Review Article

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# Surgical Templates as a Guide to Perfect Implant Placement: A Review

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## ABSTRACT

**Background**: Prosthodontic rehabilitation of completely edentulous arch with implant supported prosthesis requires a stent, to evaluate the relationship between anatomical structures and to aid in implant placement for successful treatment result. This article highlights the rationale of implant-retained surgical templates and reviews guidelines for construction of surgical guides to direct dental implant placement. A variety of guides are described that can be fabricated for partially and fully edentulous arches.

**Keywords:** Prosthodontics, Implant, Dentistry.

## INTRODUCTION

Implant dentistry has evolved into one of the most predictable treatment alternatives for partially and completely edentulous patients.[1]Since the introduction of dental implant, the need for appropriate placement of the implant has been paramount.[2] Recent advances in implant dentistry have introduced a number of alternative treatment options for the rehabilitation of partially and completely edentulous patients.[3] The success of implant-supported restorations is not only related to the level of implant integration in the bone but also to the position of the implant. Implant position may affect the esthetics and function of the restoration.[4]

Despite significant advances in devices and techniques, placing dental implants in a correct position still remains a challenge.[5] Proper implant placement, according to both osseous limitations and prosthetic demands, is a key factor contributing to the success of implant-supported prostheses.[6] In recent years, focus has shifted to a great extent into the restoration-driven approach for the placement of dental implants through a detailed pre-surgical planning.[3] Restoratively driven treatment planning and implant placement require precise assessment of the surgical site.[4] Mal-aligned implants often complicate the clinical laboratory procedures employed for fabrication of superstructures.[7] The parallelism and proper buccal and lingual placement of endosseous implants are important for the restorative dentist to produce a functional and esthetic prosthesis.[8] Due to improper load distribution, an overall increase in stress concentration on supporting structures may occur. This may compromise the maintenance of the bone implant interface.[7]

In the diagnostic and surgical stage of implant therapy, stents are needed to establish a

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logical continuity between diagnosis, prosthetic planning and surgical phases. The term 'stent' was coined after an English dentist Charles R Stent.[2] A stent is an appliance used either for radiographic evaluation during treatment planning for assisting in determining the dimension, location and angulation of implant according to available bone, vital structures and proposed prosthesis; or during surgical procedures to provide optimum implants placement.[7] The implant surgeon should have a well-planned and well-adapted surgical stent to aid in the surgical placement of endosseous implants.[8] Predictable implant supported prosthesis also requires a determination of final prosthesis in treatment planning stage. Thus for a successful implant supported prosthesis the Prosthodontist should plan the implant position in accordance with accurate mesiodistal and buccolingual location, angulation with residual bone and correct implant orientation.[5]

A variety of surgical templates differing in design, cost, and stability have been described in the literature. Stents should be made of transparent material, stable and rigid when in position, should cover enough teeth to stabilize its position, and when no teeth are present, stents should extend onto unreflected soft tissue regions.[7]

**FABRICATION OF A SURGICAL GUIDE TEMPLATE**

The goal of implant dentistry is not the implant; it is the tooth that we replace. 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. To facilitate accurate translation from the desired plan to the surgical reality, templates or surgical guides should be used.[1] A surgical guide must be designed such that it meets the surgeon's objectives and the restorative dentist's expectations. When fabricating a surgical guide, the following should be considered as tenets of therapy: (1) initiate planning with the desired outcome in mind, not only the existing problem; (2) Determine optimal implant position to attain that goal; and (3) Compromise when necessary.[9] An ideal surgical stent should not be bulky, be simple to insert, and should not obscure surrounding surgical landmarks. The stent must not contaminate the surgical field during bone graft or implant placement, and should also be transparent and allow easy access to surgeon and assistant. The stent should relate to ideal facial contour. Many edentulous ridges have lost facial bone, and the stent can assist in determining the amount of augmentation required for implant placement or support of the lips and face. The surgical stents are used for placement of bone graft, implant, and again for implant uncovery.[2]

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.[1] Many types of surgical guides have been developed and used in dentistry. Generally, the surgical guide fabrication process begins with a diagnostic tooth positioning, either through a diagnostic waxing, denture teeth arrangement, or via the duplication of the pre-existing dentition/restoration.[4]

**DESIGN OF A SURGICAL GUIDE TEMPLATE**

Surgical guide design can vary with respect to implant site selection for an overdenture or a fixed prosthesis, and is dictated by what is attached to the implant. If a fixed cementable prosthesis is planned (implant-supported crowns or bridges), the location of an implant is critical because the implant needs to be positioned to emerge at a site that coincides with a future tooth restoration.[9] Fabrication techniques may vary in the manner of transferring such diagnostic information to a surgical guide and the guide's application during surgery. Surgical guides may be categorized based on the material used and amount of surgical restriction. Clear vacuum-formed matrices, with or without the use of autopolymerized acrylic resin, and gutta-percha, or metal rods for contrast and radiographic assessment, have been used.[4]

Parel and Funk made acrylic resin guides with facial contours, only. Akca et al used a channel guide placed into an autopolymerized acrylic resin guide. Sicilia et al placed wires occlusally and

gingivally, which were bent following the facial contour of the proposed restoration in the edentulous area. The authors used autopolymerized acrylic resin to secure these wires in the dentate area. These wires were used to maximize the visibility of the surgical site instead of acrylic resin. Other materials, such as light polymerizing composite resin tray material or a combination of acrylic resin and composite resin, have been used as alternatives, as well. More restricted types of guides were also introduced to guide drills with sleeves or channels. Burns et al set metal tubes in the guide using a surveyor at the proposed center of restoration with the desired angulation and used acrylic resin to fix the tubes in place. Disks and incremental tubes or channels were also used to guide drills sequentially. Cehreli used 2-, 3-, and 3.8-mm incremental tubes in acrylic resin surgical guides along with computerized tomography (CT)-derived data.[4] Computer assisted design and manufacturing of surgical guides with recent advancements in multiple engineering techniques such as laser sintering are now available to fabricate 3D models.[2]

