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Radiologist's Perspective On Computer Guided Implant Surgery: Review

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ABSTRACT:
Surgical guide gives stability in the surgical field and enhanced the accuracy in implant positioning based upon prosthetically driven restoration, thus ensuring predictable treatment outcomes. Successful rehabilitation lies in the correct sequence of surgical and prosthetic procedures. Whenever a staged approach of implant placement is planned, the clinician can effectively use the initially placed implants as anchors for the surgical template during the second phase of implant surgery. Keywords: Implantation, dental; dental implant; implant-supported dental prosthesis; dental restoration, surgical template.

Key Words: Surgical Template, CBCT, Implant Planning

INTRODUCTION

As dental implants increased in popularity as tooth replacement therapy, the accurate assessment of patient anatomy and the collaboration between restorative clinicians and surgeons have become critical determinants of successful outcomes. Advances in digital technology have enabled the development of systems that can assist the clinician in diagnosis, treatment planning, and the surgical treatment itself. Three-dimensional computer-assisted interactive implant planning software tools have sufficient accuracy and reliability required for predictable clinical use.[1,2]

Implant planning software allows one to virtually plan the implant surgery and to derive surgical templates from the information acquired. Surgical guide is the one that allows the practitioner to accurately place the implant with a predefined insertion path.

IMPLANT-GUIDED SURGERY PLANNING

Cone Beam Computed Radiograph plays vital role in Implant Assessments. The analysis of CBCT data includes the right qualitative and quantitative assessments of all relevant anatomy and boundary conditions. A condition is defined as any and every one anatomic constraints of an anatomic zone which will limit or influence implant placement and subsequent final restorations.[3]

Once measurements are wiped out the cross-sectional images, the clinician can virtually select and place implants within the region of interest. Most implant planning software packages do include implant libraries with most of the available implants within the market and every one the compatible abutments.4 (Fig1)

All systems of surgical guide use sleeve and drill combinations for the guidance. Different types of metal sleeves such as Pilot sleeve, Master Sleeve, Custom Sleeve and Drill Spoon during preparation of implant cavity, consistent with the virtual planning (Arisan et al. 2010). First, a fit of surgical guide with tooth or mucosa should be precisely the same thereupon at the time of preoperative CT acquisition, because a scan template used on the CT acquisition are often customized to a surgical guide for implant surgery. Second, data on the diagnostic software as numerical form are often directly used for personalisation of surgical guide. Third, a milling cutter can reduce displacement possibility of implant cavity position from virtual planning, because the cutter is initially wont to shave bone surface as flat before drilling, and therefore, drills are difficult to slide. Moreover, sleeves are often selected due to inter-occlusal distance between jaws.[5,6] (Fig 2)

