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Case Report

Digital Planning and Mucosa-supported Guided Implant Surgery: A Case Report

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Abstract: Guided implant surgery simplifies the execution of implant placement procedures and provides optimal clinical outcomes. The aim of this report was to demonstrate digital implant surgery process and to evaluate implant deviations at apex and platform. Case: A 55-year-old man with no relevant medical history and having an edentulous maxilla referred to the department of oral and maxillofacial surgery. Mucosa-supported guide and implant locations based on the desired prosthetic design was planned via Codiagnostix® software. Six implants were inserted and immediate provisional prosthesis was adapted to the maxilla. To analyze implant deviations, pre-planned image and post-operative cone beam computed tomography were superimposed. Digitally guided implant surgery is a beneficial and minimal invasive method for providing pre-treatment prosthetic evaluation and reducing intraoperative human error and surgery time. Although implant deviations were diagnosed in all implants with different degrees, final prosthetic rehabilitation was successfully achieved.

Keywords: *Digital planning; guided implant surgery; hybrid prosthesis; deviations; mucosa-supported guide; cone beam computed tomography*

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1. Introduction

Implant therapy has become a routine procedure to rehabilitate the edentulous patient. As the demand for the implant therapy has increased, several treatment modalities have been recommended to manage the complex cases. Guided implant surgery has been used for many years in practice to place implants in a correct position and reduce intraoperative human factor (Rosenfeld et al., 2006). The most important factors which affect the implant success are stable and healthy tissues surrounding the implant, precise placement of an implant based on the prosthetic and esthetic needs to prevent bone loss and compromised esthetics (Tardieu et al., 2007).

The most important advantage of guided implant surgery is the ability to anticipate the needs for the prosthetic and esthetics prior to the surgery and incorporate them into the surgical planning (Ganz, 2008; Jacobs, 2003; Parashis and Diamantopoulos, 2008; Schnitman et al., 2014). This method allows the surgeon to insert the implants into the sufficient hard and soft tissue at the pre-determined locations. The objective of this case report was to show the steps of guided implant surgery and to compare the digitally pre-planned and post-operative implant locations via CBCTs.

2. Case

A 55-year-old man with no relevant medical history presented for the replacement of his missing maxillary teeth, which had been removed three months ago (Figure 1). Mucosa supported guided implant surgery including an immediate provisional prosthesis was planned. A teeth set up was prepared to ensure accurate esthetics and function prior to the surgery. As a scanning appliance, an acrylic material and teeth with radiopacity were used to make it distinguishable in the radiographs. Pre-operative tomography scan was obtained with the scanning prosthesis mounted to the maxilla. All pre-operative and post-operative computed tomography scans were taken with a 1 mm slice thickness and 0.5 mm voxel size.

To obtain digital intraoral impressions of the maxillary edentulous jaw, provisional scanning prosthesis and stone cast of the upper jaw were scanned via laboratory digital scanner (Strauman 7series, Dental Wings, Canada). The prosthetic plan and CBCT data of the subject were imported into the digital planning software (CoDiagnostiX®). Before superimposition, three different points on the teeth and bone were used for image fusion of the intraoral scan data and CBCT data.

Figure 1. Frontal and intraoral views of the patient

2.1. *3D Implant Planning*

By considering the desired prosthetic plan, locations for six implants in variable lengths and diameters were determined (Figure 2). Implant positions, diameter and lengths of all implants were given in Table 1.

Table 1. Implant Properties

Position	**Model**	**Length**	**Diameter** (Ø)
15	Bone Level Tapered Roxolid® SLA® (NC)	10.00 mm	3.30 mm
14	Template Fixation Pin, Ø 1.3mm	28.00 mm	1.30 mm
13	Bone Level Tapered Roxolid® SLA® (NC)	12.00 mm	3.30 mm
12	Template Fixation Pin, Ø 1.3mm	28.00 mm	1.30 mm
11	Bone Level Tapered Roxolid® SLA® (NC)	10.00 mm	3.30 mm
21	Bone Level Tapered Roxolid® SLA® (NC)	10.00 mm	3.30 mm
23	Bone Level Tapered Roxolid® SLA® (NC)	10.00 mm	3.30 mm
24	Template Fixation Pin, Ø 1.3mm	28.00 mm	1.30 mm
25	Bone Level Tapered Roxolid® SLA® (NC)	10.00 mm	3.30 mm

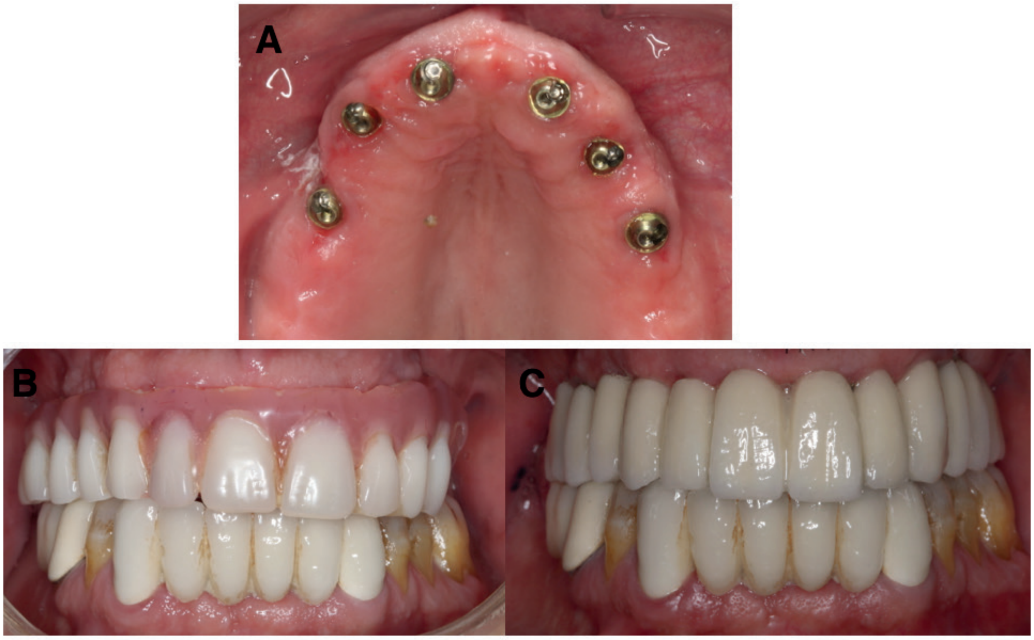
Once virtual implant planning was finished, the DICOM files were transferred to the Rapid Shape P30 printer (Rapid Shape GmbH, Heimsheim, Germany). A single guide was manufactured to manage the whole steps of the surgery (from mucosal excision to the implant insertion). The guide, then was visually checked for fit. Pre-determined sleeves were adapted to this surgery guide.

