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Fabricating an Accurate Implant Master Cast: A Technique Report

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Abstract

The technique for fabricating an accurate implant master cast following the 12-week healing period after Teeth in a Day® dental implant surgery is detailed. The clinical, functional, and esthetic details captured during the final master impression are vital to creating an accurate master cast. This technique uses the properties of the all-acrylic resin interim prosthesis to capture these details. This impression captures the relationship between the remodeled soft tissue and the interim prosthesis. This provides the laboratory technician with an accurate orientation of the implant replicas in the master cast with which a passive fitting restoration can be fabricated.

The original Brånemark protocol prescribed a two-stage surgical procedure with a healing period between 3 and 6 months before functional loading.[1] Since then, placing implants under immediate functional load has garnered wide acceptance as an improved treatment protocol, resulting in a high success rate.[2-4] The current surgical and prosthetic protocols have been previously described.[5,6]

Much has been published regarding protocols for providing the patient with a definitive metal-reinforced, implant-supported prosthesis. As there is the potential for distortion at several points of the impression process, effort must be expended to achieve an accurate master impression for osseointegrated dental implants. Clinically, there are factors that affect the accuracy of the implant impression, making the impression material used and impression technique applied critical to creating an accurate master cast. Traditionally, there are two master impression techniques for recording implant position and orientation. In the closed tray (indirect) technique, the copings are connected to the implants, and an impression is made and separated from the mouth, leaving the copings intraoral. The copings are removed from the patient, connected to the implant analogs, and then the coping-analog assemblies are reinserted in the impression before creating the master cast. In the open tray (direct) technique, access holes are created within the custom tray, allowing long guide pins to extend beyond the occlusal surface of the custom tray. Before separating from the implants, the guide pins are unscrewed, and the copings are removed inside the impression. The implant analogs are connected to the copings with the guide pins to fabricate the master cast. Lee et al[7] evaluated 14 studies comparing the accuracy of closed and open tray techniques. In 12 instances, the open tray technique showed more accurate impressions and was ultimately preferred. These outcomes are congruent with findings reported by Cabral and Guedes[8] who compared both closed and open tray techniques. Previous methods of open tray technique involve impressions where the impression copings were splinted with an autopolymerizing resin[9] (DuraLay; Reliance Dental Mfg. Co, Worth, IL) prior to adding impression material to the tray; however, Liou et al[10] discovered that the open tray technique pickup did not always result in an accurate master cast.

In 1986, Loos advocated using orthodontic wire as a medium for acrylic resin to create a rigid splint between the individual impression copings inside a rigid impression material.[11] Another method used square copings splinted together, using dental floss as a matrix for the subsequent addition of an autopolymerizing acrylic resin index.[12] A custom tray loaded with impression material is placed over the splinted copings, and the tray is removed from the mouth for pouring. This seemed to produce the most consistent results with regard

to impression accuracy[13]; however, when large amounts of acrylic resin are used for this index, it can lead to significant distortion during polymerization, and subsequently an inaccurate impression.[12,14] Assif et al[15] proposed a modification to the latter splinting technique, in which a custom tray is constructed at least 48 hours in advance of the impression to avoid polymerizing distortion and used to allow splinting of the impression copings directly to the tray. A small incremental amount of autopolymerizing acrylic resin is added, to keep distortion to a minimum. This method eliminated the use of dental floss matrices and subsequent steps.[10,15] In a subsequent study, Assif et al[16] compared impression copings that were luted together with autopolymerizing acrylic resin, dual-cured acrylic resin, or impression plaster. The accuracy of the fit of the framework on the casts obtained from the different groups was tested using strain gauges. Their findings further supported that impression copings splinted together using autopolymerizing acrylic resin or plaster produced the most accurate impressions of the three materials. Based on the results, impression plaster was preferred for the completely edentulous patient.[17] The prosthodontic authors of this technique report have used impression plaster (Snow White Plaster; Kerr Corporation, Orange, CA) in the past to fabricate an implant master cast with a relatively high level of accuracy. Despite the accuracy impression plaster provides, the material's fast set time and rigidity make it difficult to manage and may cause the patient unnecessary discomfort.

