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The role of cone-beam computed tomography in imaging-guided implantology: A case report of imaging-guided placement of single tooth dental implant

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Abstract
Three-dimensional imaging, particularly cone-beam computed tomography (CBCT), has made significant contributions to the planning and placement of dental implants. The accuracy of CBCT data can be used to fabricate a surgical guide that transfers the implant planning information to the surgical site, which facilitates implant placement. Prosthetically driven implant prosthesis assures good aesthetics, function, and most importantly hygiene maintenance, which enhances the long-term success rates. Precision in this treatment planning and implementation of planned treatment is vital for this success.
Here we describe a method for applying CBCT data to aid in the accurate planning and placement of single tooth implant.

Keywords: Cone-beam computed tomography (CBCT), implant planning, surgical guide

1. Introduction
The actual standards of care for replacement of missing teeth by means of dental implants demand not only the replacement of missing teeth in terms of function, but also the achievement of satisfactory aesthetics [1]. Optimal positioning of the dental implant through prosthetically driven decision-making is mandatory to achieve these goals [2, 3].
Computer-aided treatment planning may offer significant advantages to the clinicians by enabling successful placement of the implant while alleviating the need for elevation of large mucoperiosteal flaps. Thus, not only does the clinician benefit greatly from this technique, but the patient advantages in terms of decreased intra- and post-operative pain and discomfort, are of immense significance.
Patients can largely benefit from the imaging-guided prosthetic replacement, in terms of having flapless and painless replacement procedures for the missing teeth immediately. However, precise and meticulous planning of the implant-based replacement in advance of the procedure to be performed, is indispensible to the success outcomes. The conventional free-hand dental implant placement is challenged by many factors that jeopardize the desirable beneficial outcomes. Some of these factors include movement of the patient during drilling, and a limited arial vision of the operative field, which is mostly limited to the edentulous soft tissues in the area of concern. Moreover, the accurate diagnosis of the surgical site surface on a 2-dimensional radiograph, its interpretation, and transfer of the acquired 2-dimensional data into the actual 3-dimensional surgical environment, pose a great challenge for achieving the integration of aesthetic, biomechanical and functional aspects, the principle pre-requisites for long-term success outcomes. Thus the maxillofacial radiologist is faced with numerous dilemmas ranging from the surgical perspective to the implant positioning, all in a critical time period. A thorough preoperative planning done by the oral radiologist with the view point of accurate placement of dental implant will ensure uneventful placement procedures, while allowing more time for the surgeon to concentrate on patient and tissue handling.
The growing interest in flapless minimally invasive implant placement procedures followed by immediate replacement with pre-fabricated temporary prosthesis to restore function and aesthetics, have led to the development of numerous three-dimensional (3D) visual software programmes. 3D visualization of the site characteristics, neighbouring anatomy, and proximity of vital structures, provides the clinicians with a thorough vision of the surgical, prosthetic

and aesthetic requirements of the ideal treatment plan. This enhances the decision-making, thereby increasing the overall reliability and success outcome of the dental implant treatment.

Computerised imaging-guided dental implant placement calls for 3-dimensional imaging of both the jaw bones and virtual planning of the prosthesis. Such integration of the planned prosthesis within the intra-oral dental implant is achieved through a double-scan technique with fiducial marker-based matching; means the use of gutta-percha incorporated in the temporary prosthesis during the second scan [11]. The first scan is obtained with the temporary prosthesis stabilised in position in the patient's mouth with an occlusal silicone index. The same planned prosthesis is than scanned separately with different exposure parameters as suggested by the specific guide designing software, in order to allow its 3D visualization. As the markers are visible in both sets of scans, they can be fused, and the prosthesis properly positioned, within the maxillofacial structures. A recently introduced 3D implant planning software (Nobel Clinician, Nobel Bio- care,) automatically combines the Digital Imaging and Communication in Medicine (DICOM) data belonging to the CT/CBCT examination of the patient with the STL data derived from the optical digital high-resolution scan of the preoperative patient master cast [12].

An additional benefit of this streamlined workflow is that multiple planning options can be visualized and considered well before the surgery is done, and the treatment plan which best fulfills the functional and esthetic demands of the surgical site can be opted for. Once the planning is completed and approved by the clinician, the digital information is used to produce the surgical stent or template that will be tooth supported with CAM rapid prototype (milling or 3D printing.) [13, 14]

Implant placements in the aesthetic zone continue to present a major challenge for the surgical as well as prosthetic phase [8]. Potential advantage of computer-guided implant placement in the aesthetic zone includes a decreased mucosal recession and maximum preservation of the peri-implant papillae when the implant is positioned properly [9].

