Simplifying Implant Placement in the Maxillary Anterior

INTRODUCTION

Dental implant placement can be challenging based on the geometry of the bone present, especially in the maxillary anterior where the angle of the premaxilla requires a different trajectory then the prosthetic axis that will be placed during restoration.[1] Traditional radiographs (periapical and panoramic) only provide 2D views of the 3D anatomy practitioners operate within. Thus, information regarding the inclination of the "triangle of bone" is absent, and implant placement requires a flapped approach to fully view the facial plate to aid in osteotomy preparation during implant placement.[2,3] Even under these circumstances, the surgeon must center the drills in the space for that single implant to attempt to properly position the implant in the mesial-distal orientation.[4] This becomes more complex with greater potential error when placing 2 implants adjacent to each other and increases as more adjacent implants are planned. Angulation errors in the facial-lingual dimension can still occur when "free-handing" placement, leading to prosthetic complications during the restorative phase.[5]

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Poor placement can result in insufficient bone on the facial aspect of the implant....

Simple surgical guides have been in use for a guided approach that is prosthetically driven.[6] These have ranged from guides created with denture teeth on the cast[7] with a guide hole to position the initial drills to metal sleeves[8] that can, with appropriate inserts in the sleeve incorporated in the guide, allow the guidance of each drill and implant insertion into the site. Unfortunately, these guides do not consider the 3D anatomy when they are fabricated and are created using the cast and viewing traditional radiographs to guide a hole drilled into that cast to position the sleeve and capture those sleeves in a resin that will stabilize intraorally on the adjacent teeth. Depending on the design of the guide and position in the arch, these guides may allow a flapless surgical approach, or they still may require a flap to verify the orientation of the osteotomy in reference to the anatomy present. These factors can be challenging when single implants are planned in a partially edentulous arch.[9] Cone-beam computed tomography (CBCT) has helped in eliminating the lack of information that traditional radiographs have provided by allowing analysis of the intended surgical area in 3D.[10,11] Technology has expanded on this improved information by permitting virtual planning of the implants and fabrication of CAD/CAM surgical stents to better guide the drills to create the osteotomy that is anatomically and prosthetically guided. The benefit of this approach is a fully flapless surgery that can be performed to guide implant placement. These guides are typically created by a lab following transmission of the virtual planned implant placement from the CBCT scanner using various software packages on the market. The lab then creates the surgical guide and returns it to the surgeon, and the implant placement is performed. The negatives of these lab-fabricated surgical guides are the 2-to-3-week turnaround time between submission of the virtual plan and receipt of the CAD/CAM surgical guide and the lab fee for that guide from the lab. This can be cost-prohibitive for the patient when a single implant is planned. Some of these problems are eliminated for those practitioners who are CAD/CAM milling or printing in their practices, shortening guide-fabrication time to a day from several days, and the cost for the guide is substantially reduced. Unfortunately, most practitioners are not set up in their practices to create milled or printed guides. A simpler approach has been developed that uses a surgical guide fabricated in-office that does not require milling or printing. The guide is worn during a CBCT scan, and that data is imported into the implant planning software, where corrections to the planned trajectory and 3D position are made to the final in-office guide to be created. The result is a cost-effective surgical guide that can be quickly created in-office and is guided based on 3D anatomy, allowing a flap-free surgical approach that eliminates potential prosthetic complica-

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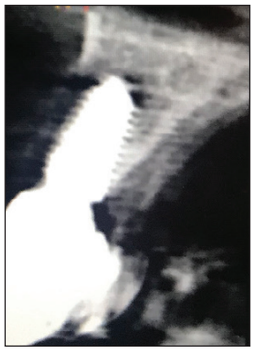

Figure 1. A CBCT scan of the failing implant at the left maxillary central incisor site demonstrating a lack of facial bone overlying the implant and poor angulation related to the angle of the premaxilla at the site.

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tions if bone is adequate based on the desired implant position. A case demonstrating this technique and application with regard to a single implant placed in the anterior maxilla is presented here.

