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A Methodical Review On Guided Implant Surgery

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ABSTRACT

The usefulness of static implant surgery with conventional workflow has been extensively studied. With the introduction of CBCT (cone beam computed tomography) the application of guided surgery has reached new horizons for simple and accurate placement of implant. This review focusses on the static guided implant surgery and its advantages and disadvantages.

Key words: Implant, CBCT, Guided surgery, CAD/CAM

I. Introduction

In the last few years the developments in the field of computer technology and its aided or assisted design (CAD/CAM) have been well received and it has brought a revolution in the field of dentistry especially in the field of oral implantology. The recent approach of this innovation is guided surgery which became easier with the development of CBCT. This allows three dimensional planning of implant to be done pre-operatively which basically combines the art of CT scan three dimensional images and the CAD/CAM technology.[1] Various software's are available that allows the clinician to virtually plan the implants in the 3D image that is constructed via the CBCT.[1] The placement of conventional implants has various shortcomings like movement of patient and the amount of time consumed to place implants is also more. With the help of CT and the implant planning software it is easy to thoroughly plan the number, size, inclination and position of implant keeping in mind the anatomical and prosthetic consideration preoperatively making it easier to concentrate only on tissue handling at the time of implant placement.[2]

II. History

Since the introduction of CBCT, manufactures are constantly upgrading the machines and software with multiple features. [3]In 1980, it wasDentascanwhich was used to evaluate the bone for implant placement in both maxilla and mandible. Following it in 1988, Columbia scientific introduced 3D software for dentistry. In the year 1991, Image master 101 allowed placement of implants graphically in cross-sectional images. In the year 19991, Image master 101 was introduced. Following which Sim implant was introduced in 1993which allowed the virtual implant placement on Ct images in exact dimensions. In the year1999, Simplant6.0 was introduced. It was in 2000, First dynamic guided surgery was introduced in implant dentistry. Following these revolutionary changes, Nobel BioCare introduced complete implant planning system the Nobel Guide in the year 2005. In the year 2011, it was upgraded as Nobel Clinicians.

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III. Types

The two types of guided protocol are Computer guided- Static and Computer navigation- Dynamic.

Computer guided- Static

The static implant surgery uses a static surgical guide/template which allows the reproduction or the transfer of virtual implant position from CT to the surgical template and does not allow any modification intra-orally at the time of implant placement

Computer guided- Dynamic

On the other hand the dynamic approach uses navigation system to transfer the virtual implant position from CT to the surgical template and allows for intra operative changes to be done during implant placement. It is based on real time tracking of the implant drill and the patient throughout the surgical process.[4]

Computer guided	**Computer navigation**
Static	dynamic
Surgical guide is used to transfer the virtual implant position	The position of the drill is tracked by real time monitoring throughout the process
Does not allow changes intraoperatively	Changes during the procedure is possible due to the real time tracking of the drills
The guides are manufactured by computer-aided design/computer-assisted manufacture technology, such as stereolithography, or in a dental laboratory manually	Does not need an intraoperative set up as it allows real time transfer of the pre-operative planning onto the display screen
Surgery is by guidance of the drill using drill keys in the template/ guide	Positioning of the bur is through optical tracking

Table 1: Difference between static and dynamic guided implant surgery[2,4]

IV. Steps in guided surgery [1, 2]

As aforementioned the introduction of CT and various implant planning software's have made preoperative implant planning efficient. The planned data for implant placement is transferred to fabricate the surgical guide through stereolithography which allows the placement of implant in a flapless pre-planned position.

The following are the Steps involved which include Treatment plan, Intra oral Scan for prosthesis fabrication, CBCT scanning, Fabrication of the surgical template and planning of implant placement through respective software, guided implant insertion and Prosthetic procedures

V. CBCT and intra oral scanning

The digital planning of implant is now carried out virtually with the help of CT and CBCT. Nowadays the CBCT are preferred more than the CT because of low radiation and cost.[5] Intra oral scanners are devices that helps to capture direct optical impression. Just like any other scanners available they project light source like lasers or structured light onto the object to be scanned which captures the image through image sensors and is later processed by scanning software's. The software generates point cloud which are triangulated using the same software creating a 3D model as an virtual alternative to plaster models.[6] The advantage of these scanning system is that the image fusion between the intra oral scan and CBCT reports maximum accuracy for placement of implant and also reduced the cost and time for the planning procedure. [5]

VI. Surgical guide

With the help of 3D imaging and design the surgical guides were earlier produced by photopolymerization and now with the concept of image fusion superimposing the intra-oral scanning data and digital computerized tomography data the surgical guides are now processed easily. This requires mutual landmarks on both intra oral scanning image and the CBCT such as teeth. The patients anatomy, number and location of teeth in the arch to be treated and opposing arch determines the fabrication of surgical guide.[4]

VII. Guide design

The surgical guide consists of sleeves made of steel with a diameter that is predetermined guides the drills for placement of implant in its predetermined position. There are various types of guides available. The pilot guide allows preparing the initial osteotomy site after which the procedure can be performed free handed. Other guide allows complete preparation of osteotomy site with the entire drilling sequence and free handed implant placement, or complete drilling sequence along with implant placement. The surgical guide also has vertical stops or depth control systems that allows the clinician to control the level of insertion.[7]

Guide support:

There are 4 types of guide support [4]

Tooth support	Placed on remaining teeth
Mucosa support	Mucosal surface mostly in completely edentulous patients
Bone support	Placed on bone after a full thickness mucoperiosteal flap is elevated mostly indicated in patients requiring extensive bone surgeries

Special supported, (mini) implant, pin-supported	Guide attached to implant before or during implant surgery

Table 2: Types of guide support

According to systematic review from the 5th InternationalTeam for Implantology Consensus Conference among the four types of guide support system the highest inaccuracy was from the bone supported guide system.

