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The Accuracy of Dental Implant Placement Using Conventional versus Stereolithographic Tooth Supported Surgical Guide; (Randomize Control Trial)

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ABSTRACT

Aim: This can be done by computed tomography (CT), three dimensional implant planning software, image guided template production techniques, and computer aided surgery. **Subjects and Methods**: 20 implant placed in selected adult patients of both sexes ,divided into two groups. Group I: included 10 conventional implants placed in patients. Group II: Included 10 guided implants placed in patients (by using steriolithography.). Clinical photographs were taken before ,during and after procedures .Conebeam computed tomography was performed. Surgical procedure was done and implant were positioned. Implant evaluation clinically by implant primary stability by measuring the accuracy of the surgical guide on the postoperative image after implant insertion by recorded linear deviation(coronal ,apical)angular deviation ,and measurement of deviation in the post-operative implant position from the preoperative virtual implant planning. **Results:** We found noticeable high significant difference in group I than Group II in Coronal ,apical ,angular direction. **Conclusion:** The results proved the benefit of Using surgical guide template .It enables the clinician to optimize implant position, angle, diameter and length by dictating the drilling position and angulation

KEYWORDS

Dental implant, Cone Beam Computed Tomography, Guided Implant, Steriolithography

INTRODUCTION

The success of implant therapy depends primarily on appropriate treatment planning and properly performed implant placement surgery positioned in optimal three-dimensional position, this will allow for optimal support and stability of peri-implant bone and soft tissues, essential for a functional restoration, and esthetic outcome[1].

Planning of implant depend on Computer-Aided Design/Computer-Aided Manufacturing (CAD/CAM).This technique based on volumetric tomography using a 2D providing an area detector. This is combined with a 3D x-ray beam which enables reformatting the image data to create cross-sectional tomographic images of the implant site. This help in differentiation and quantification of both soft and hard

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tissues and provides a unique imaging analysis of proposed surgery or implant sites[2].

Conventional Surgical Template(CST) is a guide used to assist in proper surgical placement and angulations of dental implants.The surgical guide template is fabricated by a dental technician after the pre surgical restorative appointments. Surgical guide can be manufactured by additive or subtractive method, The subtractive method is provide more homogeneous objects with acceptable accuracy that may be more suitable to produce intraoral prostheses where high occlusal forces are anticipated. Additive manufacturing methods have the ability to produce large work pieces with significant surface variation and competitive accuracy[3].

Guided surgery divided into two types, fully guided or partialy guided surgery. The fully type guides the surgeon during preparation of the osteotomy and implant placement; the latter type is used only to prepare the implant bed. The advantages of fully guided techniques are the possibility of implant insertion without raising a mucoperiosteal flap (biological benefits) ,greater predictability of immediate loading and the possibility of placing a prefabricated prosthesis ,improved patient and clinician comfort because of a shorter operative time ,easier treatment of patients with other health problems [4].

Stereolithographic (SLA) printing is one of the most popular groups of techniques called modern Additive Manufacturing (AM) systems; additive means that the systems build objects in a layer-by-layer manner .It is a computer-guided, laser-dependent, rapid prototyping polymerization process that can duplicate the exact shape of the patient's skeletal anatomic landmarks in a sequential layer of a special polymer to produce a special 3D transparent resin model, which fits intimately with the hard and/or soft tissue surface. It aim to transfer the ideal implant position (established during planning) to the surgical feld, using templates in the guided surgery [5].

Accordingly ,the present study was conducted to compare between "Accuracy of placing dental implant by using conventional surgical stent and steriolitheographical tooth supported surgical guide radiographically.

PATIENTS AND METHODS

Twenty implant placed in selected adult patients of both sexes ,divided into two groups.Group I: included 10 conventional implants placed in patients. Group II: Included 10 guided implants placed in patients (by using steriolithography. Patients selected from those attending at the out-patients clinic, Oral Medicine and Periodontology Department, Faculty of Dental Medicine, Al-Azhar University, Assiut branch.

Inclusion criteria:

Patients were free from any systemic disease according to Cornell medical index[6] . Patients were cooperative, motivated, and had good oral hygiene after receiving phase 1 therapy.The implant sites had sufficient bone quantity (width & height) and adequate bone quality .

