Fabrication of a Dual-Purpose Surgical Template for Correct Labiopalatal Positioning of Dental Implants

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An implant-supported prosthesis can potentially provide a functional and esthetic reconstruction, provided that the implants are precisely placed in the predetermined location and angulation. Since the accurate placement of osseointegrated implants in the anterior maxilla with questionable bone support is often a clinical challenge, the use of computed tomography and surgical guides is crucial. This article describes a technique to fabricate a template that served as a guide for radiographic evaluation and was then modified for use in the surgical phase of the treatment. (Int J Oral Maxillofac Implants 2000;15:278–282)

Key words: *dental implants, dual-purpose surgical aid, implant placement, maxilla*

The success of implant reconstruction depends on meticulous care being taken in diagnosis and treatment planning for the patient. Evaluation of the potential recipient sites for implant placement with computed tomography (CT) is invaluable. Templates with radiopaque markers, such as gutta percha,[1–4] metal bearings,[5] lead foil,[6] metal rods or tubes,[7–9] and resin teeth made with barium sulfate,[10] are helpful guides in determining the necessary dimension, location, and angulation of the implant according to available bone, vital structures, and the predesigned prosthesis. From an esthetic standpoint, correct placement of implants in the anterior maxillary region is critical since regional soft tissue, bone morphology, and contour may affect the emergence profile of the prosthesis and compromise final appearance. Implants placed in the interproximal areas of the superstructure may cause oral maintenance problems, while implants overangulated toward the labial can lead to esthetic disharmony, which may necessitate location of the opening for screw access on the facial surface of the prosthesis or its complete removal. Implants placed too lingual relative to the superstructure usually result in a bulky prosthesis with an unfavorable palatal contour, which may also interfere with speech.

The use of surgical templates or guides for correct implant placement can be a determinant for success. Radiographic templates that are then modified for surgical purposes have the advantage of transferring the radiographic information to the surgical guide. The rationale for the utilization of a dual-purpose device depends on the following objectives:

1. In the CT evaluation, the radiopaque markers incorporated into the radiographic template should provide proper guidance in determining the location and the axis of the implant and the abutment. Relevant data should be transferred to the working cast through the markers, which dictate accurate reorientation of the surveying table for guiding channel preparation. An effective radiopaque marker should stay in place during modification procedures. Thus, if the design of the guide utilizes removal of the markers for channel preparation, the procedure must also include another guide for accurate transfer of the data from 2 to 3 dimensions.

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2. Conversion of the radiographic template to a surgical aid should facilitate correct placement of the implants with the desired path of insertion, which is correlated with the data obtained from a 2-dimensional scan image. The surgical guide should rest firmly on available structures and provide the surgeon with ease in site preparation and accurate visualization of the implant sites.

The objective of the aforementioned technique was to fabricate a surgical template that offers critical information about the location and angulation of the implant, as well as the position and angulation of the anticipated abutment relative to the predesigned superstructure with computed tomographic evaluation. Thereafter, modification of the device for surgical procedures is accomplished.

Fig 1 Occlusal view of the polished resin structure on the cast.

TECHNICAL PROCEDURE

Complete-arch impressions are made and maxillary and mandibular casts are poured in type III dental stone. The casts are mounted on a semiadjustable articulator using a facebow transfer and a centric relation record. After the potential implant recipient sites are determined, an appropriate arrangement of artificial teeth is completed. A condensational cure silicone (Coltene, Whaledent, Mahwah, NJ) is used to make an impression of the setup by a single mix technique. Upon setting, the silicone impression is retrieved from the cast and denture teeth are removed from the impression and from the cast. The wax is eliminated with hot water, and the cast is coated with a tin foil substitute.

A mix of clear autopolymerized methyl methacrylate resin (Orthocryl 2000, Dentaurum, Inspringen, Germany) is flowed into the silicone impression in the space previously occupied by the denture teeth. The cast is firmly inserted in the impression and secured with an elastic band, and the assembly is placed in a pressure cooker for polymerization. The impression is removed, the acrylic template is gently dislodged, excess material at the borders is trimmed off, and the guide is shaped and polished (Fig 1).