CASE REPORT: SINGLE ANTERIOR IMPLANT PLACEMENT IN THE MAXILLA

A 68-year-old male patient presented for consultation for a failing implant that replaced his maxillary left central incisor. Examination noted a facial 8-mm probable pocket and absence of bone at the facial aspect of the crest related to peri-implantitis (Figure 1). The implant was removed, and the site was grafted with a mixture of Puros (Zimmer Biomet), OsteoGen Plug (IMPLADENT LTD), and Infuse Bone Graft (Medtronic). Three months later, an impression was taken. The patient was scheduled to return for a CBCT scan, and a guide was made to indicate the prosthetic planned trajectory for the implant orientation.

Components of the Guide Right system (DePlaque) were utilized to create the initial (diagnostic) guide to be used for the CBCT scan and the subsequent corrected surgical guide and osteotomy correction (Figure 2). The previously taken impression was poured in stone to create a cast. A 3/32-in drill (Figure 2c, left) was used to place a hole in the cast at site No. 9 that was centered in the edentulous site at the estimated position and had a trajectory based on the orientation mesial and distal to the missing tooth (Figure 3). A Guide Post (Figure 2a, left) was inserted into the hole in the cast, and a 3-mm Guide Sleeve (Figure 2b, right) was placed over the post with its retention element (cleat) oriented to the palatal (Figure 4). The palatal and occlusal surfaces of the cast were lubricated to prevent resin adherence to the guide to be fabricated. A light-curable resin (primopattern LC Gel [primotec USA]) was expressed on the cast over the cleat and adjacent teeth to create a stabilizer for the diagnostic guide when inserted intraorally and is light-cured (Figure 5).

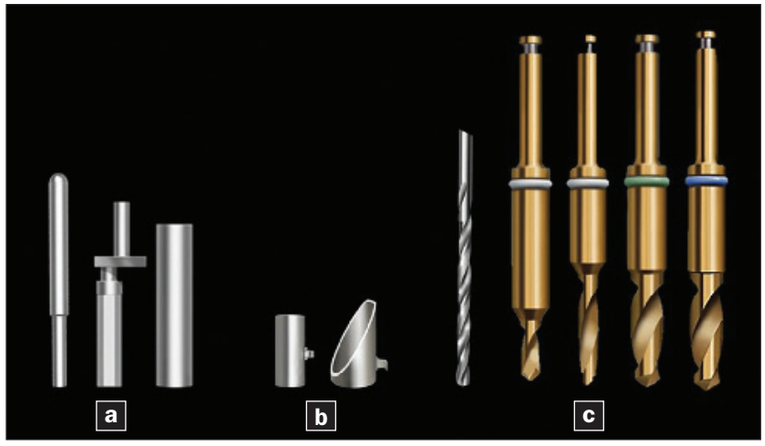

Figure 2. Components of the Guide Right system (DePlaque): **(a)** Guide Posts, **(b)** Guide Sleeves, and **(c)** drills.

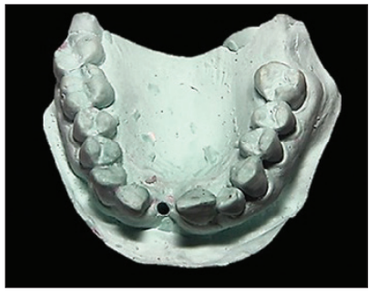

Figure 3. A pilot hole was created in the study model at the planned implant site with a 3/32-in drill, estimating the proposed osteotomy axis and position.

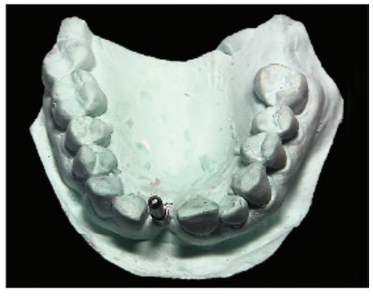

Figure 4. A 3-mm diagnostic Guide Post was inserted into the pilot hole in the study model, and a 3-mm Guide Sleeve was placed over the post with the retention element (cleat) on the sleeve oriented to the lingual.

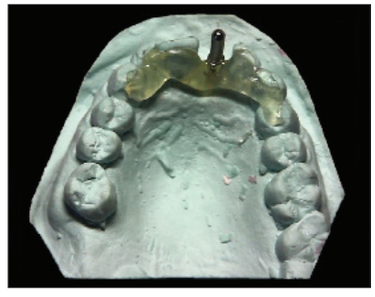

Figure 5. A light-curable resin (primopattern LC Gel [primotec USA]) was applied to capture the 3-mm Guide Sleeve cleat to create the diagnostic guide in preparation for a CBCT scan for implant planning.

