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Clinical Application Of Various Surgical Guides For Optimal Implant Placement

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Abstract:

With the current concepts of, 'prosthetically driven implantology', the three-dimensional positioning of implant is determined during the phase of treatment planning according to the future intraoral prosthetic position. There are various designs of surgical guides available which makes the implant positioning more predictable and accurate. The objective of this paper is to review the literature and recent advancements in this field, based on design concept.

Key words: implant guide, implant placement, surgical guide, surgical template, implant dentistry.

Introduction:

Dental implants arewidely used treatment modality for the replacement of lost teeth. Recent advances in dental implants has made implant supported oral restoration as treatment option for partially edentulous and completely edentulous patients, also even in patients with severe bone loss and in locations which all previously considered unsuitable for implant placement has been made possible by means of bone augmentation, regeneration and soft tissue regeneration procedures.[1]In spite of the success in implant treatment, most surgical and prosthetic complications with improper diagnosis and implant placement has also been documented.[2] Accurate placement is required to achieve best functional and aesthetic result. Since the oral cavity is a relatively restricted space, a high degree of accuracy in placement of implant is very important for success of the prostheses. This can be achieved by means of a surgical guide which provides adequate information regarding implant placement and at the time of surgery which fits on to the existing dentition or on to the edentulous span.[3]

In the past, the implant position and direction were dictated by the residual alveolar bone. The desire for successful fixedprosthesis led to the development of a newer concept

of'prosthetically guidedimplantology'.According to this concept, planned definitive restoration during the planning phase dictates the position and direction of the implant. [4]

In early 90s, problems related to maxillary implant placement where that the surgeons used to position the implant by eyeballing the dental implant, relative to the maxillary ridge. A line drawn from the anterior maxilla to the mandibular ridge became more acute as the mandible was opened. This change in angulation led the surgeon to lingually incline the dental implants. This inclination resulted in a prosthesis that had the anterior teeth cantilevered forward at a distance from the dental implant, making it very difficult to create an accurate framework and causing hygiene problems. [5]

The current philosophy of prosthetically driven implantology, necessitates certain parameters like:

1) Developing an adequate volume of bone to support the implant as an extension of the restoration.

2) A sufficient volume of soft tissue to allow for adjustment of the prosthetic recipient site and

3) A three-dimensional restoration-generated site allowing for a gingival margin of appropriate shape and tone.

The ideal placement of dental implants should be determined by prosthetic parameters which depend on the position of a tooth in the arch. The exact positioning of the implant in bone with respect to location and angulation is often difficult to accurately match the prosthetic requirements [6] Many different types of guides have been proposed, varying from the very simple designs, which may not provide the desired information to achieve pleasing results, to ones that are extremely complex which require a great deal of time and money to fabricate and are so precise as to not allow for any intraoperative changes that could arise due to local anatomy.[7]

Surgical guide is any device used to assist in proper surgical placement and angulation of dental implants. Surgical guide is the link between what's in mind (treatment planned) and what will be executed (treatment).[8]

Uses of surgical guide:

• Guidance of osteotomy drills at correct position, angulation and depth.

• Guidance of implant fixtures at correct position, angulation and depth.

• Guidance of amount of bone reduction or bone harvesting if necessary (both soft tissue and hard tissue harvesting). [9]

Classification of surgical guides:

1) Based on the area of operation:
   - Guides for partially edentulous sites (tooth supported or bone supported-depending on amount of the edentulous space).
   - Guides for completely edentulous sites (mucosa or bone supported).

2) Based on the support the surgical guide derives: [10]
   - Tooth supported guides - Minimum three stable teeth should be present to support the guide during surgery. [Fig.1]
   - Mucosa supported guides - It is used in fully edentulous sites. Advantage-less or no tissue reflection is required, so less postoperative discomfort. Will require scan prosthesis and surgical guides during surgery. [Fig.2]
   - Bone supported guides - they are used in partially edentulous sites and completely edentulous sites. When used in partially edentulous sites, it should possess at least 3 cm of supporting bone or 3 teeth would need replacement. Bone guides are especially used when edentulous sites possess thin bone. Raised flap should provide a good view to implant sites and insertion of guides. [Fig.3]

3) Based on the accessibility Surgical guides can be open sleeve or closed sleeve (increased accessibility). [10][Fig.4, 5a,5b]

4) Based on utility:[10]

- Pilot guides/ Non-limiting - The sleeves only allow pilot drills. Angulation control is achieved. Depth control is to be obtained manually by assessing markings on drills. Later, the surgical guide is removed, and osteotomy site is expanded in the absence of surgical guide.
- Complete drill guides/ Partially limiting - It uses drill keys or sleeves. Different sleeves for different diameters of drills, which are changed concomitantly as osteotomy is widened. Angulation as well as the size of osteotomy is controlled by guide; depth is controlled manually.
- Safe guides/easy guides/ Completely limiting - Uses drill key or sleeves as above with additional implant stopper that controls the depth of drilling. Allows both osteotomy preparations with surgical drills and installation of implants.