VIII. Softwares

Specific software's are used for planning of implant surgery which allows the transfer of the original data set to DICOM format(Digital Imaging and Communications in Medicine). Specific software brands are present for different Computed Tomography brands that aids in 3-D implant planning. E.g. Dental CT software (Siemens, Erlangen, Germany) are reconstructed from Siemens spiral CT, and General Electric's MSCT acquired CT data are reconstructed using Dentascan software (GE, Medical Systems, Milkwaukee, WI).[2]

IX. Implant insertion through guided surgery

There are various protocols described in literature for guided surgery. Some systems require several guide according to the increasing protocol of the drills used for osteotomy site preparation. On the other hand one single guide can also be used along with adjustable drill handles. As aforementioned the insertion protocol can be a fully guided protocol or it can also be guided osteotomy alone allowing freehand implant placement. According to the 5th International Team for Implantology Consensus Conference findings among the two protocol the fully guided protocol had high accuracy when compared to guided osteotomy with freehand implant placement.[4]

The use of drill keys within the steel sleeves guide the consecutive drills in the pre-determined position and angulation. Physical or visual stops are present on the drills that controls the depth of insertion. The guided surgery is difficult if there is limited interocclusal space and therefore some systems have drill guides with lateral openings that allows the entry from buccal or lingual side reducing the amount of interocclusal space required.[4]

X. Indications[3. 8]

The indication of guided implant surgery include placement of three or four implants in a row,Vital anatomical structure present adjacent to implant site, Bone deficiency (height, width or irregular bony contours), Need for flapless implant placementand Patient with medical or physical or psychiatric comorbidities.

XI. Clinical outcomes[4, 9]

Implant survival	91-100% according to study by Tahmaseb et al 2013 International

	Team for Implantologyconsensus conference
Accuracy	Recommended in cases where critical anatomical situations limit the use off freehand or conventional implant placement Precision in aesthetic zones
Complications	Fracture of the surgical guides Alterations in surgical plan Early prosthetic complications

Table 3: Clinical outcomes of guided implant surgery

XII. Sources of error

The sources of error in guided implant surgery are grouped into radiographic technique whereLinear or volumetric inaccuracy and poor image qualities are the possible risks which can be managed by proper use of instrument and experienced operator. The restorations should be eliminated from the field of interest to reduce the artefact formation. The next source of error is patient's movement where the image quality in the cone beam CT will be affected if the patient moves during the scanning process. This can be prevented by stabilizing the lower jaw and scan prosthesis by occlusal bite index or simply to watch the patient during the scanning process to confirm any absence of movement. The following source of error where position of the scan prosthesis that involves correct positioning of scanning prosthesis is important. An index is very important intraorally which is helps to stabilize the guide during the process. The next being treatment planning software whereimproper planning leads to improper placement of implant. This can be overcome if clinician has a thorough knowledge of accuracy and limitation of the guided system used and more importantly the clinician should be trained to use the guided system of implant placement. The important source of error being surgical guides production where it can be done by laboratory or manual method or by using stereolithography. The chances of the surgical guide fracture during the placement of implant or the improper adaptation of the surgical guide also affects the placement of the implant in the determined position. This can be overcome by opting for experienced manufactures of the template. The appropriate selection of guide support (tooth,mucosal,bone) depending on the need also determines the success of the procedure. The next foremost source of error improper guide positioning can also influence the inaccuracy. This can be overcome by using mini screws to stabilize the mucosa or bone supported guides. It is advisable to reconfirm the guide position while changing the drills for better outcome. The biotype can also influence the outcome of mucosa supported guides.Improper drill use and any deviation or inadequate irrigation can also affect the outcome. It is managed my ensuring proper fit of the guide and frequently replacing the drills and keys. Copious irrigation is important to prevent bone necrosis.Poor knowledge and understanding of the guided system can influence the outcome of the procedure. Thorough understanding and training is necessary for successful outcomes[10, 11].

XIII. Advantages

The advantages include Minimally invasive (flapless along with surgical guidance of the drills for depth and inclination), Accuracy for placement of implant, Safety, Less post-operative discomfort, Reduced time, Reduced number of appointments and Easy treatment option for patients with strong anxiety.[12]

XIV. Disadvantages

The disadvantages includeComplexity of the guided system, The sleeves in the surgical guide obstruct irrigation to the drilling system causing high temperature at the place, Not cost effective (scanning, software planning system and fabrication of guides) and Clinician must be well versed with the guide system.[13]

XV. Conclusion

Guided surgery with 3D planning and evaluation has opened the gates for safer, accurate implant placement. Successful implant placement by guided surgery depends on the knowledge and understanding of these technologies. Further research is warranted to improvise the shortcomings of the guided system.

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