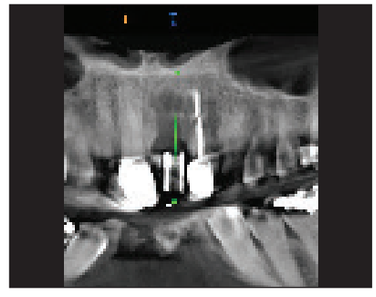

Figure 6. CBCT scan demonstrating implant trajectory in the tangential view in relation to the available bone at the planned site.

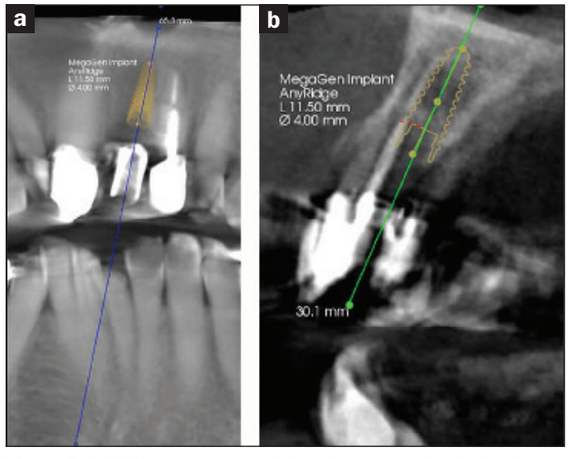

Figure 7. A CBCT scan (tangential and cross-sectional views) prior to correction of the guide sleeve in the planning software indicated the trajectory of the implant if the sleeve was followed, which would have resulted in thin bone on the palatal surface.

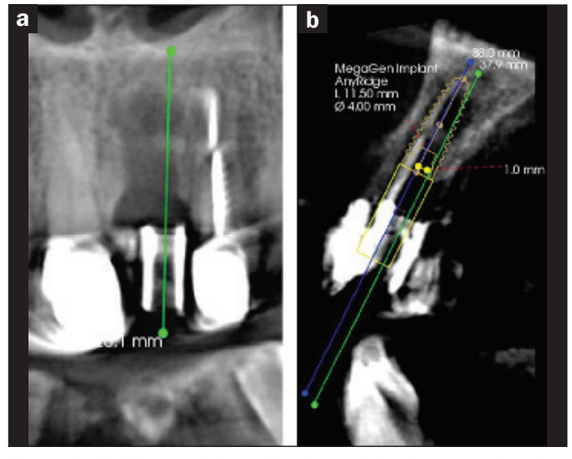

Figure 8. CBCT scan of the guide sleeve following correction of the implant trajectory in the planning software to a better position in relation to the available bone of the site (green line) that is offset 1.0 mm facially and 0.5 mm mesially from the initial trajectory (blue line), a 1.06-mm correction mesiobuccally.

The patient returned for a capture of the CBCT scan with the diagnostic guide. The guide was inserted intraorally, and the CBCT scan was taken (Figure 6). The scan was imported into the implant planning software (Carestream Dental). The metal sleeve was visible on the scan, and its radiolucent center length allowed a trajectory to demonstrate the mesial-distal and facial-palatal orientations of the implant should the original sleeve be used to guide the implant drills in creating the osteotomy. CBCT tangential and cross-sectional views in the planning software noted that the implant, based on the initial sleeve position, would be positioned the implant too far palatal, which would result in thin bone on the palatal surface of the implant when placed (Figure 7). The virtual implant was moved 1.0 mm to the buccal, maintaining the same trajectory angle (Figure 8, green line) from

