate under masticatory forces. The presence of periodontal ligament in natural teeth permits more movement than an osseointegrated implant.[9] Therefore, when restoring teeth with a conventional fixed partial prosthesis, multiple soldering indexes must be done to compensate for movement errors.[1] In contrast, implants are almost rigid if fully osseointegrated.[1] When a procedure is reliable in transferring the relationship of the implants to a master cast with a high degree of accuracy, the fabrication of a single multiple-implant restoration framework can be simplified. The clinical situation presented in this article shows up to 100 μm difference in accuracy of fit in some clinical sites. Although one clinical presentation hardly proves the superiority of a procedure, it does present another method to use and test and it provides the background for a scientific study.

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