Figure 2. Representation of six designated implant locations based on the desired prosthetic plan. A) Frontal view, B) Sagittal view

2.2. *Surgical Protocol*

Putty (polyvinyl siloxane impression material) was used to ensure the accuracy of the position of the guide. The putty material was seated and adapted intraorally to avoid the deviation between the guide and the maxillary basis at every steps. The patient received local articaine anesthesia at the beginning of the intervention. Full seating of the surgical guides was verified by touch sensivity and direct visualization. Digital pressure around the premolar-molar region was bilaterally applied to immobilize the guide before inserting three template fixation pins buccally to further secure the guide. Sequential guided surgery protocol was performed according to the manufacturer (Straumann®). 3.3×10mm and 3.3×12 mm bone level tapered implants (Roxolid®, SLA®, Straumann Ag, Basel, Switzerland) were inserted. Key height handpieces were used inside the metal sleeves to match every drill. Guide position and immobilization were checked during every drilling and implant insertion step. Immediate provisional prosthesis was adapted to the implants via abutments and final hybrid prosthesis was adapted two months later (Figure 3).

Figure 3. A) Locations of six implants, B) Immediate provisional prosthesis, C) Final hybrid prosthesis



2.3. *Radiologic Diagnosis and Deviations*

Virtually planned image and post-surgical CBCT scan were superimposed in STL files to compare the differences between the pre- and post-operative implant locations using the same surfaces of teeth and bone. Apex or platform measurements were taken from the apical/platform center of the virtual implant to the apical/platform center of the placed implant. 3D deviation at implant crest and implant apex (Figure 4) were measured and all values were shown in Table 2.

Figure 4. A) Sagittal view of the implant, B) Coronal view of the implant, C) Comparision of pre- (blue) and post-operative (red) implant positions and representation of implant deviations at apex and platform regions

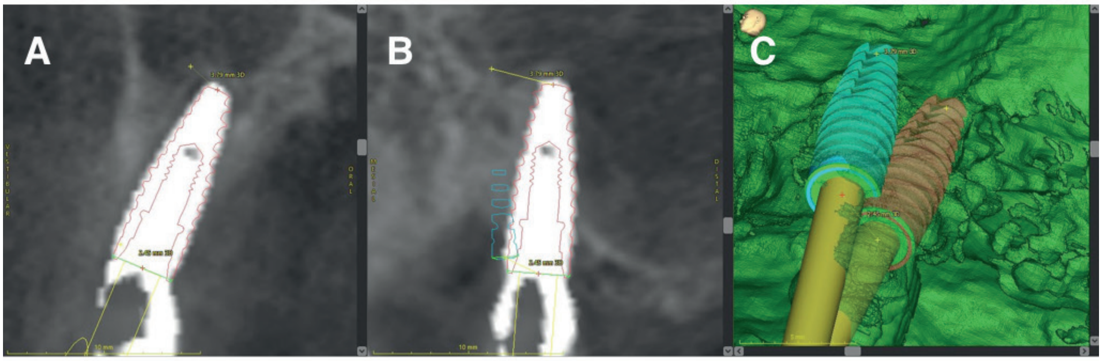


Table 2. Evaluation of treatment outcomes (IP: Implant position, ID: Implant diameter (mm), IL: Implant length (mm), DP: Deviation at platform (mm), DA: Deviation at apex (mm))

IP	ID(mm)	IL (mm)	DP (mm)	DA (mm)
11	3.3	10	0.95	1.61
21	3.3	10	0.80	0.99
13	3.3	12	0.98	1.21
23	3.3	10	1.60	2.57
15	3.3	10	0.86	1.77
25	3.3	10	2.45	3.79

The highest 3D deviation value around the implant (25#) was recorded in millimeters. Left side values for 3D deviation were found to be higher than right side values. Improper alignment and registration between the digital scanned model and the cone beam computed tomography model, manufacturing process used for fabrication of surgical guide, positioning error of the template, opposite side to the senior surgeon and posterior location of the implant may affect the accuracy of the pre-operative planning (Tatakis et al., 2019; Widmann and Bale, 2006).

Conclusion

Guided implant surgery can be an accurate and clinically advantageous procedure when implant therapy is indicated. However, pre-operative and intraoperative factors impact the final accuracy of the process. It is possible to reduce the possible risks with complete understanding of the guided implant surgery process and adequate case preparation.

Conflict of Interest

Authors declare no conflict of interest.

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