the original trajectory (Figure 8, blue line). This new position allowed the implant to be placed buccally, centering it in the alveolar ridge based on the anatomy present as analyzed in the CBCT scan. A Guide Post with a 1.5-mm offset (Figure 2a, center) was inserted into the previously placed hole in the cast with the offset position oriented toward the buccal. The offset Guide Post was rotated 0.5 mm mesially at 45° to reposition the upper extension of the offset post to a better prosthetic position (Figure 9). A 2-Piece Upper Removable Part (URP) (Figure 2a, right) was placed over the upper extension of the offset post protruding from the cast, and a 3.9-mm Angle-Cut Guide Sleeve (Figure 2b, left) was placed over the 3.9-mm URP with the retention cleat to the palatal (Figure 10). A light-cure resin gel was placed over the cleat on the sleeve and continued over the incisal/occlusal surfaces of the adjacent tooth to create the corrected surgical guide that would be stable on the adjacent teeth when inserted intraorally (Figures 11 and 12). Based on virtual planning, a 4.0-mm × 11.5-mm implant was planned for the site.

The patient presented for the surgical appointment, the corrected surgical guide was tried in, and its stability on the teeth was confirmed. Topical anesthetic was applied to the planned surgical site, and 4% articaine with 1:200,000 epi was injected for local infiltration. The site was swabbed with Betadine, and the surgical guide was placed and immersed in Betadine for 3 minutes, then rinsed in sterile saline.

The surgical plan included the placement of graft material to build out the coronal-facial aspect of the ridge to fill the present defect and create a better aesthetic result. A scalpel was utilized to create a mid-crestal incision, and a full-thickness flap was elevated toward the buccal. The surgical guide was inserted. The initial osteotomy drill (with a 1.8-mm tip that widens to 2.2 mm with a 6-mm length before the guide sleeve portion of the drill) was introduced into the guide sleeve until the widened portion of the drill contacted the crestal bone and could not proceed farther apically (Figure 13). The osteotomy continued, using a 2.2- × 8-mm, 2.2- × 10-mm, and 2.2-mm-diameter drill to the 11.5-mm depth of the planned implant to the drill stop where the wider portion of the drill contacts the crestal bone, preventing further advancement) (Figure 14). Osteotomy continued in the guide sleeve using a 3.3-mm-diameter drill to the 11.5-mm depth (Figure 15). The osteotomy was finalized with a 3.7-mm-diameter drill to the 11.5-mm depth in the guide sleeve (Figure 16). The osteotomy was completed, and the surgical guide was removed intraorally. A 4.0- × 11.5-mm implant (AnyRidge [Mega'Gen]) was introduced into the osteotomy using the surgical handpiece until it stopped at 50 N, and insertion was completed with a hand torque wrench until the proper depth was achieved (Figure 17a).

The graft material was prepared, which consisted of 0.0050 g of Infuse Bone Graft material, which contains a recombinant version of bone morphogenetic protein-2 (rhBMP-2) that was reconstituted with 0.5 ml of sterile saline. This was then added to a 6- × 25-mm OsteoGen Plug, which was cut into 2 pieces and placed into 0.5 g of Puros cancellous fine particle bone graft (Zimmer Biomet Dental) and left for the Infuse protein to bind to the collagen prior to placement according to the manufacturer's directions. The labial surface that would be overlaid with a graft to build out the ridge was scored with a round carbide bur in the surgical handpiece to create bleeding points to aid in graft conversion with host osteogenic cells. An i-Gen 2-mm flat abutment (M1.8) (Mega'Gen) and a

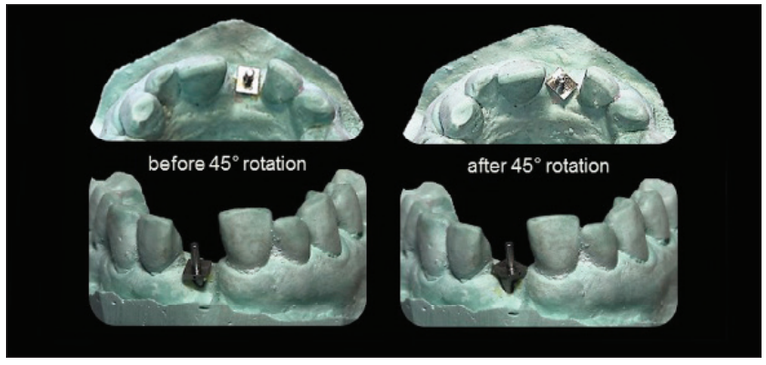

Figure 9. Occlusal and facial view of the 1.5-mm offset Guide Post before (left, top and bottom) and after (right, top and bottom) rotation to better reposition the axis prosthetically.