Exclusion criteria:

Uncooperative and smokers patients. para functional habits such as bruxism. Presence of acute infection around the failing tooth. Perforation and/or loss of labial bony plate following tooth removal and/or implant osteotomy. Inability to achieve primary implant stability following implant placement

Patients grouping and interventions:

Group I: included 10 conventional implants placed in patients (by conventional free hand implant gp). **Group II:** Included 10 guided implants placed in patients (by using steriolithography)

The treatment protocol for computer assisted implant surgery follows the fundamental steps:

1. **Cone-beam computed tomography (CBCT) scanning:** 3D images are taken preoperatively via cone-beam computed tomography to analyzes bone volume for implant placement, mucosal thickness,adjacent teeth structures,maxillary sinus position[7].
2. **Software program execution:** Software programs are available for planning and guided implant surgery. The 3D images are transformed into Digital Imaging and Communications in Medicine (DICOM) format. After reformatting the images, proper size of the implants is chosen at the site level of placing implant. This provides a virtual environment mimicking surgical procedure, exhibiting the coronal and apical location of the implant in an imported 3D image model of the jaw bone [8].
3. **Fabrication of surgical drilling guides:** Upper and lower impressions are taken and bite is registered. Later, the impressions need to be articulated as the poured models on an articulator. The surgical guides are prepared manually or using computer-assisted methods after planning preoperatively[9].
1. **4. Surgical procedure:** Before procedure, the surgical guide is fitted in the mouth. It must be precisely adapted and stabilized to the soft tissues or teeth using an index .A flap or flapless approach is followed.

Using the static computer-assisted approach:

The use of static computer-assisted system, using flapless approach,that is very advantageous, which helps in replicating the precise implant position in the dental arch. There are some challenges when placing these surgical guides in the restricted mouth opening or in the posterior regions due to its varying sizes of the drills[10,11].

Clinical evaluations:

Implant primary stability: All implants were evaluated for primary stability once after implant insertion with an Osstell®*[12] Mentor magnetic resonance device that uses resonance frequency analysis for determining implant stability. The evaluation method :carried out in this study was Measurement of deviation in the post-operative implant position from the preoperative virtual implant planning concerning the coronal and apical linear deviation and the inter-implant angle. This was done by superimposition of the CBCT images of pre-operative virtual planning with the post-operative actual implant placed in the patient's mouth. The comparison between the real placed implant and virtual implant was analyzed by computer software 3D. Diagnosys.[2]to record linear and angular deviations[13]. Recorded linear deviation: The linear deviation was recorded for each implant. The central axis of the placed implant and the virtual implant was determined,and the linear distance between both was measured. The central axis at the coronal and apex of the implants was measured in mm. and the linear values were recorded and compared in two groups included:

A- Coronal linear deviation: The coronal linear deviations for both groups were measured at three axes. X axis (bucco- lingual), Y axis (mesio- distal) and Z axis (vertical).

B- Apical linear deviations: The apical linear deviations in two groups were measured at X axis (bucco- lingual), Y axis (mesiodistal) and Z axis (vertical).

Angular deviation : The central axis of the placed implant and the virtual implant was determined and the angular deviation between the central axes of the implants was measured in degree. The angular values were recorded and compared in two groups.

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* *Osstell; Integration Diagnostics Ltd, Goteborg, Sweden*

Fig. (1) Clinical photograph showing A) Conventional guide B) Surgical guide Steriolethography.

Fig. (2) Clinical photograph showing female 30 years (A) with multiple extraction teeth.(B) Surgical guide in position

