



Accuracy evaluation of computer-designed surgical guide template in oral implantology



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ABSTRACT

Objective: The purpose of this study was to assess the accuracy of implant placement using surgical guide templates, and to compare the results with implant placement based on computer-aided design (CAD) planning merely.

Material and methods: A total of 60 patients with dentition defects were included in our study, who were equally divided into group I and group II. Preoperative cone beam computed tomography (CBCT) was performed and preoperative planning was designed with Simplant software for all 60 patients. A total of 52 implants were placed in group I patients based on the preoperative planning without surgical guide templates. Implant surgical guide templates for group II patients were designed and produced by a rapid prototyping (RP) technique. A total of 57 implants were inserted in group II patients with the assistance of surgical templates. Postoperative CBCT was performed for all 60 patients. Image registration was carried out between postoperative CBCT data and that of preoperative planning data. Deviations of the implant between the actual and planned positions were measured and compared.

Results: There was no significant structure damage during the surgery. Osseointegration was achieved in all implants, and both soft and hard tissues around implants were stable. Variation at the implant shoulder in group II was 1.18 ± 0.72 mm, apex 1.43 ± 0.74 mm, angulation 4.21 ± 1.91 mm, and depth 0.54 ± 0.29 mm, whereas the variation in group I was 2.07 ± 0.51 mm ($P < 0.01$), 2.89 ± 1.02 mm ($P < 0.01$), 8.84 ± 4.64 mm ($P < 0.05$), and 0.78 ± 0.33 mm ($P > 0.05$).

Conclusion: The use of surgical guide templates can achieve higher precision and accuracy in implant shoulder, apex, and angulation, which is much more suitable for complicated procedures and conditions such as the flapless method, immediate loading, aesthetic restoration, and insufficient bone height.

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1. Introduction

Dentition defect is one of the most common disease conditions in the dental clinic. Implant rehabilitation, as an ideal treatment for dentition defect, has been growing toward maturity and perfection (Adell et al., 1981). With the development of oral implantology, osseointegration is not the only goal of implant surgery: How to install prostheses precisely and to restore tooth function and beauty become the ultimate goals in stomatology (Bahat et al., 1993). As a result, more and more attention has been paid to aesthetic and minimally invasive implant restoration. However, due

to the limitations of bone mass and anatomy, it is necessary to perform adequate preoperative assessment to improve accuracy and to avoid complications (Chan et al., 2010).

Although cone beam computed tomography (CBCT) combined with computer-aided design (CAD) can assist in diagnosing problems and predicting rehabilitative effects, there are also difficulties in transferring the treatment plan to the surgical procedure (Guerrero et al., 2006; Worthington et al., 2010). Recently, with the development of the RP technique, the implant surgical guide template has become more and more popular in the clinic, as it can solve this problem and simplify the surgical steps. Thus, this digital guide template seems to express great potential for accuracy and simplification (Hultin et al., 2012). However, it is not completely clear whether the surgical template can actually increase the accuracy of the implant. Although there are reports on the comparison between use of the surgical template and free-hand implant, there are few data concerning the accuracy of the surgical template compared with CAD planning alone. In the present study, we aimed to assess the accuracy of the planned and actual implant position using the surgical template or CAD data only, and to analyse the advantages of the surgical template.

2. Material and methods

2.1. Patients

A total of 60 patients who visited Oral Surgery Department at the Ninth People's Hospital, Shanghai Jiao Tong University School of Medicine for dental implant surgery from February 2013 to December 2013 were included in our study. The patients consisted of 26 males and 34 females with a mean age of 40 years (range 22–64 years). The patients were randomized into 2 groups and each of them was 30 patients. Group I included 14 men and 16 women with a mean age of 39 years, whereas group II comprised 12 males and 18 females with a mean age of 41 years. This study was conducted in accordance with the Ethics Committee of Shanghai Jiao Tong University School of Medicine.