5) Based on material:[10]

Self/light cure acrylic resin, metal reinforced acrylic templates; vacuum formed polymers, milling, CAD-CAM prosthesis, stereo lithographic models. The surgical accuracy of manually processed resin and vacuum formed guides is less in comparison to the latter mentioned milling, CAD-CAM prosthesis or stereo lithographic models.

Advantages of surgical guide: [9, 11]

1. Decreases manual errors associated with free hand implant placement.
2. Minimally invasive - since surgical guides allow minimal intervention, postoperative surgical problems are minimized providing psychological benefit to both patient and clinician.
3. Precision - Implants are prosthetically driven components; any deviation in 3D position of the implant can lead to abrupt prosthetic results which affects the function. With surgical guides, implant placement has become more accurate.
4. Safety - With guides, deviations in 3D placement of implant can be prevented also damage to Vital structures is easily prevented.
5. Predictability - The treatment decided during planning stage is ensured.
6. Aesthetics, Hygiene and for best survival, implant supported prosthesis should be placed in pre-planned positions. Guides can help such quality placements of implants.
7. Surgical time is minimized.
8. Special surgical guide types, such as bone reduction guides are available that can enable graft harvesting.
9. Guide itself can act as a temporary prosthesis for fully edentulous cases.
10. Increased visibility of the surgical site and easy access for flap exposure Accurate results for beginners.
11. Can be used in non-cooperative patients in whom multiple implants are planned under conscious sedation/general anaesthesia.

Disadvantages of surgical guide:[11]

1. Once if guides are fabricated, they do not allow any change or modification from predetermined position if required at the time of surgery.
2. Any tissue changes (e.g. Swelling, loss of abutment teeth) between time of ordering and implant installation can alter fit of the prosthesis ultimately functioning of implant prosthesis.

3. Guide dislocation can occur during surgery if the guide is not stabilized.
4. Drill lodgement in stents.
5. Guide dislocation also occurs when drilling is intended to penetrate hard bone, producing torsional forces on the sleeves, thus lifting off the guide.
6. Start-up cost associated with software purchasing.
7. Great learning curves.
8. Flapless guides implant surgery has a disadvantage that grafting is not possible during surgery.

Ideal requisites of surgical guide:

The surgical guide should accurately translate diagnostic information from pre-surgical diagnostic work-up to direct implant placement in three dimensions.[Fig.6]

1. Bucco-lingually
2. Mesio-distally, and
3. Apico-coronally.

The guide should, if possible, be able to carry radiographic markers to provide contrast between the guide and sites selected for implant trajectory to be used in diagnostic imaging. The American Academy of Oral and Maxillofacial Radiology has recommended the use of surgical templates with radiographic markers in conjunction with imaging.

Ideally, the surgical guide should possess the following characteristics: [12]

1. Simple and cost-effective to fabricate.
2. Stable retention in surgical field (adjacent teeth or landmark).
3. Easy access of drills/ guide pins/ osteotomies intra-operatively.[Fig.7]
4. Ability to translate pre-surgical work-up information accurately to operating field.

Discussion:

Fabricating a Surgical guide template involves a diagnostic tooth arrangement by means of:[13]

(1) a diagnostic waxing,

(2) a trial denture teeth arrangement, or

(3) the duplication of a pre-existing dentition/restoration

The design concepts are classified based on the amount of surgical restriction offered by the surgical guide template into[14]

1) Non limiting design
2) Partially limiting design
3) Completely limiting design

Non limiting design only provides an indication to the surgeon as to where the proposed prosthesis is in relation to the selected implant site. Blustein et al[15], Engelman et al[16],have described technique in which a guide pin hole was drilled through a clear vacuum-formed matrix [figure 1].Almog et al[17]. described the circumference lead strip guide in which a lead strip was attached to the external surfaces of the diagnostic waxing. This was used to outline the tooth position over the implant site It has been observed that the use of these guides may result in unacceptable placement of the access hole and/or unacceptable implant angulation. Hence, these templates can serve as imaging indicators during the surgical phase of implant placement

Partially limiting designthe first drill used for the osteotomy is directed using the surgical guide, and the remainder of the osteotomy and implant placement is then finished freehand by the surgeon[20]. Here the radiographic template is converted into a surgical guide after radiographic evaluation. These guides also fail to completely restrict the angulation of the surgical drills.

Completely limiting design restricts all of the instruments used for the osteotomy in a buccolingual and mesiodistal plane [figure2,3]. As the surgical guides become more restrictive, less of the decision-making and subsequent

surgical execution is done intraoperatively. This includes 2 popular designs: cast-based guided surgical guide and computer-assisted design and manufacturing (CAD/CAM) based surgical guide.

