REVIEW ARTICLE
Volume-9 | Issue-5 | May-2020 | PRINT ISSN No. 2277 - 8179 | DOI : 10.36106/ijsr
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

SURGICAL GUIDE TEMPLATES FOR DENTAL IMPLANTS: A REVIEW

Dental Science

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ABSTRACT

Implant complications are often inadvertent sequelae of improper diagnosis, treatment planning, surgical method, and placement. This can be overcome by using surgical guides for implant positioning. Ideal placement of the implant facilitates the establishment of favourable forces on the implants and the prosthetic components as well as ensures an esthetic outcome. This article reviews the ideal requisites of a surgical guide along with basic methods of surgical guide fabrication and certain recent advances in this field.

KEYWORDS

Templates, radiograph, Cad-Cam, Stereolithography

INTRODUCTION

Implant dentistry has evolved considerably since early treatment protocols in which positioning of implants was not considered critical to a successful outcome, and the emphasis was on functional outcome. In the past, the implant site and direction were dictated by residual bone availability[1]. Incorrect implant placement can lead to problem with esthetic or function. The desire for a predictable fixed partial prosthesis led to the development of a newer concept of "prosthetically driven implantology". This concept establishes the correct implant postion based on the planned definitive restoration and is achieved from early planning phase[1].Esthetic results are closely related to high level of accuracy in positioning of implants. This can be achieved by means of surgical guide which assist the surgeon in implant placement to create biomechanically sound implant locations.[2].

According to Misch, the surgical template dictates to the surgeon the implant placement that offers the best combination of support for the repetitive forces of occlusion, aesthetics and hygiene requirements.[3]

According to GPT 9, The surgical guide is defined as, a pattern, mold, or gauge used as a guide.

Template function:

1)Represent desired 3D tooth feature and position on prosthesis.
2)Relate d esired tooth position s to intended implant sites.
3)Indicates the need to replace hard and soft tissue contour.

4)Can be used in patients mouth during:

I) Surgical and radiographic assessment of implant site and hard tissue
ii) Surgical placement of implant.

The surgical guide should accurately translate the diagnostic information from pre-surgical diagnostic work-up to direct implant placement in three dimension:

- Bucco-lingually,
- Mesio-distally
- Apico-coronally[4].

The surgical guide should be able to carry radiographic markers to provide contrast between the guides and sites selected for implant trajectory to be used in diagnostic imaging[4].The template should have

- Stable retention & rigidity in surgical field
- Easy access of drills/guide pins/osteotomes intraoperatively
- Ability to translate pre-surgical work-up information accurately to operating field.
- Extend onto unreflected soft tissue regions,when no remaining teeth are present. Hence, the templates can be used after the soft tissue has been reflected from the implant site.
- Ideal angulation of implant insertion to be visualized during surgery and requires, at least, two reference points for each implants, which corresponds to the path of ideal implant insertion. The ideal angulation is perpendicular to the occlusal plane and parallel to the most anterior abutment joined to the implant.
- Relate the ideal gingival contour position.

The surgical template may be used in conjunction with a bone graft, and later the same template may be used for insertion of implants and again for implant uncovery. A sturdy templates permits re-sterilization and use for several procedures[2]. The surgical template may also indicate the shape of the proposed final restoration.

A surgical guide is the union of two components. The guiding cylinders and the contact surface. The contact surface fits either on an element of a patient's gums or on the patient's jaw. Cylinders within the drill guides help in tranferring the plan by guiding the drill in the exact location and orientation.[5]

Three techniques commonly used for preparing the guide holes and fabricating the radiographic and surgical implant guides are conventional free-hand, milling and computer-aided design/computer-assisted manufacture (CAD-CAM) technology.[6]

CONVENTIONAL RADIOGRAPHIC S URGICAL TEMPLATE

The radiographic template is the key to success, since it allows the transfer of predetermined prosthetic setup to the actual implant planning. Panoramic radiography is still the standard for planning of implants. The implant placement planning is guided by quality and quantity of the bone, as well as the position of the teeth for phonetics and esthetics[7]. However, precise measuring of the bone architecture is impossible, because they have a magnification factor that is not always uniform. Based on the magnification factor and the known dimensions of the metal, the depth and dimensions of the implants are planned[5].