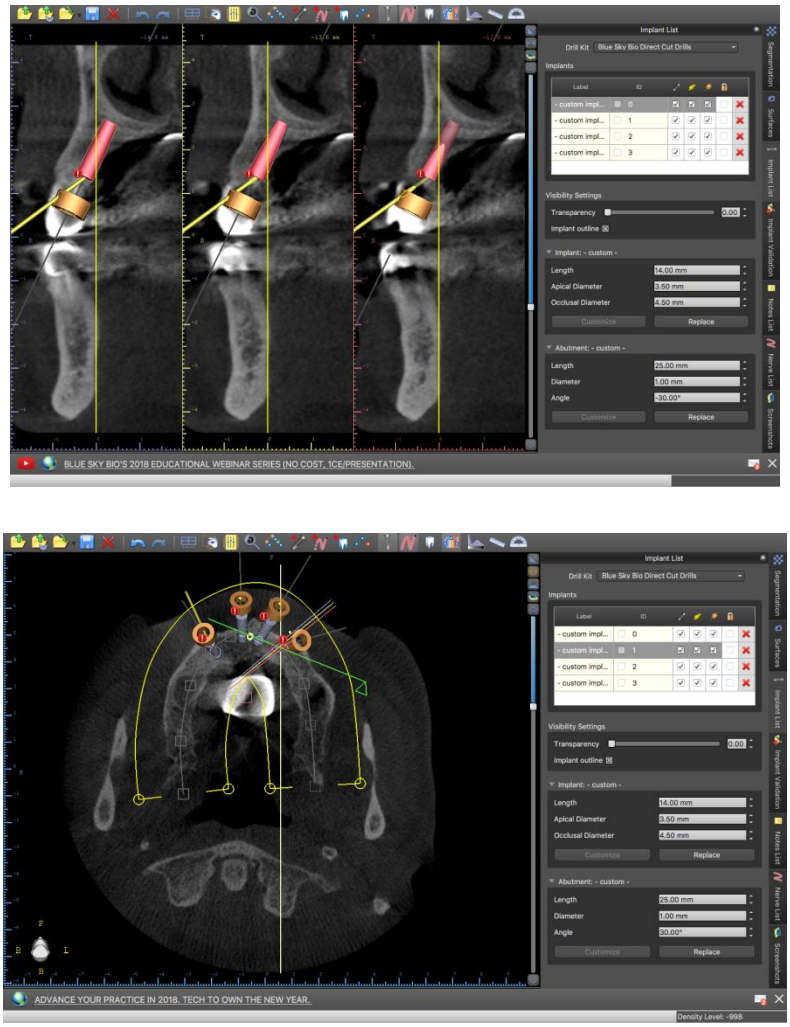

Fig 1: Virtual Implant placement using CBCT data (Bluskybio software)

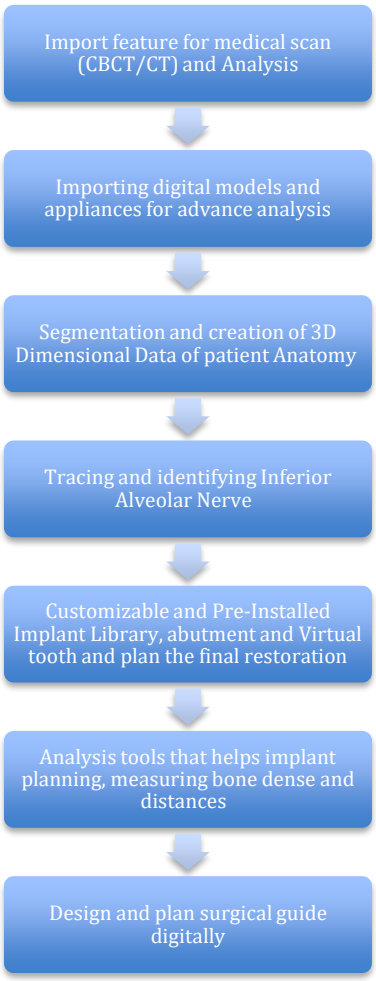

Fig 2: Schematic representation of Guided Surgery Planning

SURGICAL GUIDES

Once the implant is virtually planned, the project is often transferred to the clinical setting by employing a surgical guide. Surgical guides are appliances that are computer designed and are fabricated of an acrylic by a process called stereo lithography. The surgical guides contain steel sleeves with a predefined diameter to guide the drills during the osteotomy process. Parameters such as Inner Diameter, Outer Diameter, Height and Lip of the Sleeves should be considered before preparing the guide. There are differing types of surgical guides like a pilot guide, which allows the clinician to make the initial osteotomy. After the pilot osteotomy is made, the guide is removed and therefore the remainder of the method is completed free- handed. Surgical guides are often categorized consistent with the sort of stabilization they need like teeth, bone, or soft tissue. Surgical guides for edentulous patients are stabilized through temporary fixation pins which will even be planned using advanced tools within the

software packages. Two methods for a computer-based transfer are available: direct navigation and stereolithographic drill guides.[7]