Fig. (3) Clinical photograph showing patient with final restoration

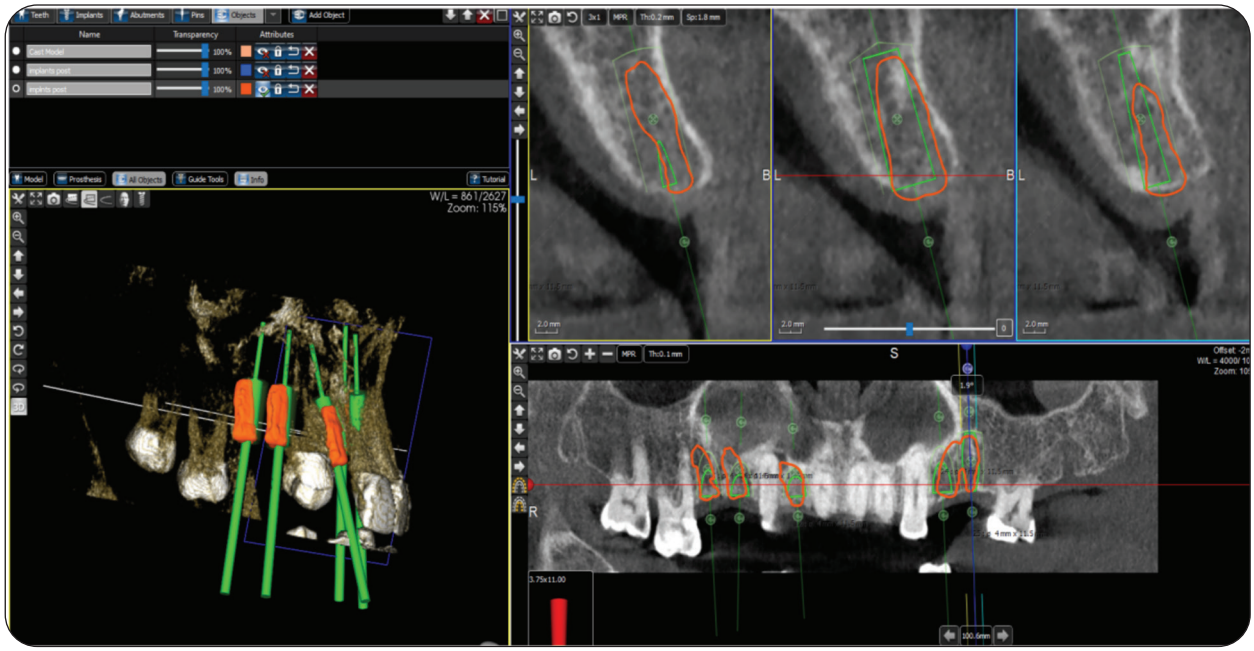

Fig. (4) Radiographic implant planning

Statistical Analysis

The data were collected, tabulated and statistically analyzed by SPSS (Statistical Package for Social Sciences) version 24 that programmed to produce:. Data were explored for normality using Kolmogorov- Smirnov and Shapiro-Wilk tests, data are presented as the Mean ± standard deviation (SD) which showed non-parametric (not normal) distribution. Mann-Whitney was used to compare between two groups in non-related samples. Wilcoxon was used to compare between two groups in related samples. Spearman correlation was used to find the correlation between different parameters and the significance level was set at $P \leq 0.05$. Statistical analysis was performed with IBM® SPSS® Statistics Version 20 for Windows.

RESULT

This study was carried out on 20 implant placed in adult patients of both sexes. Table (1) show Correlation between Coronal, Apical and Angular Deviations in Group I &II. Accuracy results: Coronal: (Buccolingual deviation (X), Mesial deviation (Y), Vertical deviation): There was a statistically significant difference between (Group I) and (Group II) where ($p \leq 0.001$). The highest mean value (Least accuracy) was found in (Group I), while the least mean value (More accuracy) was found in (Group II). Apical: (Buccolingual deviation (X), Mesial deviation (Y) ,Vertical deviation (Z),: There was a statistically significant difference between (Group I) and(Group II)where ($p<0.001$). The highest mean value (Least accuracy) was found in(Group I), while the least mean value (More accuracy) was found in (Group II). Angular:There was a statistically significant difference between (Group I) and (Group II) where ($p<0.001$). Regarding correlations between different parameters, a positive correlation was found between Coronal deviation and each of Apical and Angular deviations. Also, Apical deviation showed a strong positive correlation with Angularin gp I.While in gp II showed a positive correlation was found between Angular deviation and each of Coronal and Apical deviations. While Coronal deviation showed a negative correlation with Apical deviation.

Table (1) *Correlation between Coronal, Apical and Angular Deviation in Group I &II:*

Group I					Group I				
		Coronal deviation	Apical deviation	Angular deviation			Coronal deviation	Apical deviation	Angular deviation
Coronal deviation	Pearson Correlation	1	0.114	0.578	Coronal deviation	Pearson Correlation	1	-0.412	0.532
	p-value		0.754	0.08		p-value		0.237	0.113
Apical deviation	Pearson Correlation	0.114	1	.859**	Apical deviation	Pearson Correlation	-0.412	1	0.391
	p-value	0.754		0.001		p-value	0.237		0.264
Angular deviation	Pearson Correlation	0.578	.859**	1	Angular deviation	Pearson Correlation	0.532	0.391	1
	p-value	0.08	0.001			p-value	0.113	0.264	

DISCUSSION

The present study conducted to compare tha accuracy in placement techniques between conventional surgical guide dental implant and steriolethography guided. The performance of computer-guided implant systems and their accuracy relies on all the cumulative and interactive errors involved, from examination, impression, CBCT data acquisition, and guide manufacturing to the surgical procedure and improvements of templates design should be performed to reduce inaccuracy[17].

Stereolithography offers the clinician a 3D solid model for analyzing a multisensorial approach with regard to the implant placement, without the surgeon meet the patient. therefore, steriolethography very useful for surgical simulation in order to facilitate anatomic reduction and diminish operation invasiveness and time. So this technology has proven to be an effective adjunct for placing and restoring implants, through the use of surgical guides. Some disadvantages of stereolithography are the high cost of manufacturing the physical model [18].

The surgical guide requires an adequate gap between the implants, mucosa, and adjacent teeth to provide accuracy.Computer-assisted guidance allowed an error of <2 mm linear deviation and angular deviance <5°, when compared with a laboratory-made acrylic guide[19]. Cassetta et al. consider the chance of implant deviations may occur as an error, during planning or surgical procedures as noted minimal deviation at the coronal and apical part of implant and slight change in angulation of implant [20].