Polymethyl methacrylate (PMMA) is an autopolymerizing acrylic resin commonly used to splint impression copings. Susceptible to the effects of creep, PMMA is subject to deformation that occurs under constant load at stress below the yield stress.[18] Depending on materials, deformation may occur due to temperature fluctuations, or pressure caused by external stress or under constant load bearing. Initially, postsurgical stress derived from screw tightening and masticatory forces may affect bone remodeling[19] and encourage creep.

Rubber-based impression materials have advanced since they were first introduced in 1955. Silicone elastomer represents an important advancement in impression techniques, due to its high degree of accuracy, dimensional stability, and ease of manipulation.[20] Elastomers are available in four consistencies: a thin, easy flowing, light-bodied material, a creamy medium-bodied material, a highly viscous heavy-bodied material, and a kneadable putty material.[20] Vinylpolysiloxane (VPS) has become the most widely used impression material in restorative dentistry.[21] These products come in a wide variety of viscosities to produce impressions with great detail and are odorless and tasteless. Polyether (PE) materials are also widely used; however, they are not ideal, as they possess an undesirable odor and taste for the patient, can absorb water from the atmosphere, and produce ethyl alcohol as a by-product of the setting time. Evaporation of the alcohol will result in distortion of the impression.[22] Furthermore, while modern VPS materials are marketed as hydrophilic, all rubber-like elastomeric impression materials require a dry preparation surface.[22]

Osseointegration provides the basis for a successful implant surgery. As defined by Brånemark,[23] osseointegration is "a direct structural and functional connection between ordered living bone and the surface of a load carrying implant." The premise is that bone heals around the implants to conform to the positional relation of an all-acrylic splint.[24] Insult to the bone sustained during surgery will be repaired during the natural course of bone remodeling. This is a continuous dynamic process, fluctuating between bone formation and bone resorption, engaging osteoclast cells and osteoblast cells, which operate in concert via paracrine cell signaling. Skalak[25] studied the macroscopic stress distribution and load transfer mechanism at the junction between the bone and implant level and found that an osseointegrated implant provides direct contact with the bone and transmits stress applied to the fixtures. He recommended a shock-absorbing material be used to absorb the impact. Also for this reason, adherence to a soft diet during the healing process is paramount to promote healing, minimize micromotion, and avoid unwanted occlusal force overload.[26] Following the healing period, final impressions and necessary laboratory work can proceed toward completion of a functional implant-supported definitive prosthesis. The purpose of this technical report is to describe an innovative technique and identify materials used to create an accurate implant impression, thereby creating an accurate master cast.

Technique

The Teeth in a Day® protocol is supported by having a laboratory onsite to fabricate a master cast. The technique described within this report is contingent upon the interim prosthesis being fully seated on the abutments and that no gaps exist between the implants and the abutments. This is verified with a panoramic radiograph taken on the day of surgery (Fig 1). Should the clinician discover a cylinder in the interim prosthesis is not fully seated on the abutment, it should be removed and reconnected into the proper position. If the abutment is not fully seated on or in the implant, the abutment needs to be adjusted,

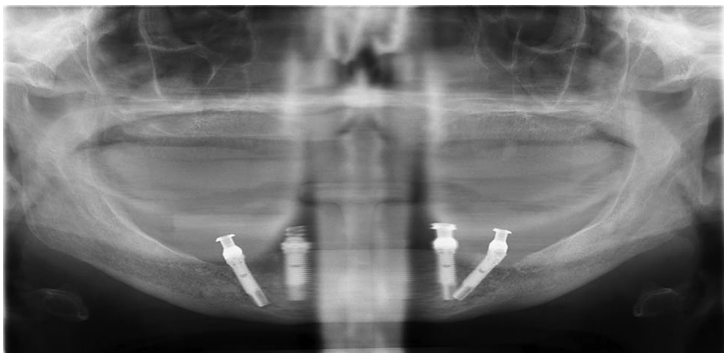

Figure 1 A panoramic radiograph taken on the day of surgery confirms that all implant components are fully seated.