The cast is placed on the surveying table. The surveying table is tilted to determine the appropriate angulation of the implant in accordance with the anticipated bone angulations. Since the implants may not be parallel to one another, guiding marks are placed for each implant site to enable further reorientation of the cast. The template is placed on the cast, and labial cervical margins of the teeth are traced on the cast with a pen. The template is removed, and for each implant site, a mark is placed 1.5 mm palatally to the most labial point of the trace. (This distance represents the usual thickness of a porcelain-fused-to-metal restoration [Figs 2 and 3]). The template is repositioned, and a drill parallel to the longitudinal axis of the potential abutment is secured, while the tip of the drill is aimed toward the reference point and placed 1.5 mm palatally to the most labial point of the tracing (Fig 4a). For each implant site, a pin hole is prepared, and a pin compatible with the length and diameter of the hole is secured (Fig 4b). The template is placed in the patient's mouth, and a 2-dimensional CT scan is obtained. With the scan as a guide, the angle of the bone and amount of necessary tilt of the surveying table for each implant site are determined.

The image of the pins facilitates angulated abutment selection (Fig 5). For each implant site, the pins are removed from the template, the surveying table is reoriented, and a groove (approximately 4 mm in diameter) is prepared with a carbide bur on the cingulum of the restoration. The distance between the reference point placed 1.5 mm palatally to the most labial point of the tracing and the central axis of the implant, determined from evaluation of the scan, is measured at the crestal level (Fig 6). A stainless steel tube is attached to the analyzing rod, whose inner diameter matches the diameter of the surgical drills and is located in accordance with the measurements made. This will provide correct labiopalatal positioning of the implant. For each implant site, the metal tubes are fixed with acrylic resin. The height of the tubes is reduced so as not to restrict the use of surgical drills to the bone, and the borders are smoothed and polished (Fig 7).

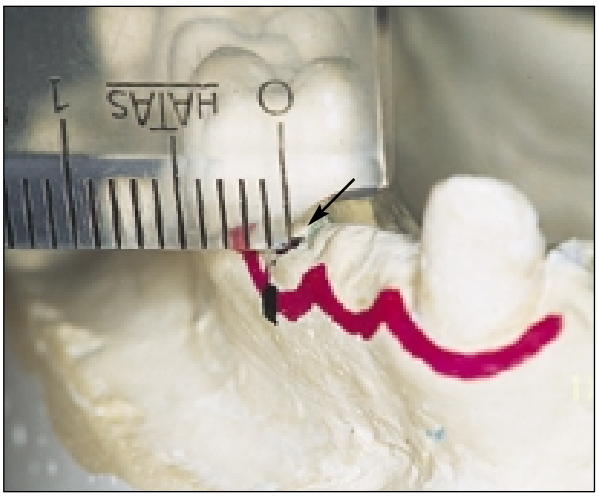
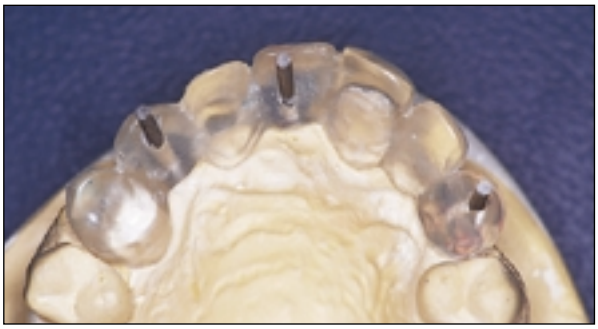


Fig 2 The dot *(arrow)* is the reference mark placed 1.5 mm midpalatally to the tracing that denotes the cervical margins of the restoration.

Fig 3 Line "b" represents the central axis of the implant. The red dot is the mark placed 1.5 mm midpalatally to the tracing.

Fig 4a *(Left)* The cast on the surveying table is tilted to determine the ideal abutment axis. Note the tip of the drill is in contact with the mark placed.

Fig 4b *(Below)* Finished radiographic template with pins secured in place.



DISCUSSION

The selection of an angulated abutment, particularly in the anterior maxillary region, is critical, since fixed prostheses supported by multiple abutments in a cross-arch position may require fabrication of custom abutments. The reference point, which represents the usual thickness of a porcelain-fused-to-metal restoration, aids in positioning of the abutment relative to the restoration while avoiding a compromised emergence profile. Based on this principle, the technique promotes abutment selection according to the restoration and the implant.