According to our study ,The guided implant surgery provides precise, effective, and efficient implant placement compared to freehand implant surgery without damaging the critical anatomic dental structures. Guided surgery requires specialized knowledge and high standards of care**. Nokar et al** show similar results that were reported in his study when compared the accuracy of an advanced surgical template based on computer-aided design/ computer assisted manufacture (CAD/CAM) with the conventional surgical template. **Stumpel** argued that the use of surgical guides is beneficial from an operative perspective. All the decisions regarding implant positioning have been planned prior to surgery and hence, the surgery is just a matter of executing this plan. This is true if the guide is more restrictive where the implant placement procedure may only last for a few minutes and would allow flapless types of surgery. This would reflect positively on the patient with less postoperative comfort and faster healing [21].

Finally, the use of computer guided surgery planning changes the surgeon's approach whereas the use of conventional guides permits a certain degree of offset from what was planned, while the use of computer guides allows implants to be inserted in more precise way. The limits of the present study were the small number of included patients. Although the "hand" of the operator is decisive in the occurrence of some deviation from the expected outcomes, these results can be useful for sample size calculation of further studies, establishing a minimum number of patients based on a statistical test to draw relevant conclusions.

Conclusion : Using Steriolithography guided surgery in implant placement offer better surgical and restorative results, and, obviously, in favor of ours patients when compare the results with free hand conventional guided surgery .

RECOMMENDATIONS:

Using guided surgical template steriolithography in treatment planning were helpful for assessing implant placement accuracy when compared with free hand implant surgery without damage to critical anatomic dental structure. General dentists must possess a basic knowledge about the applications and advantages of new 3D modeling technologies used in dentistry, such as those of stereolithography, as adjunctive tool for designing implant placement.

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دقة وضع الغرسات السنية باستخدام الدليل الجراحى المحوسب والتقليدى (تجربة سريرية عشوائية)

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الملخص :

الهدف: تعتبر زراعة الأسنان خياراً تأهيلياً جديداً للأسنان المفقودة. يرتبط نجاح زراعة الأسنان في علاج المرضى ارتباطًا مباشرًا بتقييم المريض والتخطيط الدقيق للعلاج. يتم تحقيق ذلك عن طريق دليل جراحي يوفر معلومات كافية بشأن وضع الزرع وفي وقت الجراحة، يتم وضعها على الأسنان الموجودة أو في المساحة الضيقة، ويمكن القيام بذلك عن طريق التصوير المقطعي (CT)، زرع ثلاثي الأبعاد برنامج التخطيط، وتقنيات إنتاج القوالب الموجهة بالصور ، والجراحة بمساعدة الكمبيوتر.

المواد والاساليب: 20 عملية زرع في مجموعة مختارة من المرضى البالغين من كلا الجنسين ، مقسمة إلى مجموعتين. المجموعة الأولى: تضمنت 10 عمليات زرع تقليدية تم وضعها في المرضى. المجموعة الثانية: تضمنت 10 غرسات موجهة يتم وضعها في المرضى (باستخدام ستيريوليثوغرافيا). اختيار الزرع من زراعة الأسنان NEOBIOTECH: تم التقاط الصور السريرية قبل وأثناء وبعد الإجراءات. تم إجراء العملية الجراحية وتم وضع الزرع. تقييم الزرع إكلينيكيًا عن طريق الثبات الأولي للزرع عن طريق قياس دقة الدليل الجراحي على الصورة بعد العملية الجراحية بعد إدخال الغرسة عن طريق الانحراف الخطي المسجل (إكليلي ، قمي) الانحراف الزاوي ، وقياس الانحراف في العمود -وضع الزرع الجراحي من تخطيط الزرع الافتراضي قبل الجراحة. تم استكشاف البيانات الخاصة بالحالة الطبيعية باستخدام اختبارات KOLMOGOROV- SMIRNOV و SHAPIRO-WILK. وأظهرت البيانات توزيعًا غير حدودي (غير طبيعي).

النتائج: وجدنا اختلافًا ملحوظًا في المجموعة الأولى عن المجموعة الثانية في الاتجاه التاجي والقمي والزاوي.

الخلاصة: أثبتت النتائج فائدة استخدام الدليل الجراحي للقالب ، حيث تمكن الطبيب من تحسين موضع الزرع وزاويته وقطره وطوله من خلال إملاء موضع الحفر والزاوية. ومع ذلك ، ينبغي إجراء مزيد من الدراسات باستخدام حجم عينة أكبر لتأكيد نتائجنا

الكلمات المفتاحية: زراعة الأسنان ، التصوير المقطعي المحوسب ، الزرع الموجه ، التصوير الليثوغرافي.