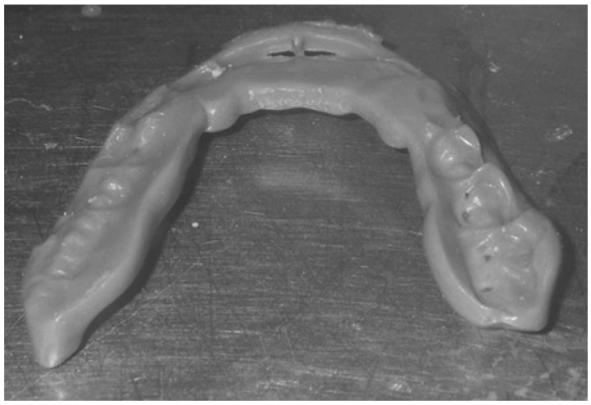

Figure 2 Occlusal registration at centric relation.

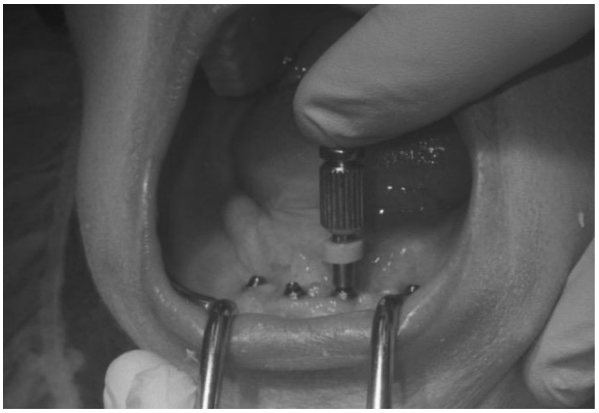

Figure 3 Abutments are checked for tightness.

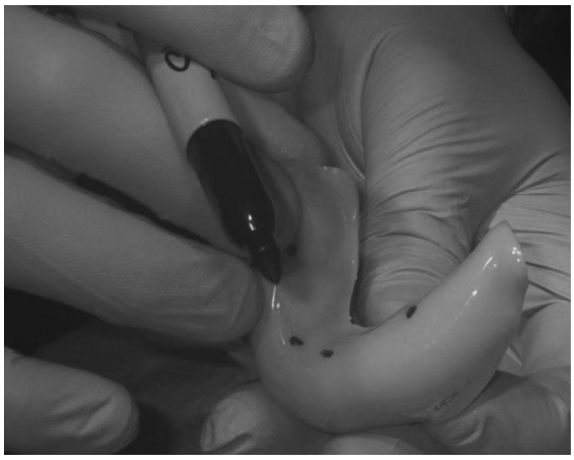

Figure 4 A custom tray is marked to indicate placement of the guide pins.

otherwise the impression will be inaccurate. If either of these scenarios occurs, they should be addressed as close to the day of implant placement as possible to maintain the accuracy of this impression technique.

The final impression is taken 12 weeks postsurgery. At this time, impressions of both arches are made with a dustless fast-set alginate impression material (Jeltrate Plus; Dentsply, York, PA). Since alginate has a propensity to distort, an on-site laboratory pours the impressions minutes following removal from the patient.

Figure 5 A custom tray is dry fit over the guide pins and adjusted as necessary.

