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The Role of the Template in Prosthetically Guided Implantology

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Abstract

In prosthetically guided implantology, where ideal placement of implants is determined by the definitive restoration, the use of a radiographic/surgical template plays an essential role. This article describes how to fabricate a radiographic/surgical template to be used for radiographic diagnosis of the selected implant sites and as a guide during surgery for the insertion of the implant with correct angulation.

In the past, implant site and inclination were dictated by residual bone quantity. The desire for a predictable prosthesis,[1-2] particularly for fixed partial dentures, led to the development of a new concept of "prosthetically guided implantology." This concept establishes the correct implant position during the diagnostic stage according to the planned definitive restoration.[1-7]

To identify the implant site according to the habitual occlusion, the static, functional, and dynamic relationship of the occlusal condition is analyzed. Information about the ideal loading axis, gathered from diagnostic/study mounted casts and a diagnostic wax-up, is transferred during treatment planning to the radiographic/surgical template.[8-12]

The template should be stable, rigid, of limited size, easy to insert, transparent, modifiable, and sterilizable.

Occlusal stability and open-mouth stability are key elements. When radiographic examination is made, specifically using CT DentaScan, the correct and stable mandibular position in occlusion is necessary to achieve a high quality, distortion-free examination, and the ultimate display of reliable images.

During surgical procedures, open-mouth stability helps compliance of the defined insertion parameters and prevents any excessive increase of new alveolar width, which would make it unsuitable to the implant size and morphology. Patients with residual dentition have better intraoral operative immobility. In edentulous patients, the reflection of the mucoperiosteal flap changes the fit of the template base on the underlying tissues. For instance, for the maxilla, the template needs a suitable palatal support with extensions to the tuberosities, while for the mandible, the ideal solution is a tripod supported by two posterior flanges resting on both retromolar pads and by an anterior extension, measuring a few millimeters in width, in the symphysis region.[7]

The template must be rigid, should not deform in time or with exposure to physical and/or chemical agents. It should not undergo changes or breaks when inserted during radiographic examination and surgical stages.

Size must be limited, so as to facilitate surgical procedures, while complying with rigidity and stability requirements. The template's resin structure should have a reduced height in edentulous areas, allowing the reflection of access mucous flaps. The occlusal surface should be smoothed so that when light finger pressure is applied, the template is comfortably placed to ensure immobility during the drilling of the implant site.

Both the patient during radiographic examination and/or the surgeon during surgery should be able to insert the template. This procedure can be easily be done depending on the template's size. Sometimes it is necessary to remove all internal undercuts and to reduce the template's height of the resin on the supporting teeth.

Transparency is not indispensable, although it may be useful during surgery, as it provides a clearer view of the operative field. Furthermore, it allows a better orientation of the drills, taking as a reference the inclination of the sleeve, which is visible from the outside.

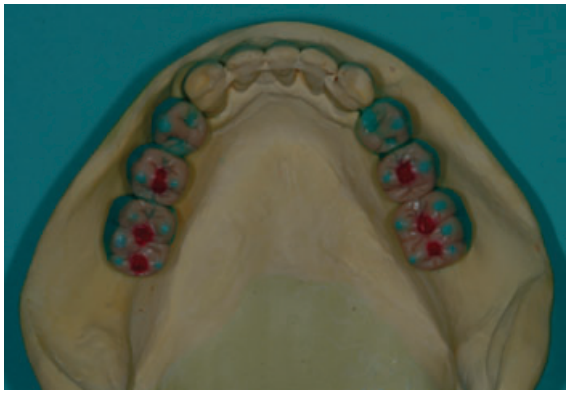

Figure 1 Diagnostic wax-up, occlusal view.

A template is adjustable when it is possible to change the position and inclination of sleeves. This is possible by means of a radiographic examination at the time of surgical planning.

Finally, the template used in surgery must be sterilizable. This is difficult to obtain with the resinous materials currently used, as they must be disinfected with chemical substances.

