Presurgical Planning With CT-Derived Fabrication of Surgical Guides

*Scott D. Ganz, DMD**

As implant dentistry is evolving toward accelerated treatment protocols, with immediate or delayed functional and nonfunctional loading, the importance of presurgical planning becomes paramount. The paradigm for restorative-driven implant placement works best when templates are used to transfer information from the desired plan to the surgical reality. The advent of computed tomography (CT) imaging, and CT-derived surgical templates allow for clinically significant improvements in accuracy, time efficiency, and reduction in surgical error, benefiting the patient, surgeon, restorative dentist, and the laboratory. Continued advances in the state-of-the-art software applications that enable enhanced planning give clinicians the vision necessary to deliver the desired results, while serving as an excellent communication tool between all members of the implant team. This article illustrates the advantages of using CT scan-based templates through various clinical presentations. Procedures were illustrated for single and multiple tooth applications in both mandibular and maxillary arches.

J Oral Maxillofac Surg 63:59-71, 2005, Suppl 2

Implant dentistry has evolved into one of the most predictable treatment alternatives for partially and completely edentulous patients. The initial excitement about successful osseointegration has allowed clinicians to offer an extended set of treatment alternatives that include single tooth replacement to full mouth reconstruction. Pioneering protocols of the early 1980s relied on a 2-stage surgical approach allowing for the biological aspects of osseointegration to be achieved at the cellular level, ensuring long-term success. However, these procedures often required extended periods of time to complete. Through strategic marketing and word of mouth, demand for implant-related treatment continues to grow, which in turn has compelled clinicians to search for new and improved methods to deliver such care within a shorter time period, without sacrificing the accuracy required to meet patient expectations. As treatment protocols have progressed, implant manufacturers have met the challenge of providing both surgical and prosthetic components to maximize outcomes in function and esthetics. However, as with any surgical intervention, problems can arise. Often, difficulties related to poor surgical or prosthetic outcomes can be directly linked to the diagnostic and treatment planning phase.

Proper treatment planning should consist of a thorough assessment of the intraoral hard and soft tissue via direct examination, periapical and panoramic radiography, mounted study models, and when required a diagnostic wax-up of the desired result. Although basic in concept, most dental students trained during the last 25 years (in the United States) were not taught how to adequately diagnose or plan a dental implant case. Other available diagnostic tools for preoperative assessment can include 2-dimensional cephalometric or tomographic films (analog or digital), and tissue or bone mapping techniques to assess underlying bone geometry, and drilling into stone models to simulate intraoral implant positioning. Recently emphasis has shifted from relatively arbitrary implant placement in good available host bone (assessed by the surgeon at the time of surgery) to placing implants with consideration of the final prosthetic outcome, soft tissue management, emergence profile, and tooth morphology. Remember, the goal of implant dentistry is not the implant, it is the tooth that we replace.[1] To facilitate accurate translation from the desired plan to the surgical reality, templates or surgical guides should be used.

When a single missing tooth needs to be replaced, the surgeon can freehand the drill without a prefabricated template, and hope to align the osteotomy perfectly between adjacent teeth in all directions,

*Assistant Clinical Professor, Department of Prosthodontics and Restorative Dentistry, University of Medicine and Dentistry, Newark, NJ; Clinical Attending Staff, Hackensack University Medical Center, Hackensack, NJ; and Private Practice, Prosthodontics and Implant Dentistry, Fort Lee, NJ.

Address correspondence and reprint requests to Dr Ganz: 158 Linwood Plaza, Suite 204, Fort Lee, NJ 07024; e-mail: sdgimplant@aol.com

0278-2391/05/6309-0207$30.00/0
doi:10.1016/j.joms.2005.05.156

FIGURE 1. A processed acrylic template indicating the desired implant position on the master cast.

Scott D. Ganz. CT-Derived Fabrication of Surgical Guides. J Oral Maxillofac Surg 2005.

FIGURE 2. The holes in the occlusal/lingual surface are used to start the osteotomy preparation.

Scott D. Ganz. CT-Derived Fabrication of Surgical Guides. J Oral Maxillofac Surg 2005.

mesial, distal, facial, and lingual. The implant will then be positioned based on the surgeon's idealized vision of the fixture within the bone, which may differ from the restorative needs of that particular site. In the fully edentulous arch, orientation and bone topography can vary greatly, creating an atmosphere where implants can be misaligned, or worse. Templates can be created by various methods to help guide the surgical specialist or implantologist during the surgical placement of the implant, leaving most of the decision making process at the presurgical level, whether in partially edentulous or completely edentulous presentations. In its elementary form, a template (the use of the word "stent" is a misnomer) is fabricated based on information of the final tooth form, not the bone. A template design based on conventional prosthodontic protocols, including tooth morphology, emergence profile, occlusion, contacts, and embrasures would guide the implant placement in the desired position which will best allow for proper restoration.[2,3]

The first steps required to fabricate a basic template are impressions of the patient's existing dentition, which yields plaster or stone models that can be articulated and analyzed in terms of the desired occlusion and tooth morphology. A diagnostic wax-up or placement of denture teeth onto the stone model will demonstrate the desired restorative replacement, which can be translated to the surgeon through a simple vacuum-formed matrix, or a laboratory-processed acrylic prosthesis (Figs 1, 2). This vital information helps the surgeon visualize the restorative requirements during the surgical procedure, and can often lead to satisfactory results.[4,5] An all acrylic template indicates the desired tooth position, facilitates the placement of 4 implants, which leads to the successful restoration in the anterior mandible as illustrated by the postoperative panoramic radiograph in Figure 3. Basic templates made entirely of acrylic, or with cut-out windows, are less accurate than those that incorporate a metal sleeve or tube to help stabilize the drill during the osteotomy.[6,7] Using drills of similar diameter to the actual implant, a hole is created in the stone model that corresponds with the diameter of the implant to be placed. Once created, the appropriate implant analog is placed into the cast at the desired angulation and vertical depth approximately 3 to 4 mm below the cemento-enamel junction of the adjacent teeth. Using a long screw attached to the analog, a stainless steel tube can be dropped into position. A light or heat cured acrylic material then captures this position, and ensures that the plan will be easily transferred to the patient (Fig 4). The steel tube should be slightly wider that the drill, preventing accidental deviation. The tube should be a known height, and the acrylic should be relieved so that the head of the drilling unit is not impeded in any way (Fig 5).

Many solutions have been presented to help solve the dilemma of translating the restorative require-

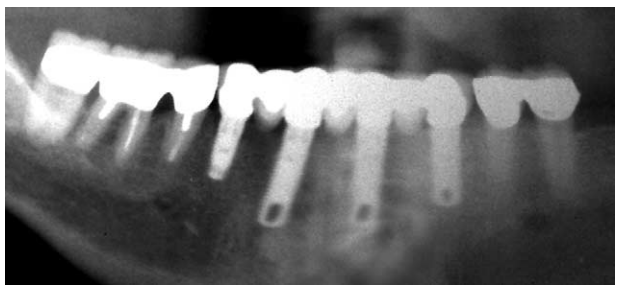

FIGURE 3. The postoperative, panoramic radiograph revealing successful implant placement which supported a 6 unit ceramometal restoration.

Scott D. Ganz. CT-Derived Fabrication of Surgical Guides. J Oral Maxillofac Surg 2005.