

*Research Article***Implant Surgical Guide Accuracy: CBCT cast scan**

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Abstract

Objective: The aim of this study is to evaluate the accuracy of implant placement using implant surgical guide by CBCT cast scan. **Patients and methods:** seven resin surgical guide models were used in this study. Implant position was virtually planned using 3D planning software. Surgical guides were designed on the software and exported in STL format. Ten implants were placed. The 3D position of the planned and placed implants, in terms of the linear deviations of the implant head and apex and the angular deviations of the implant axis, was compared by superimposing the pre- and postoperative CBCT using software. Data showed parametric distribution so; it was represented by mean and standard deviation (SD) values. **Result:** Angular deviation was 2.38 ± 0.37 degree. Coronal deviation of Implant was 0.49 ± 0.12 mm. Apical deviation of implant Apex was 1.28 ± 0.15 mm, although the implant position was slightly different than the planning but, there was no statistically significant difference. **Conclusion** Implant surgical guide fabricated with CBCT cast scan has accepted accuracy and it is less costly technique with accepted accuracy.

Key words: Accuracy, CBCT, dental cast model, surgical guide.

Introduction

Dental implants constitute a fast-growing procedure for treatment of partially or fully edentulous patients. Prior to dental implant procedure, a full clinical assessment of the patient is mandatory so that appropriate techniques can be selected. In this regard the three dimensional (3D) based pre-implant diagnosis has become widespread in dentistry with the introduction of cone beam computerized tomography (CBCT).⁽¹⁾

The protocol for a successful implant insertion is one that help in osseointegration (through sufficient bone volume), as well as proper position of the implant to obtain an esthetic and functional restoration. Ideal placement helps to distribute favorable forces to the implants and prosthetic components and ensure the esthetic outcome. This will increase the predictability of success.⁽²⁾

The recent technique in this field is a method of making a guide for implant placement using 3D printing technique. Prepared guide reduces surgical complication and place the implant in the most optimal position for prosthetic restoration.⁽³⁾

The advantages of this surgical protocol are its minimally invasive nature, accuracy of implant placement, predictability, less postsurgical discomfort, and reduced time required for definitive rehabilitation.⁽⁴⁾

Surgical guides facilitate proper positioning and angulation of the implants in the bone. The surgical guide helps in proper positioning of implant body so that it offers proper, support of occlusal forces and placement of restoration.⁽⁵⁾

Stereolithographic (SLA) guide fabrication consists of 3 key steps including a scan to obtain anatomical information, software segmentation of information, and fabrication with rapid prototype technology. Each step is associated with inherent errors. This can lead to deviation at the implant head, apex, depth, and angular deviation.^(5,6)

The degree of the difference between the proposed and actual implant direction may be influenced by various factors, such as the construction accuracy of the template, the accuracy of the study model, the accuracy of the

stereolithographic machines and the measurement accuracy.⁽⁷⁾

CBCT imaging information of hard tissues is highly accurate, but because of the poor contrast resolution, the information for soft tissue is inaccurate. So, optical scanning technology was incorporated to implant planning software packages. With optical scanning, stone models provide soft tissue profile information as well as accurate information of teeth. The scanning system provides STL (Standard Tessellation Language) file.⁽⁸⁾

Digitalization of cast can be done by cone beam computed tomography (CBCT) for using in digital implant planning and orthodontics⁽⁹⁾

3D Scanners are automatic 3D acquisition devices which creates the digital 3D model from real 3D objects effectively in lesser time and cost. 3D scanning technologies are used to convert a physical model into digital 3D computer-aided design (CAD) file.⁽¹⁰⁾

Pre- and post-surgical CT scans have been used to evaluate the accuracy of surgical guide by detection of the difference between 3D planned implants and the actual location of the surgically placed implants defined as the deviation between the planned implant and position of the implant in the mouth.⁽¹⁰⁾

The aim of this study is to compare the accuracy of implant placement using implant surgical guides fabricated by CBCT cast scan.

Patients and Methods

Patient selection: seven patients were selected (4 male, 3 female) from outpatient clinics of dental hospital faculty of dentistry, Minia university. Patient inclusion criteria were partially edentulous patient with at least 6 remaining teeth, age above 18 years, in need of an implant-supported fixed restoration by at least two implants. Exclusion criteria: Age below 18, edentulous patients, patients who need bone graft before implant. patient with uncontrolled systemic disease, severe bruxism or clenching and patients who received radiation therapy, chemotherapy, or both.

This study was approved by the Research Ethics Committee (REC) under number 318/2018, Faculty of Dentistry, Minia University before

starting the research. Written, informed consent was obtained for all participants.

Patient history and clinical examination

Detailed history taking and clinical examination of the patients were performed, thorough extra- and intra-oral examinations were performed for every patient.

Cone beam computed tomography (CBCT)

All patients examined by CBCT first to select cases suitable for implant treatment with implant surgical guide. CBCT images were obtained using a Promax 3D unit (Planmeca Oy, Helsinki, Finland), operating at 84 kVp, 9–14 mA, with a 0.16 mm voxel size, an exposure and a field of view of 8*5 cm. CBCT scans were saved and viewed into Romexis 4.4.2.r. software (Planmeca Oy, Helsinki, Finland). Images were exported in Digital Imaging and Communications in Medicine (DICOM).