The purpose of this article is to describe how to fabricate a radiographic/surgical template to be used for radiographic diagnosis of the selected implant sites and as a guide during surgery for the insertion of the implant with correct angulation.

Template fabrication procedure

(1) Make two alginate impressions (Jeltrate Dentsply, Konstanz, Germany) of both upper and lower dental arches.
(2) Mount the diagnostic/study casts on a semi-adjustable articulator (model SAM 3 Prazisionstechnik GmbH Gauting bei, Munich, Germany) using a centric relation record (the technique of bimanual manipulation is used to locate the centric relation position).[13]
(3) Complete a diagnostic wax-up of the prosthetic restoration according to gnathological/occlusal condition (Fig 1).
(4) Make a silicone matrix of the diagnostic wax-up (Titanium Zhermack, Zhermack, Rovigo, Italy) and trim from the most coronal portion to the occlusal surface of the teeth.
(5) Remove the teeth, place the silicone matrix, and mark with pencil the emergence profile and the ideal loading center (Fig 2).
(6) Place the diagnostic/study cast on a dental surveyor. Using a drill, make a hole for each implant site placed at the center of the tooth profile (equidistant from mesial and distal surfaces, and from oral/buccal aspect of the tooth).
(7) Place a cylindrical marker (Falappa Medical Device, Rome, Italy) on the drill rod inserted in the hole (Fig 3). Stainless steel or titanium cylinders should be used with a minimum thickness to limit radiographic artifacts. Moreover, they should be suitably shaped and sized in order

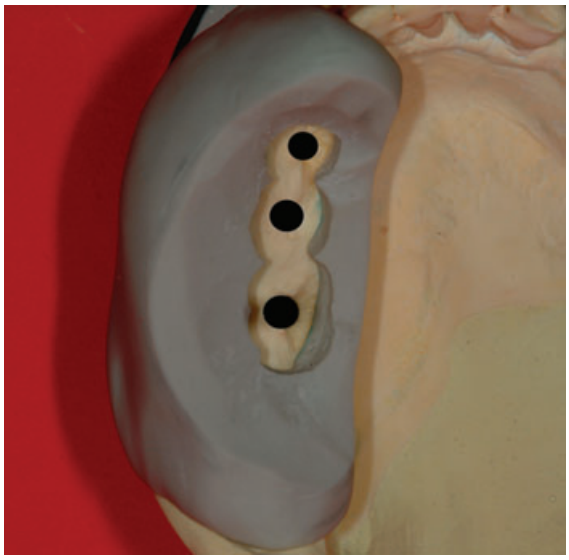

Figure 2 Silicone matrix.

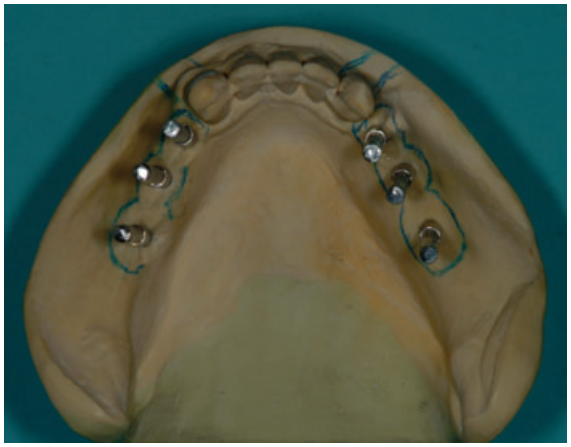

Figure 3 Drill rods in position, onto which the cylindrical radio-opaque marker is placed.

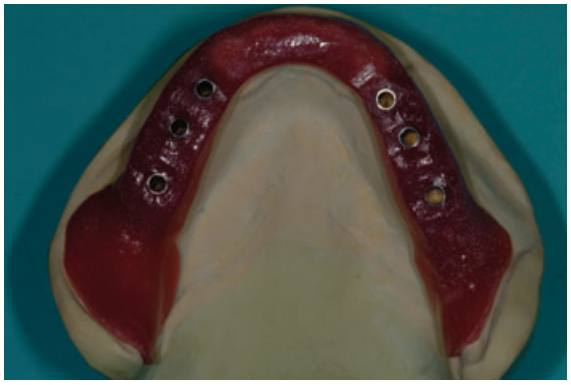

Figure 4 Radiographic-surgical template.