2. Case Report

A 26 year old female patient reported with the chiegf complaint of removal of lower posterior tooth due to decayed 2 months before. As the adjacent teeth were healthy she was not in position to go for grinding of those teeth as a line of treatment for fixed bridge in the missing tooth region.so the only option of Dental Implant in missing tooth region was the option by choic to replace the missing tooth. On examination 35 was missing and radiographically healing socket was steel observd. no relevant medical history as patients health was concern.. On routine IOPA slightly immature bone seen as of history of extraction just 2 month before.

As planneded for the Single tooth implant the Cone beam CT was advised to determine for accurate Bone width, Length and possible bone density in edentulous area along with inferior alveolar nerve tracing of left side.

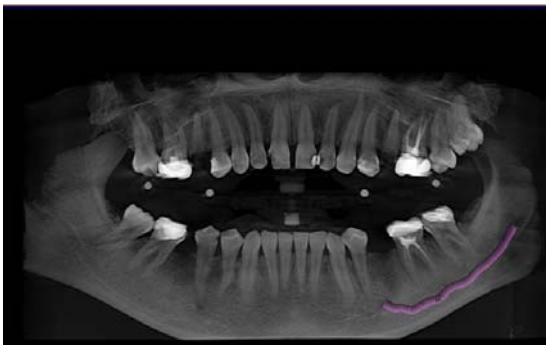

Fig 1: CBCT Scan with Radiographic Marker.

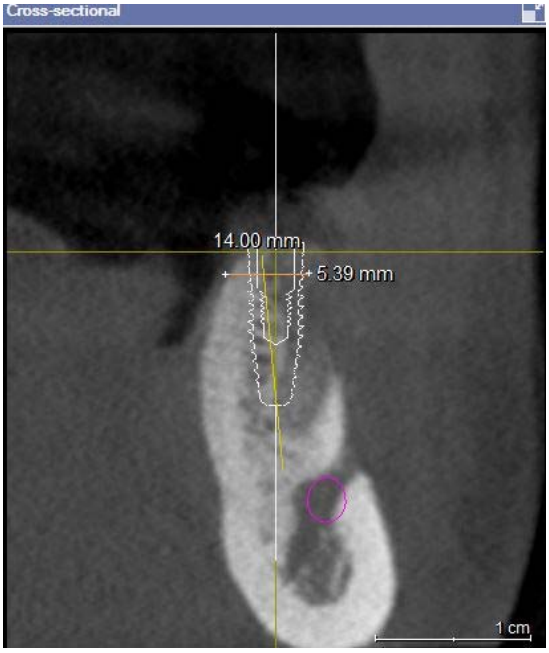

Fig 2: The Cone beam CT gives the accurate dimension on cross section.

Dual scan with Marker integrated with DICOM to facilitate the exact implant positioning.

The final Template is designed and ordered with Nobel clinician software. and Virtually planned implant is placed in the edentulous area followed by prosthetic phase..

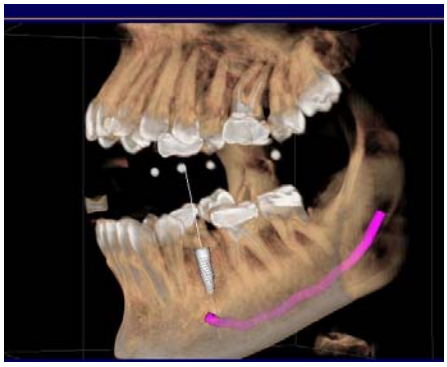

Fig 3: Virtually Planned Implant in 35.

3. Discussion

Digital technology has proved to be an invaluable boon in the art of diagnosis and treatment planning. However, even the most perfectly formulated plans carry no worth, if they are not executed properly. Anatomical limitations and better prosthetic standards demand that the surgeon gain better precision in the surgical positioning of dental implants. During oral implant placement, the drill (position, depth and angulation) must be guided by the surgeon according to the final form of the prosthetics [4]. Ideal placement facilitates the establishment of favorable forces on the implants and on the prosthetic component[5]. In this regard, surgical guides have shown better predictability of placement, thereby yielding better prosthetic results. Several guides have been reported in literature, including the self/light cure acrylic resin, metal reinforced acrylic templates, vacuum formed polymers, milling, CAD-CAM prosthesis and stereo lithographic models [6]. Of these, milling, CAD-CAM prosthesis or stereo lithographic models have been known to provide good results[7].Care should be taken in deciding the type of surgical guide and its method of fabrication, selection of anchors (depending on site, implant number, angulation, and anatomical limitation).

4. Conclusion

Transfer of the computed tomographic treatment plan to actual surgical field remains a critical point in implantology, and surgical guide is proving its worth. Surgical guides enables the clinician to establish good implant prosthetics, providing excellent esthetic, function, and hygiene maintenan.

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