Since the lead foil application[6] comprises the application of the foil to the outer surface of the denture, which could be considered as a curved surface, the actual line representing the angle of the implant would definitely be a tangent of the curve

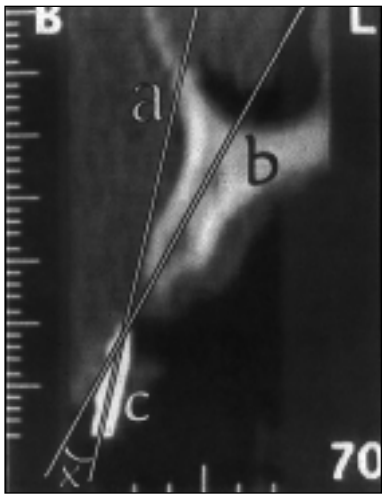


Fig 5 Line "a" represents the angulation of the restoration. Line "b" is the central axis of the implant. The angle in between "x" is the desired abutment angulation.

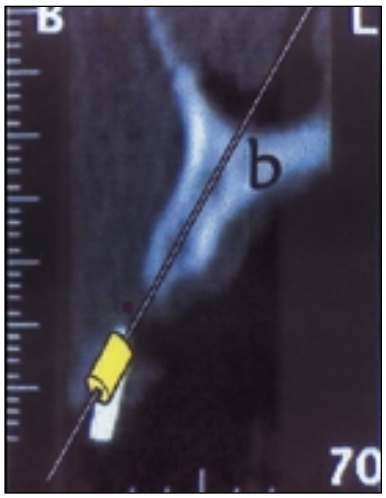


Fig 6 The amount of required labiopalatal movement of the analyzing rod is the distance between the red mark and line "b," which is measured at the crestal level. The yellow cylinder represents the tube that will be incorporated for surgical guidance.

Fig 7 Modified template for surgical use, with metal tubes incorporated.

at a certain point. Thus, it may not always seem possible to correctly transfer the radiographic data to the template. Materials such as barium sulfate[10] (in tooth form) and gutta percha[1–4] have also been used. However, the use of these materials in the technique may lead to a missing reference point in the event any correction is necessary.

In the current technique, the rationale for using a pin with an average diameter of 1 mm for CT evaluation is to detect the pin in only 1 section of the scan images with its whole diameter. It is secured at the middle of the mesiodistal space and 1.5 mm palatally relative to the cervical margin of the restoration, while its tip is also in contact with the residual ridge. Thus, the scan image that is evaluated is actually the middle section of the tissues surrounding the implant. Determination of the required guide channel axis for implant placement is provided by the abutment axis and available bone angulation measured in the scan. Since the reference point on the cast is also marked at the middle of the mesiodistal space and 1.5 mm palatal to the cervical margin of the restoration, the only adjustment in guide channel preparation would require labiopalatal movement of the drill after reorientation of the cast on the surveying table. Thus, the

reference mark avoids the possible drilling error that can be made in a mesiodistal direction. In addition, the reference mark also has a restrictive effect on labiopalatal direction, which aids in preserving the esthetics of the gingival profile and the labial contour of the final prosthesis.

Misuse of the surgical drills throughout acrylic guiding channels can lead to an unfavorable change in the guidance of insertion and unsuccessful implant placement. The determined guidance provided by stainless steel tubes was considered in this situation because the available bone was too narrow, and malalignment of the implants could affect the whole treatment. However, the diameter of available tubes may not always be compatible with that of the selected surgical drills, necessitating milling of the inner surface of the tubes.

The use of a dual-purpose template is a valid choice if the modification procedures are performed in accordance with the measurements carried out on the CT scan. Although the converting process may be time-consuming, such guides offer the advantage of placing implants in the desired 3-dimensional position. Removing the radiopaque markers in the conversion procedures may lead to loss of some data provided by its guidance in a 3-dimensional scale. The information regarding location and angulation of implants that is viewed in a 2-dimensional plane can easily be transferred to a 3-dimensional environment by placing reference marks on the working cast with the radiopaque marker. Such marks facilitate correct reorientation of the working cast and further procedures with negligible error. More clinical experience is indicated to see whether this inevitable error rate in transferring the information will affect implant prosthesis success.

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