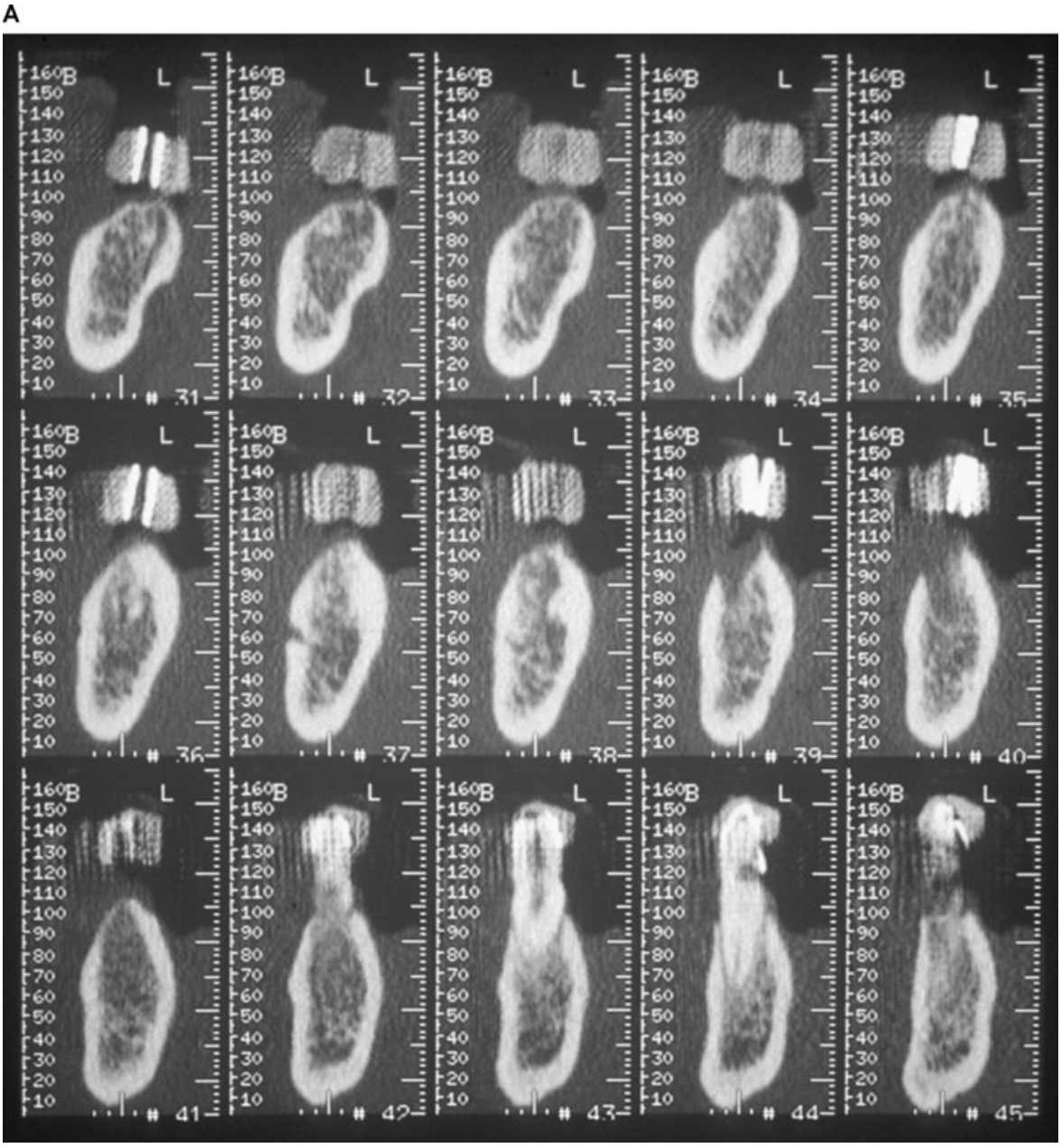

Figure 5 DentaScan (A and B).

to keep the correct inclination of the drill in the surgical phase, with a diameter of 0.1/0.2 mm in excess of the pilot drill of the implant system used and at least 7-mm length.