FABRICATION PROCESS:

Some of the commonly used techniques are mentioned briefly here. Surgical guide with radiopaque marker can be fabricated with following technique

1) Diagnostic casts of the dental arches are made from irreversible hydrocolloid impressions and acrylic teeth/tooth are waxed up. Then the impression of that waxed-up cast is taken and poured to reproduce another cast with the missing teeth/tooth replaced by dental stone and then, mesiodistal and buccolingual markings were drawn over those teeth/tooth to find the center point on the occlusal surface. After appyling separating media and blocking undercuts, self cure material is applied at the teeth to be replaced along with anterioposteror adjacent area, which confers the stability to the stent during implant placement. The holes will be drilled in the so formed center pointfor the assessment of the diameter and position of implant and filled with radiopaque marker. The efficacy of the stent is evaluated with the help of radiograph.[8]

2) In another method, after diagnostic wax up of the final restoration is completed, duplication is made and a cast is poured. Vaccum-formed template is fabricated and is placed over the cast and the edentulous space is filled with radiopaque material.[9]

Yet another method to prepare a radiographic guide is the use of guide tubes which are pre-fabricated, stainless steel, that can be obtained from implant manufacturers. The guide tube is placed onto the diagnostic cast with the center of the tube in ideal position for placement and within the buccolingual limitation as determined by bone mapping. The template is then processed using acrylic resin with guide tube in place. And the verfication of correct angulation of guide tube is determined radiographically.[10]

The radiopaque markers helps in predesigning the direction of implant placement and in comparing the angulations of radiopaque markers with the available bone and also in locating the position of vital structures to determine the angulations of implant.[9]

THE MILLING TECHNIQUE:

It is a simplified technique for fabricating a radiographical and surgical guide for optimum placement of implant. It is an accurate technique which employs parallel holes in the guide. This technique combines the accuracy of an implant milling machine with the practicality of a cost efficient, user-friendly procedure, using the aid of a conventional dental surveyor commonly available[6].

COMPUTER AIDED ADVANCED RADIOGRAPHIC TEMPLATES:

In spite of the fact that the conventional technique of template fabrication is widely used, it has certain unavoidable drawbacks that actually led the development of advanced fabrication technique. Morever, the anatomical landmarks are not exactly located, it does not confirm the underlying blood supply, its approach being two dimensional[11]. With the use of computed tomography (CT) and computer aided design(CAD)/ Computer assisted manufacturing (CAM) technology, it is now possible to construct a surgical implant guide that would allow the clinician to predetermine implant locations virtually and surgically place them without reflecting tissue flap[12,13].

Computer aided design(CAD)/ Computer assisted manufacturing (CAM) Based Surgical Guide:

CAD can be conducted through reading and interpreting multiplanar computerized tomography (CT) or cone beam CT (CBCT), performing measurements and evaluating anatomic relationship by placing virtual images on the screen[4]. The CT images are converted into the data that are recognized by a CT imaging and planning software. This software then transfer this presurgical plan to the surgery site using Stereolithographic drill guides. Utilizing the latest scanning, CAD-CAM technologies, the restoration is produced with high accuracy and precision fit.[2]

Stereo Lithography

Stereolithography, a rapid prototyping technology, a newer outcome in dentistry allows the fabrication of surgical guides from 3D computer generated models for precise placement of the implants. The surgical template fabricated by this technology are preprogrammed with individual depth, angulations, Mesio-distal and labiolingual positioning of the implant.[14] This technology develops a precise evaluation of anatomic points about size, direction and bone location for accurate positioning of implants.

In CT, multi planar reformatting allows one to reformat a volumetric data set in sagittal, axial, and coronal cuts and also helps in building multiple cross-sectional and panoramic views. Shaded surface display and volume rendering methods generate 3D reconstructions of the entire dental arch and their relevant structures, including nerves, which makes dental CT the most precise and comprehensive radiologic technique for dental implant planning. Software's specially planned allow practitioners to virtually view the implant site and plan location, angle, depth, and diameter of virtual implants, which are superimposed on the 3D data. Following backward planning, the diagnostic wax up has to be visualized through CT scan with radiographic templates in place.[5,11]

ADVANTAGES:

1. Precise placement of implants
2. Conservation of anatomic structures, three-dimensional technology allows precise evaluation of anatomic points
4. Provides information about size, direction, and bone location for accurate positioning of implants
5. High observed accuracy of 0.1 mm
6. Reduced surgical exposure time
7. Less invasive, flapless surgery, and, therefore, less chance of swelling[2,4,5]

CONCLUSION:

Improvements in surgical reconstructive methods, as well as increased prosthetic demands, require a highly accurate diagnosis, planning, and placement. Identification of the bony anatomy with respect to the teeth, prior to surgery, allows the clinician to place implants in areas where the implant-bone interface can be maximized, and the prosthetic result is optimized. The conventional guides may be simply constructed or be made using advanced radiographic computer technology i.e three-dimensional technology.Computer-aided planning and image-guided surgery can be carried out, when implant positioning is to be precisely executed, and when safe positioning of implants with optimal use of available bone, and whenever a CT scan is recommended as a diagnostic means evidence-based research still needs to be conducted to evaluate the applications of the completely limiting design and its effect on the treatment outcome in oral implantology.

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