1. A VPS occlusal registration (Fig 2) is made (Regisil 2X; Dentsply). Screw-access channels are cleared, and the prosthetic screws securing the interim prosthesis are loosened using a manual driver. The interim prosthesis is removed, and the abutments are checked manually for tightness (Fig 3). At this point, the prosthodontist determines individual implant stability and may optionally measure the progression of osseointegration via resonance frequency analysis (RFA).[27]
2. The patient is fitted with a custom tray made using a stiff polystyrene sheet (.125″ Blue Tray Material; Buffalo Dental Manufacturing, Syosset, NY). Using the patient's stone cast of the interim prosthesis poured on the day of surgery, several layers of damp paper towel are molded over the teeth. This will facilitate easy separation of the polystyrene tray material from the stone model. The tray material is heated as per the manufacturer's instructions, and vacuum formed (Econo-Vac Vacuum Former; Buffalo Dental Manufacturing) over the cast. The tray is trimmed, corresponding to the contour of the interim prosthesis and the surrounding ridge.
3. Next, the custom tray is marked with indelible ink designating where access windows will be opened (Fig 4). These openings will provide an area where long guide pins can extend beyond the occlusal surface of the interim prosthesis. The interim prosthesis is then reinstalled in the patient using the long guide pins (Fig 5).
4. Strips of flexible wax sheet (Adhesive Casting Wax 30 Gauge [0.25 mm]; Dentsply) are molded to cover the openings in the custom tray. The wax sheet is thin enough to push the guide pins through, yet sturdy enough to retain the alginate within the custom tray.
5. Alginate adhesive (Hold Impression Tray adhesive for alginate impressions; Water-Pik, Inc., Fort Collins, CO)

is painted on the interior of the custom tray (Fig 6), taking care to avoid the wax layer, and then air-dried. The adhesive serves to prevent distortion of the impression material by binding the alginate against the side of the tray and to ensure the tray and alginate can be removed from the patient's mouth as one impression.

6. Alginate material is mixed and uniformly distributed in the custom tray. Simultaneously, a tongue depressor or forefinger is used to apply alginate material to the buccal and lingual surfaces of the arch (Fig 7), thereby eliminating voids. By doing so, alginate will flow underneath the interim prosthesis to capture the healed soft tissue anatomy. The tray is then inserted into the mouth. While the alginate is setting, it is important to account for all the guide pins by pushing them through the casting wax and to clear their access holes.
7. Once the material has set, the guide pins are disengaged from the abutments and removed from the impression (Fig 8), and the impression containing the interim prosthesis is removed. Abutment analogs (Fig 9A) are secured to the cylinders of the interim prosthesis with guide pins (Fig 9B), and the impression is sent to the laboratory to fabricate the master cast.
8. Upon receipt of the final impression, the laboratory technician first simulates the gingival soft tissue (Gingifast Rigid; Zhermack Inc., River Edge, NJ), and the impression is then boxed using a strip of wax (Boxing Wax Red Regular; Coltène, Cuyahoga Falls, OH). Type IV die stone (Vel-Mix Pink; Kerr Dental Laboratory Products, Orange, CA) is poured into the boxed final impression.
9. Once set, the long guide pins are removed, and the interim prosthesis is carefully removed from the alginate and reinstalled on the master cast using prosthetic screws.
10. With the occlusal registration recorded prior, the master cast is articulated to the opposing stone cast. A stone cast of the interim prosthesis is also articulated with the opposing cast, providing the laboratory with the critical information to begin fabrication of the definitive prosthesis (Fig 10). A buccal and lingual matrix (Lab Putty Hard; Coltène) can be fabricated on the master cast with the interim prosthesis to provide precise information of the interim prosthesis contours and tooth position to aid in fabrication of the framework design, tooth position, and definitive prosthesis contours.
11. Following articulation, the prosthesis is polished, disinfected, and reinstalled in the patient's mouth with prosthetic screws. The screw access channels are sealed with Teflon tape (Thread Sealant Tape; Plumb Pak, Newington, CT) and covered with a light-curing single-component material (Telio CS Inlay/Onlay; Ivoclar Vivadent, Amherst, NY).