(8) The cylindrical markers are first fixed with sticky wax. They are finally blocked-out using acrylic resin (Orthocryl 2000, Dentaurum, Ispringen, Germany), which is also used to construct extensions on the residual denture and/or the mucosa.[8]

(9) The template is trimmed and smoothed (Fig 4). The occlusion is checked on the semi-adjustable articulator.

(10) The template is fitted in the patient's mouth before the radiographic appointment to ensure that it is comfortable and stable.

(11) The patient is instructed on how the template should be inserted and removed.

Clinical use of the template

The use of a template in radiographic evaluation is useful with such conventional methods as panoramic radiography,

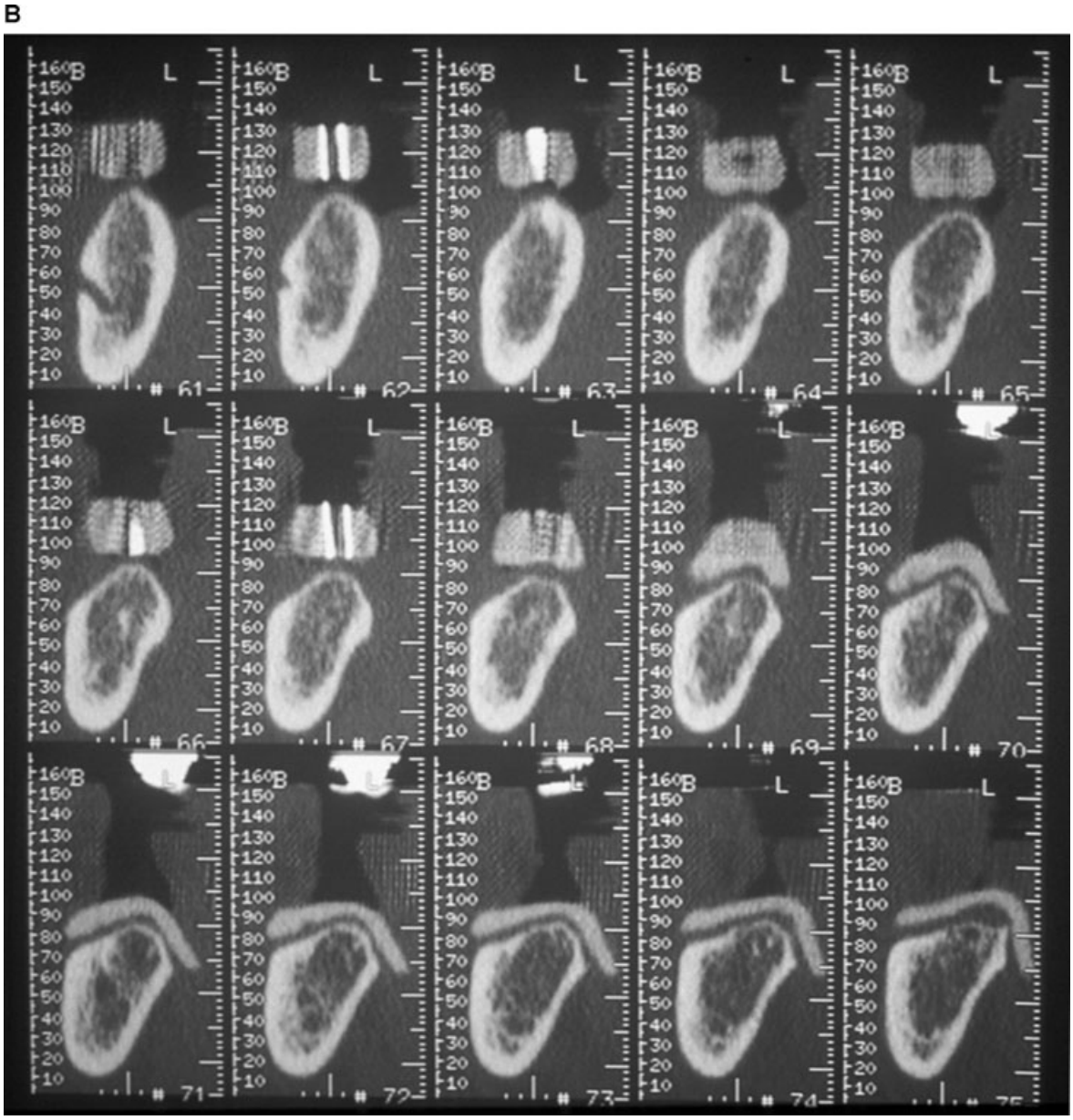

Figure 5 (*Continued*).

latero-lateral teleradiography, and peri-apical radiography, while it is irreplaceable in the CT DentaScan examination.

The clinician using the markers in taking panoramic radiography can locate the bone site selected for the implant, but cannot check the correct axis's inclination. The ridge size can exclusively be assessed on the vertical plane (i.e., height) and not on the horizontal plane (i.e., thickness), using panoramic radiography.

Also, whenever periapical radiograms are taken, the use of a template allows the measurement of only the apical-coronal and mesiodistal sizes of the bone at the implant site, but cannot measure the buccal-oral size of the bone.

On the other hand, the use of the template can provide useful information when a lateral cephalogram is performed in patients with total lower jaw edentulism. In fact, this device allows the clinician to study the intermaxillary relationship and the inclination of the symphysis axis.

When a CT DentaScan is performed with the template, it is possible to:

(1) measure quality, height, and thickness of the bone ridge in the site where an implant will be placed;
(2) assess correctness of marker inclination and therefore the prosthetically defined implant insertion axis;