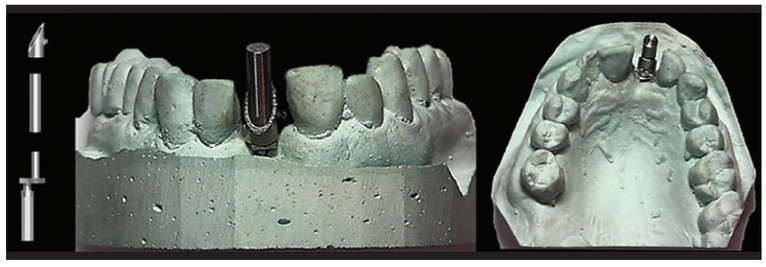

Figure 10. Buccal and lingual view of the 3.9-mm Angle-Cut Guide Sleeves over a 3.9-mm 2-Piece Upper Removable Part (URP) with the 1.5-mm offset guide post on the model for fabrication of the corrected surgical guide.

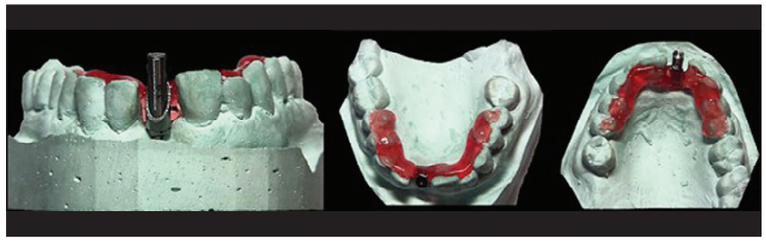

Figure 11. A light-cure resin gel (primopattern LC Gel) was applied to capture the guide post cleat over the offset Guide Post to form the surgical guide that would be utilized during osteotomy creation.

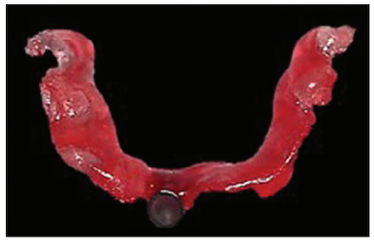

Figure 12. Surgical Guide with a 3.95-mm Angle-Cut Guide Sleeve with extension of the resin on adjacent teeth to provide stability intraorally.

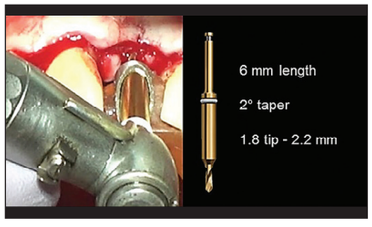

Figure 13. Initial osteotomy was performed in the cut guide sleeve to a depth of 6 mm until the wider portion of the drill contacted the crestal bone, preventing further advancement of the drill.

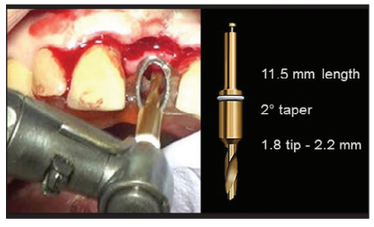

Figure 14. The osteotomy continued in the cut guide sleeve using a 1.8- × 2.2-mm-diameter drill to the 11.5-mm depth planned, stopping when the wider portion of the drill contacted the crestal bone, preventing further advancement.

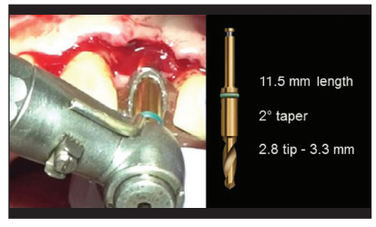

Figure 15. The osteotomy continued in the cut guide sleeve using a 3.3-mm-diameter drill to the 11.5-mm drill stop for the final osteotomy depth.