Discussion

The technique described within this report is contingent upon the abutments being fully seated on the implants and that no gaps exist between abutment and the temporary cylinder of the prosthesis. This is verified with a panoramic radiograph and cephalometric radiographs taken on the day of or shortly

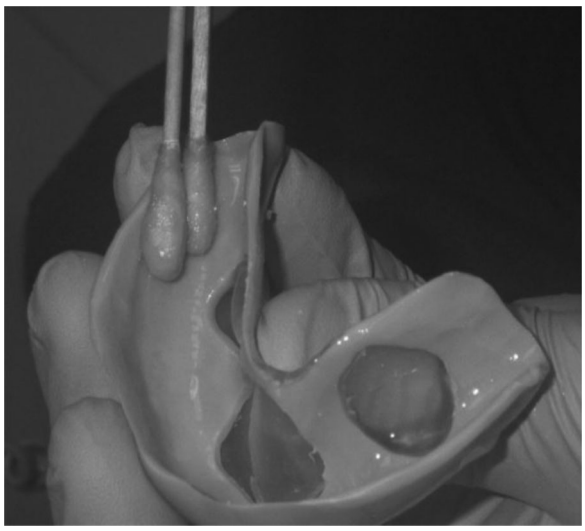

Figure 6 Hold Impression Tray adhesive is painted on the custom tray.

Figure 7 Alginate material is applied between the prosthesis and soft tissue to capture the space.

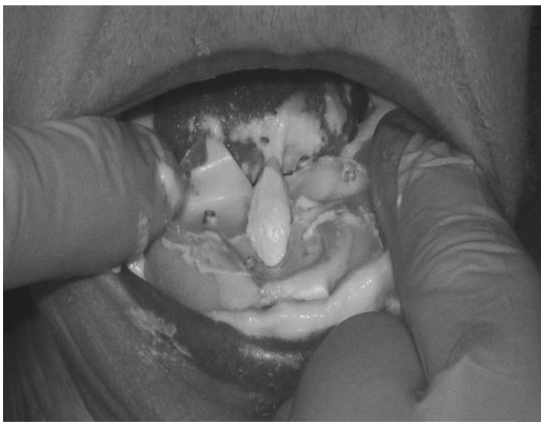

Figure 8 Once the alginate material has set, the guide pins are loosened and removed from the prosthesis. The interim prosthesis and alginate impression are removed simultaneously.

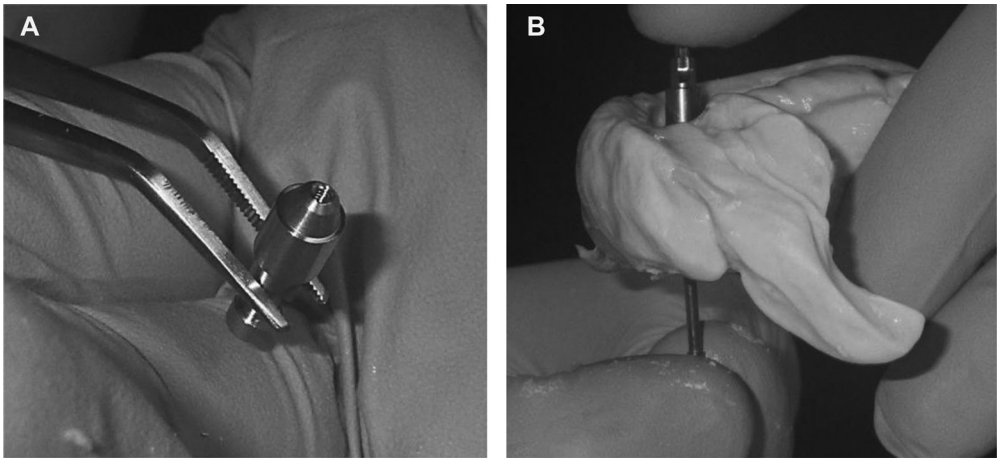

Figure 9 A and B) Abutment analogs are secured to the interim prosthesis with guide pins.

following surgery. After the recommended healing period of 12 weeks,[28] the process of constructing the definitive prosthesis begins with the final impression just described.