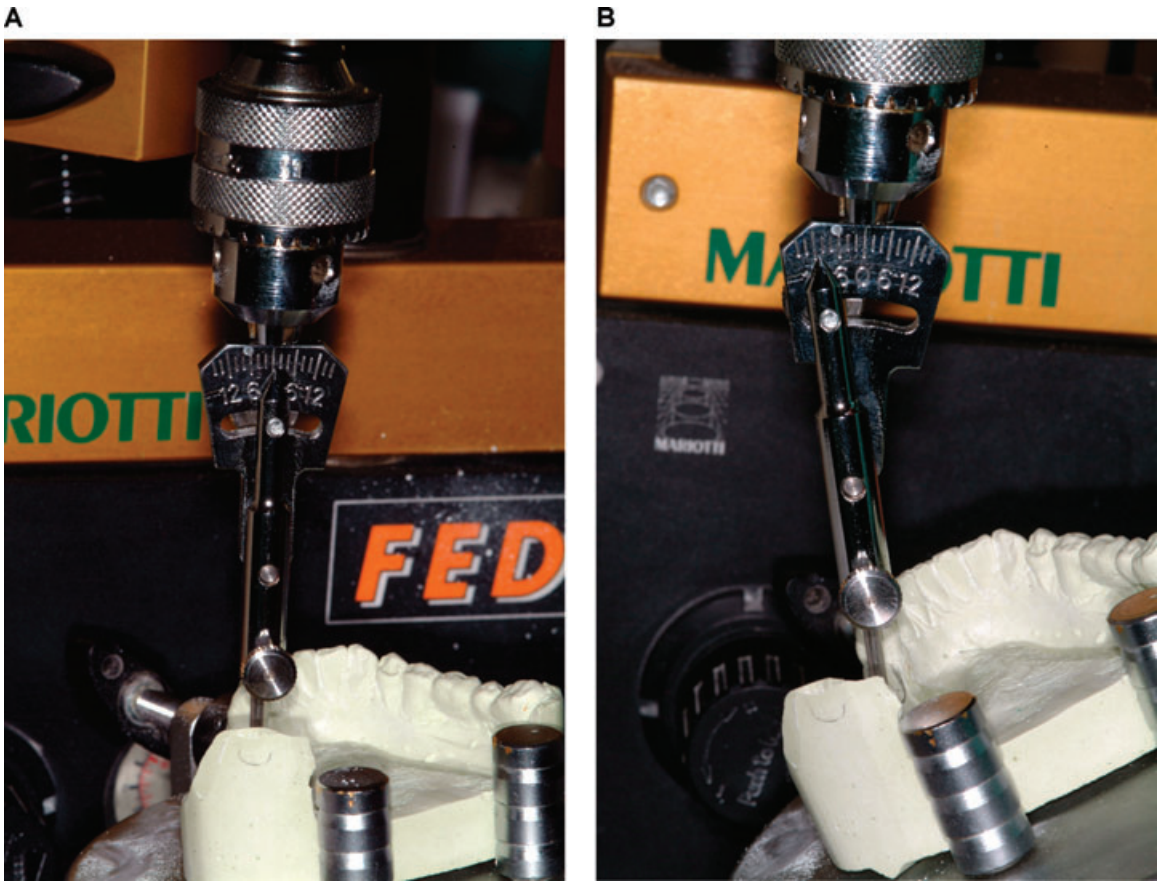

Figure 6 (A) Conometer device with the curved scale at 0°. (B) Conometer device records the shifting movement measured by the goniometer.

(3) choose implant length and diameter;
(4) define the exact location of vital anatomic structures, such as nasal cavity floor, maxillary sinus, mandibular canal, and mental foramen (Fig 5).

However, a number of factors may influence the reliability of reconstructions, such as the acquisition plane choice and, particularly, the markers' mesiodistal inclination, as in this case, coronal view reprocessing does not provide a proper view of the bone tissue in the selected implant site.

This limit is peculiar to the DentaScan software, in which scan acquisition is made in accordance with a plane perpendicular to a single marker axis and the reconstruction of cross views is performed with multiplanar sections at 1- to -2-mm intervals along planes perpendicular to that of acquisition.