(CAD/CAM) based surgical guide: it requires following steps,

1. Fabrication of the radiographic template,

2. The computerized tomography scan,

3. Implant planning using interactive implant surgical planning software, and

4. Fabrication of the stereolithographic drill guide.

Double scanning procedure[18]**:** The patient is scanned wearing the radiographic scan template and radiographic index (interocclusalindex) during the first scan, whereas the second scan is performed without the index. The first scan is used to visualize the bony architecture and anatomy of the site of interest, and a second scan is performed to visualize the nonradiopaque radiographic guide. The 2 resulting sets of 2D CT data (Digital Imaging and Communication in Medicine [DICOM files]) are then superimposed over each other according to the radiographic markers and are further converted into a file format compatible with the 3D planning program. Resulting from this fusion is an exact representation of the patient's bone structure and scanning denture in 3D space. At this point, the virtual surgical procedure can be performed. A 3D implant planning software allows for simultaneous observation of both the arches and the radiographic scan template in 3 spatial planes and helps to virtually plan the location, angle, depth, and diameter of the virtual implants. It produces an axial image, a panoramic image, and a series of cross-sectional images on the screen at the same time. Once the planning is accomplished, surgical guide, is printed using stereolithography. Once hardened, the polymeric prototype contains spaces for stainless steel or titanium drill-guiding tubes. These tubes precisely guide the osteotomy drills, precluding the need for the pilot drills.[Fig.8a,b,c,d] Various implant planning software products are available commercially, namely, SimPlant, SurgiCase (Materialise Dental Inc, Leuven, Belgium), Procera (Nobel Biocare, Go ¨teborg, Sweden), ImplantMaster (I-Dent Imaging Ltd, Hod Hasharon, Israel), coDiagnostiX (IVS Solutions AG, Chemnitz, Germany), and Easy Guide (Keystone Dental, Burlington, MA).

Conclusion:

Surgical guides are a valuable adjunct to achieving precision in prosthetic driven implantology, by enables the clinician to orient the implant three dimensionally. The guides serve both diagnostic and surgical purposes and depending on the case it may be manually constructed or CAD/CAM ones.Surgical guides also enable the clinician in establishing good implant prosthetics, predictable positioning allows for the better prosthetic outcome by simplifying abutment selection providing excellent aesthetic, function, and hygiene maintenance. But compared to the conventional technique, surgical guide requires substantially greater investment and effort. The choice of guide in terms of design and method of fabrication depends on the case and expertise of the clinician.One must have a thorough knowledge about the design consideration, laboratory procedure, advantages anddisadvantages of particular surgical guide to choose the best one for the benefit of the patient.

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LIST OF FIGURES

Fig.1: Tooth supported surgical guide

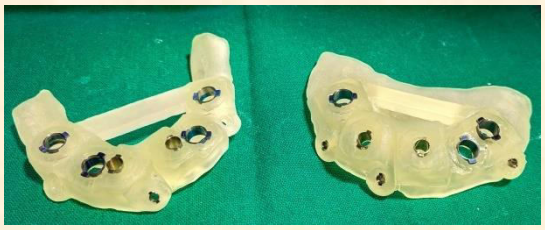

Fig.2: Mucosa supported surgical guide

Fig.3: Bone supported surgical guide

Fig.4: Open sleeve surgical guide in vacuum form pressed guide

Fig.5a: Open sleeve surgical guide. Extra oral view

Fig.5b: Open sleeve surgical guide. Intra oral view

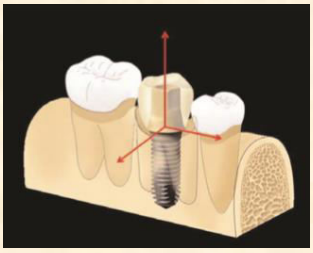

Fig.6: An ideal surgical guide should facilitate placement of a dental implant in the optimal

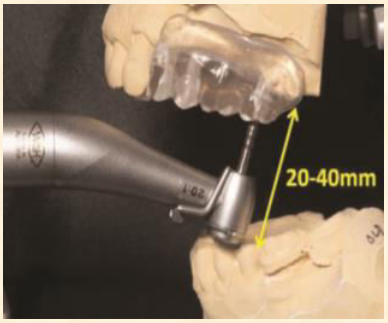

Fig.7: A surgical guide should have easy access to drills, osteotomes, and other devices commonly used during implant surgery

Fig.8a: scanning the denture

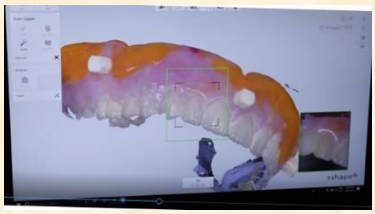

Fig.8b: software- 3shape

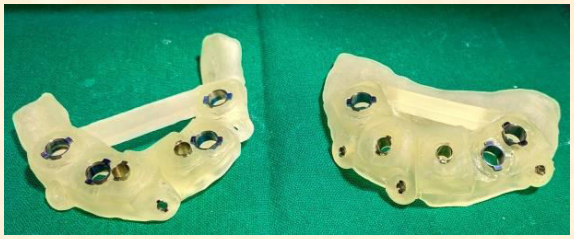

Fig.8c: completely limiting surgical guides

Fig.8d: surgical guide in-situ