Implant planning and guide fabrication

Mandibular impressions were made in suitable size stock tray for each patient using irreversible hydrocolloids. The tray was modified when necessary to guarantee that the required area will be registered properly in the impression. The impressions were poured in dental stone to obtain a study cast. A CBCT scanning was also carried out for the model (Planmeca Oy, Helsinki, Finland). DICOM files from CBCT scan of each patient were imported to implant planning software (Blue Sky Bio, LLC, Grayslake, IL, USA) and superimposed with the DICOM file from CBCT cast scan and tooth supported implant guides was done.

Surgical procedure

The surgery was performed under Local Anesthesia. The surgical templates were stabilized on the residual teeth and fixed with two to three preplanned anchor pins, implant inserted two implants in some patients and only one in the others. In2Guide Universal kit (Cybermed Inc., Seoul, Korea) was used which is a 44piece surgery kit, specifically designed for In2Guide surgical templates to perform full sequence drilling. A tissue punch was then used to remove the gingival tissue under the implant sleeves. Drilling protocol was then followed for each osteotomy site according to the drill sequence. The drilling depth was controlled by a drill stopper. After proper depth preparation the implant inserted.

post-operative

Post-operative CBCT scan was done with the same preoperative parameters. The preoperative (implant planning) and postoperative (achieved implant position) scans were then overlapped using a dedicated algorithm, which allowed the comparison of the virtually planned and the actual implant positions. Three deviation parameters between each planned and placed implant were measured. The most common method for measuring difference between planned and actual inserted dental implants, done by overlay the 3D images of implant planning and post-operative images using

dedicated software. The most used measurement parameters in the past studies were Angular deviation, Cervical deviation, and Apical deviation⁽¹¹⁾

Statistical Analysis

Numerical data were explored for normality by checking the data distribution, calculating the mean and median values, and using Kolmogorov-Smirnov and Shapiro-Wilk tests. Data showed parametric distribution so; it was represented by mean and standard deviation (SD) values.

Results

Descriptive statistics:

Descriptive statistics for deviations in different measurements were presented in table (1)

Table (1): Descriptive statistics for deviations in different measurements

Parameter	Surgical guide	Mean	Std. Deviation	Median	Min.	Max.
Angular deviation	CBCT cast scan	2.38	0.53	2.45	1.40	3.00
Coronal deviation	CBCT cast scan	0.49	0.12	0.50	0.30	0.70
Apical deviation	CBCT cast scan	1.28	0.13	1.30	1.10	1.40

Discussion

The implementation of digital technology has influenced the dentistry field at a great level and increased the progress of CAD/CAM systems. The digital workflow is continually growing in dentistry and is considered smooth and time saver. Digital workflows provide higher efficiency and facilitate data storage, reproducibility, and treatment documentation, and can even lead to advanced treatment concepts (Sulaiman, 2020)⁽¹²⁾

The present study was done to evaluate the accuracy of implant placement using implant surgical guide fabricated by CBCT cast scan.

The surgical guide was evaluated intraorally for proper seating, and the guided surgery was performed using a flapless approach. A flapless approach was chosen because of the availability of adequate keratinized tissue and bone volume that would require no contouring or other grafting procedures, Da Rosa et al., 2004⁽¹³⁾ reported that lack of flap elevation and subsequent interruption of blood flow can decrease postoperative discomfort, reduce

surgical time, reduce healing time, and reduce bone loss.

Only tooth-supported surgical guides were used in this study. This may probably be one of the reasons for the better accuracy of this study. In a meta-analysis study, Raico et al., 2017⁽¹⁴⁾ concluded that the accuracy was better for tooth-supported guides than bone and mucosa-supported guides.

Nevertheless, the mean coronal deviation at the implant platform and apex (0.49 and 1.28 mm, respectively) of the present study was still similar to that previously described in the study using a fully digital planning modality by Skjerven et al., 2019⁽¹⁵⁾ (1.05 and 1.63 mm, respectively), in which all implants were also inserted via tooth-supported surgical guides.

The angular deviations of the placed implants compared with the planned implants were $2.91^{\circ} \pm 1.3^{\circ}$ for the tooth supported stereolithography surgical guide in the study by Ozan et al., 2009⁽¹⁶⁾ and it in agree with this study which has

result of angular deviation $2.38^{\circ} \pm 0.53^{\circ}$ for CBCT cast scan.

Blue sky bio software was the software of choice. Bilal et al, 2018⁽¹⁷⁾ reported that blue sky bio provided the facility of construction of 3D images, accurate and easy superimposition than other software and easy angular measurements. Surgical guide was completely designed by blue sky bio and exported directly as STL file for prototyping.

CBCT cast scan is slightly less accurate than optical scanner cast scan but is considered to lie within a clinically acceptable margin of error and should therefore not affect the clinical applications of this digitalization process. Our results are like the findings reported by Becker et al., 2018⁽¹⁸⁾ who stated that, even if the scanner's precision is lower than that of the reference desktop scanner, it is still clinically acceptable.

The study result showed that CBCT cast scan is a valid and accurate method for cast digitalization and it is agreeing with Emara et al., 2020⁽¹⁹⁾ who found the tested CBCT scanner showed high precision and validity. To avoid additional procurement costs to the clinicians, those who already have a CBCT device with a scanning protocol need not purchase an optical scanner for digitization of the models.

Conclusion

Implant surgical guide fabricated with CBCT cast scan has accepted accuracy and it is less costly technique with accepted accuracy.

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