The foregoing information is only reliable for the cylindrical marker perpendicular to the scan plane, which is shown in two subsequent views and is reproduced in full length as its diameter measures less than 3 mm. The information does not reliably occur for other markers, which have a different inclination and are visible in at least three or four subsequent scans, with differing heights, and are located at a variable distance from the ridge top, with a different sleeve segment shown in each section.

To avoid this drawback, different software products are available to reprocess scans relating to each marker axis to provide reliable information on the qualitative and quantitative characteristics of the implant site.

Where the implant site and inclination of the markers is not perfectly compatible with the size of the underlying bone, surgical procedures may be selected to augment the local bone volume.

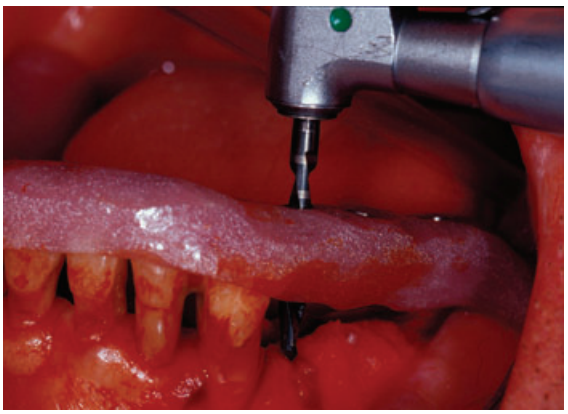

Figure 7 The template helps guide drills in the preparation of the implant alveolus.