2.2. Inclusion and exclusion criteria

All of the patients included in our study were adults with dentition defect. All of them accepted the treatment plans and provided signed informed consent. Patients with any of the following were excluded from the study: local or systemic implant surgical contraindications; periodontitis in the active stage; negative health habits such as severe smoking or consumption of alcohol; pregnancy or lactation; serious psychiatric disease; severe bruxism; or serious mouth opening limitations.

2.3. Clinical procedure

Medical history was collected and a clinical examination was performed on all of the patients. A model of the teeth was made, for a diagnostic wax-up after oral hygiene treatment. For edentulous patients or those who had more than 1 missing tooth continuously, a radiative guide template was made before CBCT (NewTown VG, Italy) and panoramic radiographs examinations. The data from CT scanning in DICOM (Digital Imaging and Communications in Medicine) format were input into an interactive Simplant Pro 11.04 (Materialise Dental, Leuven, Belgium) software program. Then preoperative planning including evaluating bone mass, choosing suitable implant sizes, determining the insertion depth and direction and avoiding vital structures were carried out. The rehabilitative effects were also predicted in three dimensions (Fig. 1). Operations were performed on the 30 patients in group I based on preoperative planning by Simplant Pro 11.04 software by the same surgeon. The implant system was TSIII (Osstem, Korea). A total of 52 implants were placed in the 30 patients in group I.

As for those patients in group II, optical scanning was performed on tooth plaster models to make 3-dimensional digital models after image examination, which were registered with computed tomography (CT) to form 3-dimensional reconstructive jaw models. Thus, the characteristics of teeth and occlusion, especially features of the oral mucosa surface, could be clearly presented (Lin et al., 2012). The preoperative planning, which

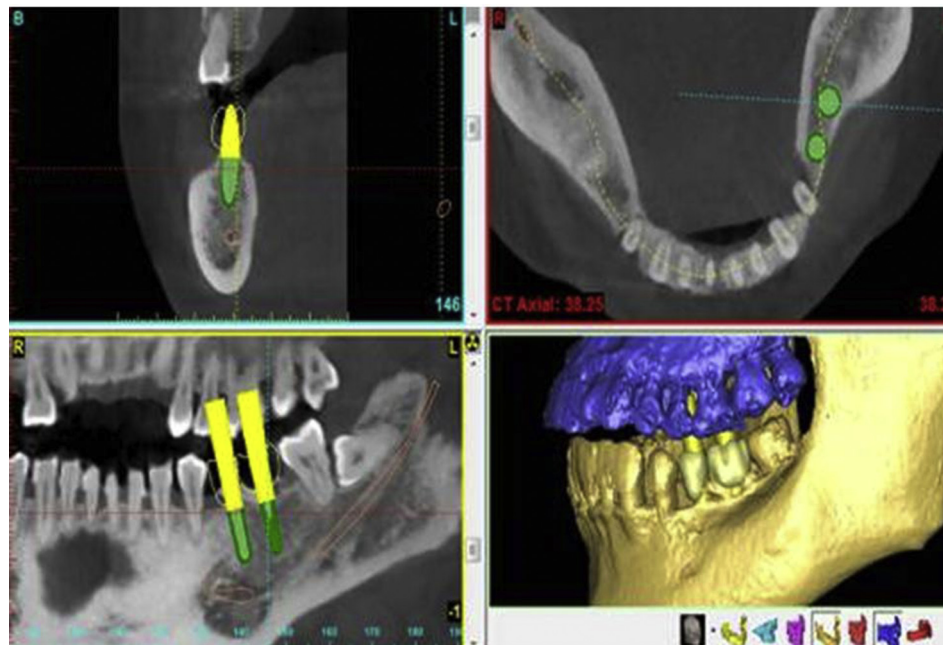


Fig. 1. Preoperative planning, including choice of suitable implant sizes and numbers, determination of the insertion depth and direction, and avoidance of vital structures were carried out using Simplant software combined with cone beam computed tomography. The effect of restoration was also predicted by Simplant software.

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