The prosthodontist will clinically determine implant stability and optionally measure the progression of osseointegration with RFA, expressed as an implant stability quotient.[27] If RFA is performed at the time of implant placement, the prosthodontist can monitor the changes in implant stability from implant installation. It also provides awareness as to the success or failure of an implant in a consistent and real-time manner. Should an implant fail, the ideal course of action would be to replace it, though this is treatment plan dependent. If an abutment screw is loose, albeit still seated, it is retightened, and it is appropriate to move forward with the final impression. It is imperative to note that unaltered abutment analogs should be installed in the final impression to maintain a high level of accuracy.

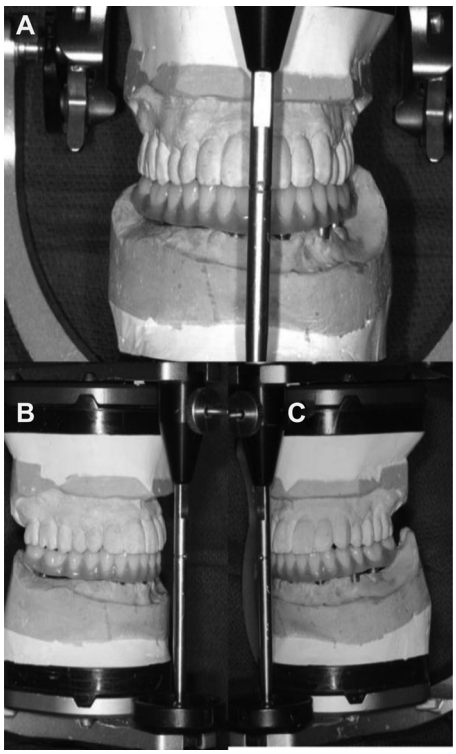

Figure 10 The interim prosthesis can also be used to articulate the master cast with the opposing cast. (A) Frontal view, (B) right lateral view, and (C) left lateral view.

A major objective in making implant-supported prostheses is the production of frameworks that exhibit a passive fit when connected to multiple implants or abutments.[29] Passivity of an implant prosthesis depends on the accuracy of the implant master cast, which is directly dependent on the accuracy of the impression technique.[30] Complications such as loosening of screw joints, fatigue fractures of components, marginal peri-implant bone loss, and loss of osseointegration may be a result of stress-related framework misfit or a poor passive fit.[31,32]

The authors recognize that the acrylic interim prosthesis is a nonpassively fitting restoration in early stages of healing and might easily displace the implants. In turn, the implants would osseointegrate in positions dictated by the restoration leading to a reduction of stresses.[33,34] Winter et al[33] noted that various authors reported bone remodeling that occurred as a consequence of mechanical loading did not compromise osseointegration, even when a nonpassive prosthesis was connected the day of implant placement. This research supports the author's position that bone remodeling occurs around the immedately loaded implants and will remodel to the neutralized stress (after creep dissipates) of an all-acrylic resin interim prosthesis.

Alginate impression material has distinct advantages that make it a suitable option for this technique. It produces an accurate negative impression of the dentition and surrounding soft tissue from which a positive reproduction is fabricated. Depending on the surrounding environment, set alginate material has a propensity to succumb to syneresis (lose water in dry conditions), or imbibition (absorb water and swell in aqueous solutions).[22] While it is generally known that this distortion

can alter an impression, this is not a concern for the authors. The all-acrylic resin interim prosthesis acts as the rigid impression splint, and an on-site laboratory pours the master cast of the impression minutes after the alginate has set. Furthermore, alginate is easy to use, and the process is expeditious, minimizing patient discomfort. Compared to VPS and PE materials, alginate is cost effective for the prosthodontist. This material, especially when used in conjunction with a custom tray, ensures uniform cross-sectional thickness[35] as well as a predictable and optimal fit for a detailed impression. Additional benefits of a custom tray include increased comfort for the patient and less waste of impression materials.

Conclusions

This technique of final impressions using the interim prosthesis and alginate to capture the relationship between the soft tissue and implants or abutments has allowed the prosthodontic authors to complete implant restorations efficiently and accurately. An accurate final impression provides the laboratory technician with a true orientation of the implant replicas in the accurate master cast with which they can fabricate definitive restorations.

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