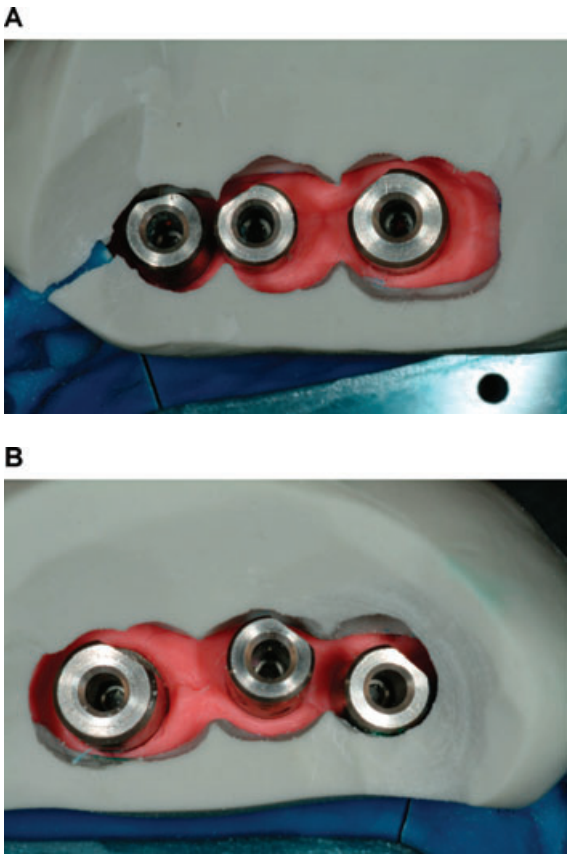

Figure 8 The silicone matrices on the master cast (A and B).

In the case of minimum discrepancy (i.e., in the range of 15°), the decision can be made to change implant insertion axis from the diagnostic position.

To change the marker position, draw on transparent graph paper the contour of the cortical bone and the outline of the marker; to trace the longitudinal axis and the new corrected axis, place a goniometer at the intersection between the two axes to measure the angle. The data thus obtained are sent to the laboratory, which will transfer the same to the template.

The cylinder shifting is determined as follows:

(1) Plaster study/casts used to manufacture the surgical template are placed on the surveying table, modified with an inserted pin in order to allow movement only in a single direction.
(2) The tip of the conometer device (type I, Laboshop, Bolzano, Italy) is positioned at 0° and is inserted in the access hole, corresponding to the cylindrical marker to be modified (Fig 6A). The surveying table is fixed to permit movement in a single direction.
(3) The surveying table must be tilted until the shifting movement measured by the goniometer on the transparent paper will be the same one registered by the conometer device (Fig 6B).
(4) The surveying table is settled in the corresponding position, and the inclination of the access hole is modified by drilling the plaster cast according to the fixed angulation.
(5) The template is placed on the cast, after removing the cylindrical marker, and the fissure bur is inserted in the correct hole
(6) The cylindrical marker is inserted on the fissure bur and fixed with acrylic resin.

During surgery, the template guides the drills in the preparation of the implant alveolus based on the diagnostically defined inclination and position. The template will also be instrumental in the reflection and protection of the access flap and may facilitate the exposure of implants, if they are not perfectly visible when they are fully covered by the bone tissue[11] (Fig 7).

The exact correspondence between the programmed implant position and inclination during the diagnostic phase with those obtained during surgery will be checked at the time of prosthesis construction by positioning the silicone matrix used for template construction on the master cast. These matrices may be used as a guide for the precision trimming of abutments and creating optimal prosthesis superstructures (Fig 8).

Conclusions

The template provides a link between diagnostic and surgical phases, as it contributes to cosmetically and functionally correct implant-supported prosthetic rehabilitation.

When compared to the many devices reported in the literature,[14-30] the template described in this article has the advantages of accurately forwarding to the surgical phase the information and data collected by diagnostic wax-up, validated through radiographic examination, to obtain optimal implant insertion based on the planned position and inclination.

Furthermore, it can be practically used in both radiographic examination and surgical phases, with the added advantages of easy manufacturing and contained costs.

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