At present, there are numerous third-party implant planning software programs like Implant (Materialise Dental Inc., Glen Burnie, MD, USA), Invivo5 (Anatomage, San Jose, CA, USA), Nobel Clinician (Nobel Biocare, Goteborg, Sweden), OnDemand3D (Cybermed Inc, Seoul, Korea), Virtual Implant Placement software (BioHorizons, Inc, Birmingham, AL, USA), coDiagnostiX (Dental Wings Inc, Montreal, CA, USA), and blue Plan (BlueSkyBio, LLC, Grayslake, IL, USA), 3SHAPE Etc., A CBCT reconstruction is obtained from all the pictures that are created and visualized from a special perspective than how the info were initially captured. Thus, a cross section, bird's eye view, multiplanar views, volume renderings, et al. are all considered CBCT reconstructions. For implant planning purposes, the cross section is that the primary diagnostic image used for the assessment of bone volume and quality. Completely edentulous patients should be scanned wearing radiographic stents with radiopaque markers (barium sulphate) to assist within the localization of specific cross sections and/or proposed implant site locations. These radiopaque markers are important to correlate tooth position with reference to the alveolar bone and CBCT cross sections. (Fig 3) Optical Scanning of models produces STL file which is additionally useful to correlate the teeth position. (Fig 4) If a surgical guide is to be produced, the precise protocols of the precise company must still be taken into consideration. In other situations, a replica of the denture is often used with fiduciary markers. a crucial factor when using radiographic guides both for dentate and edentulous patients is that the guides are positioned correctly, fully seated, and during a stable position during the scanning process. [8,9](Fig 5)

Fig 3: Radiographic Markers

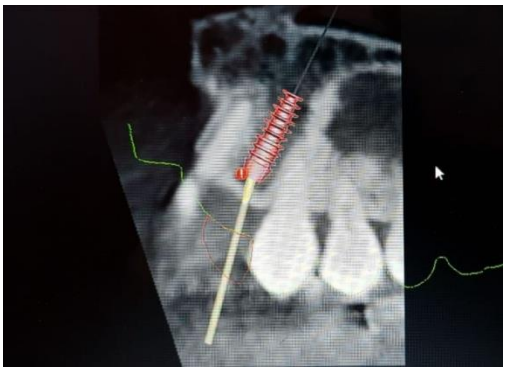

Fig 4: Stitching of optical scanning image to CBCT data

Fig 5: Fabrication of Surgical Guide (left) Placement of Guide inside mouth (right)

VOLUME RENDERING TOOLS

Volume renderings can greatly aid within the 3D visualization of implant locations and angulations and within the assessment of implants for restorative considerations. These renderings also can aid in assessing the available space for any particular restorative goal. However, they're generally lacking within the ability to accurately depict the interior anatomy and thus should only be used after or with simultaneous cross sectional analysis. the precise surface morphology of volume renderings can also not accurately represent the patient's anatomy. due to this, it's important to recollect that the 3D models are to be used as a complement to the diagnostic and planning process. Three-dimensional models offer a broad picture of the general anatomy like root eminences, bone defects that originate from healing irregularities or concavities caused by bone atrophy, excess sharp bony edges, and tooth positioning. Finally, volume renderings can function an academic tool for the patients to know how the whole process works.

Some software programs allow manipulating the 3D volumes and creating high- resolution models by using advanced segmentation tools. Scatter originated from metallic restorations causes a detriment within the image and 3D rendering quality. Scatter are often manually erased or segmented with advanced tools from the 3D volume rendering but can't be eliminated within the 2D images.[10]

CONCLUSION

The invention of Cone beam Computed Radiography, guided surgery and digital scanning software's, provide clinicians more confident on both tissue supported and teeth supported implant surgeries. The stability of surgical guide's stable fixation ensures the accuracy in implant positioning based upon the future restoration. The outcome of treatment still relies on case selection, judgement of clinicians, prosthetic and surgical protocols. Complete treatment planning is important for selection between conventional and guided cases .

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The authors report no conflicts of interest related to this study.

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