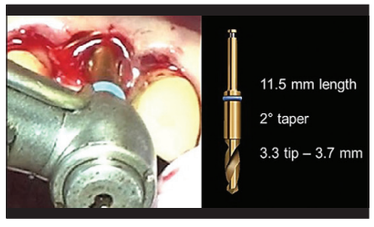

Figure 16. The osteotomy was completed utilizing a 3.7mm diameter drill to the 11.5 mm depth as guided by the surgical guide and the drills depth stop.

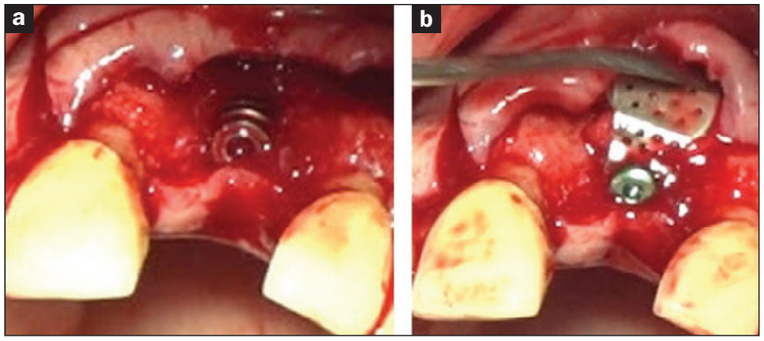

Figure 17. The implant was placed level with the palatal crest, **(a)** an i-Gen 2-mm flat abutment (Mega'Gen) was inserted with some noted facial thread exposure of the implant, and **(b)** the i-Gen titanium membrane was secured over graft material with a cover screw.

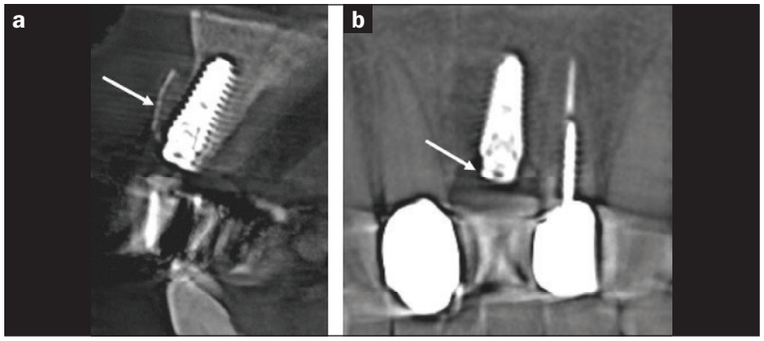

Figure 18. The postoperative CBCT scan: **(a)** A cross section after graft augmentation shown with the 2 mm flat abutment and the i-Gen titanium membrane. **(b)** Tangential radiograph of the site following implant placement.

perforated titanium membrane (A-1 [Mega'Gen]) were tried in to verify the fit over the site and under the elevated flap (Figure 17b). The titanium mesh membrane was secured to the 2-mm flat abutment with the cover screw. The graft material was placed beneath the membrane and gently compacted to the ridge and area. The flap was re-approximated beneath the membrane, and the surgical site was closed with 5-0 nylon sutures in an interrupted pattern to achieve primary closure. A CBCT scan was taken to document the implant placement and the initial presentation of the graft and titanium membrane (Figure 18).

CONCLUSION

Implant placement can be challenging relating to the position and angulation of the available bone present. This is particularly true in the anterior maxilla and with poor placement, especially when surgery is performed in a flapless manner. Poor placement can result in insufficient bone on the facial aspect of the implant, leading to eventual failure, as occurred with the initial implant the patient presented with. Evaluation of available bone is difficult with traditional 2D radiographs as the facial-lingual dimension is lost for evaluation that can only be assessed with a 3D CBCT scan. Software is then able to allow virtual planning and fabrication of a surgical guide to replicate placement based on the anatomy present and virtual positioning. A simplified process using the Guide Right system permits in-office fabrication of a simple guide that is used as a diagnostic guide worn during the CBCT scan and permits references during virtual planning and then fabrication of a corrected surgical guide, thus reducing both the cost of the surgical guide and the time required to have the guide ready for the implant placement appointment. It is an ideal option in the partially edentulous arch.✦

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Disclosures: Dr. Meitner is the developer of the Guide Right Surgical Guide System and a consultant to DePlaque Inc. Dr. Kurtzman reports no disclosures.