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 analysed 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. This vital information helps the surgeon to visualize the restorative requirements during the surgical procedure, and can often lead to satisfactory results.[1]

**OVERDENTURE**

Implants placed to assist an overdenture should emerge within the body of the denture base so that components attached to the implant do not conflict with tooth setting areas of the denture. Implants should not be positioned too far lingually because the acrylic may become bulky and interfere with phonetics. It is advantageous to place implants parallel whenever possible; otherwise, a more complex bar structure will be needed to achieve parallelism.[9]

**SINGLE MISSING TOOTH**

If there are adjacent teeth to an edentulous area and it is desired to fabricate a surgical guide, the guide should extend at least one tooth anterior and posterior to the site to receive an implant. The guide should engage one third of the clinical crowns for retention and stability. If there are multiple sites in an arch missing one tooth, the same guide design would be applicable and should be extended to include multiple locations, accounting for space requirements for each implant site. In the **premaxilla**, it is advantageous to use a surgical guide to place even a single implant. It is usually constructed to direct the buccolingual insertion of an anterior implant and should include a groove on the buccal of the guide to denote proper mesiodistal placement. The guide may consist of a vacuform suck-down with a guide hole located on the palatal aspect of the tooth corresponding to the future implant site. In the **posterior areas**, it is usually not necessary to fabricate a guide for placement of a single implant because the adjacent and opposing teeth can be used to direct implant insertion. It is important not to place the implant too far from the most distal tooth because this will result in an unusually wide restoration mesiodistally.[9]

**MULTIPLE MISSING TEETH**

When inserting several implants in the anterior segment of the arch, a vacuform guide can be used (full contour of the teeth with a guide hole), or a guide can be created maintaining either the lingual or buccal curvature of teeth to be replaced. For anterior or posterior areas, an additional option is to create a cutout channel (window), retaining both the buccal and lingual acrylic curvatures. However, the guide needs to be marked or grooved to ensure proper guidance for mesiodistal implant placement. For posterior areas, a surgical guide with occlusal guide holes corresponding to the central fossae can be used if multiple teeth are to be replaced.[9]

**EDENTULOUS ARCH**

For a completely edentulous arch, several types of surgical guides that can be fabricated are

listed as follows. They all should cover certain anatomic landmarks (eg, tuberosity, palate, retromolar pad area) to provide stability after elevation of mucoperiosteal flaps. **(1)** Duplicate the maxillary or mandibular denture, if it is an acceptable blueprint for the final restoration. Create occlusal guidance holes through the duplicated denture to correspond with the ideal placement of the implants. The spaces can be produced with a bur that corresponds to the 2-mm twist drill or a pilot drill. **(2)** Fabricate a surgical guide that has a channel guide (window guide) corresponding to where the teeth will be placed. The acrylic on the buccal and lingual surrounding the window will provide a blueprint for placement of teeth buccolingually. **(3)** A surgical guide can be modified to retain only its lingual or palatal aspect of the acrylic around the window. The tooth contours on the lingual aspect will guide buccolingual placement. Usually, a groove or marker along the lingual contour of the selected site will denote the precise location of the implant's midpoint.[9]

**RADIOGRAPHIC MARKERS**

Surgical guides can be used during radiographic evaluations to correlate tooth positions with available bone and other important structures. Materials can be incorporated into the surgical guides to identify potential implant sites including barium sulfate, lead foil, gutta-percha, amalgam, and metal sleeves. Barium sulfate can be used to create a radiopaque marker by either filling a clear vacuform with resin combined with barium sulfate (30% by weight)15 or the barium sulfate can be mixed with duralay liquid and resin (50% by weight) in a dappen dish, then painted onto the occlusal surfaces of the surgical guide.[9]

**IMAGE GUIDED SURGERY**

CT/CBCT scanners allow the dentist and surgeon to visualize a patient's anatomy in 3 dimensions. Visualization of the height and width of available bone for implant placement, soft tissue thicknesses, proximity and root anatomy of adjacent teeth, the exact location of the maxillary sinuses, and other pertinent vital structures such as the mandibular canal, mental foramen, and incisive canal are possible. Once images are imported into proprietary software programs, the clinician can then virtually plan the placement of implants for an individual patient's anatomy and case plan. The type and size of the planned implant, its position within the bone, its relationship to the planned restoration and adjacent teeth and/or implants, and its proximity to vital structures can be determined before performing surgery. Computer-generated surgical drilling guides can then be fabricated from the virtual treatment plan.[10]

## CONCLUSION

Fabrication of a surgical guide that incorporates current knowledge with regard to appropriate spacing between teeth and implants will facilitate optimal implant placement, enhance periimplant homeostasis, and attain effective prosthetic results. Design of a surgical guide depends on a clinician's preference. Adherence to detail in planning and fabrication of a guide is the best way to reduce surgical and prosthetic problems. Ultimately, a well-designed surgical guide will help the clinician fulfill the mandate for restoratively driven placement of dental implants.

## CONFLICT OF INTEREST

No potential conflict of interest relevant to this article was reported.

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