Case Report

Computer-Guided Immediate Implant Placement And Provisionalization with Definitive CAD/CAM Abutment: A Case Report

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DOI: 10.6926/JPI.201812_7(4).0001

Abstract

Immediate provisionalization with definitive customized abutment is beneficial for maintenance of the marginal bone and surrounding gingival tissue. To fabricate the definitive customized abutment before implant surgery, however, is of considerable uncertainty because it is difficult to place the implant exactly in the position and angulation as planned. This report describes a case in which computer-guided immediate implant placement and provisionalization with definitive CAD/CAM abutment was applied with a stereolithographic surgical guide. Due to the relatively proper implant position provided by this approach, the treatment process proceeded relatively smoothly, and the clinical outcomes with regard to esthetics and function were satisfactory. The technique used saved a lot of chair time, and the postsurgical discomfort of the patient was extremely low; therefore, implementation of the technique in similar clinical situations may well be appropriate.

Key words: Computer-guided surgery, Computer-aided design, Computer-aided manufacturing, Immediate dental implant, Stereolithographic surgical guide

Introduction

The procedure for flapless immediate implant placement in a fresh extraction socket with bare hands is difficult in terms of controlling the axis and depth of the implant[1, 2]. The vibrations and slippage that may occur when drilling an uneven surface of the extraction socket often cause the placement of the implant to deviate from the intended placement[3, 4]. To reduce the trauma inflicted on the patient and achieve an ideal implant position, the operator must be highly experienced, well-trained, and have excellent surgical skills[1, 2, 5, 6].

Immediate provisionalization with definitive customized abutment and implant placement right after tooth extraction can support the surrounding gingival tissue and thus prevent its collapse. This approach also simplifies the complex prosthetic procedure of making the final restoration. In contrast, when a temporary abutment is used to support the provisional crown, it must be repeatedly removed and reinstalled during the fabrication of the final crown, and this may undermine the healing of epithelial tissue and result in gingival recession and other complications[7]. However, it is

Fig. 1: Left maxillary central incisor horizontal fracture.

Fig. 2: Intraoral scanning image (left and middle) of the temporary restoration.

difficult to fabricate an appropriate definitive customized abutment for immediate implant placement in a fresh extraction socket before implant surgery due to difficulty in placing the implant with the precise positioning and angulation planned. The position of the implant shoulder and the distance between the implant and the surrounding gingiva can vary from the expected position, making the prefabricated definitive customized abutment unusable or unfavorable in terms of the margin location and abutment configuration.

This report describes a case in which computer-guided immediate implant placement was applied with a stereolithographic surgical guide. Employing a complete digital workflow, a CAD/CAM definitive abutment and a provisional crown were prefabricated according to the virtual implant treatment planning. With the assistance of the computer surgical guide, the implant was placed close to the planned position. Due to the relatively proper implant position provided by this approach, the treatment process proceeded relatively smoothly, and the clinical outcomes with regard to esthetics and function were good.

Case Report

A 42-year-old woman came to the department of dentistry in Shin Kong Wu Ho-Su Memorial Hospital complaining of a fracture to her left maxillary central incisor due to traumatic injury (Fig. 1). The tooth had previously undergone a root canal treatment and a crown restoration many years before. The patient claimed neither major systemic diseases nor allergies. She wanted to extract the retained root because she did not wish to undergo any complicated treatment procedures. Since she wanted to have dental implant treatment after extraction of the root, immediate implant placement, and provisionalization was suggested and accepted.

A temporary restoration was fabricated with fiber post and resin composite on the root for esthetic purposes. Using a large field-of-view CBCT scanner (KaVo 3D eXam, KaVo Dental, Biberach, Germany), 3-dimensional radiographic images were obtained for preoperative assessment of the alveolar bone. Using an intraoral scanner (3Shape TRIOS® 3, Copenhagen, Denmark), maxillary and mandibular digital impressions and the interocclusal registration were acquired (Fig. 2). These two forms of digital data were then imported into an implant planning software program (BenQ AB guided Service, Ashdod, Israel) and aligned. Once the alignment was verified, the surgeon could then develop a virtual implant treatment plan with the software. Considering the ideal restoration morphology and the anatomical condition of the patient, a virtual implant with proper diameter and length was designed using the implant planning software.

According to the virtual implant treatment

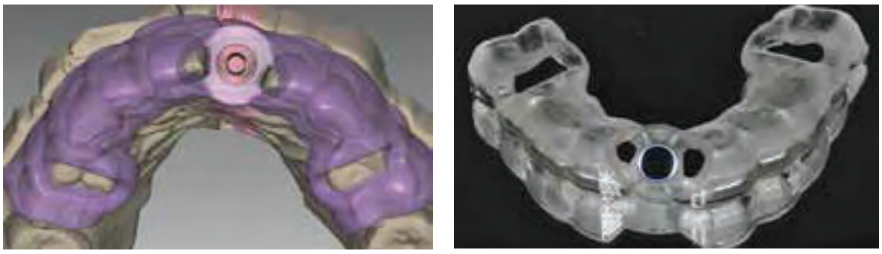

Fig. 3: Design and production of the stereolithographic surgical guide.

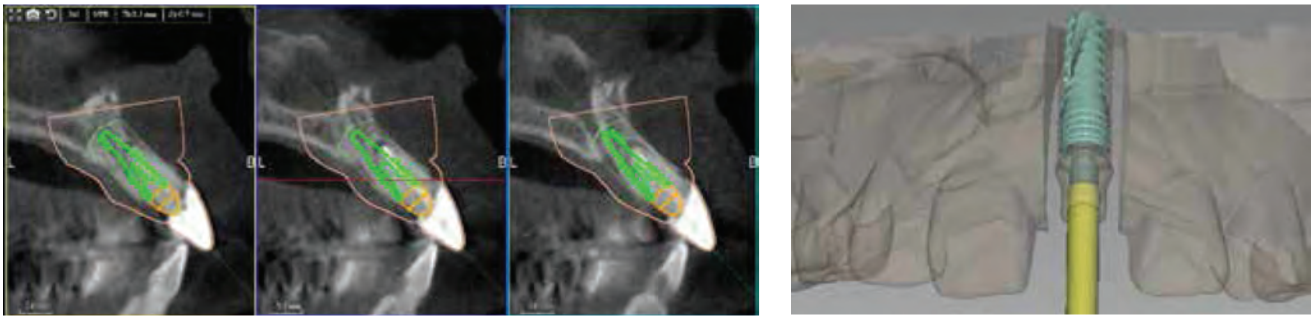

Fig. 4 : Determined virtual implant position sent to dental CAD software.

Fig. 5 : CAD/CAM production of the definitive titanium abutment and the polymethyl methacrylate-based temporary crown.

Fig. 6 : Immediate implant placement via stereolithographic surgical guide.

plan, a stereolithographic surgical guide (BenQ AB Guide, Taipei, Taiwan) was fabricated (Fig. 3). The determined virtual implant position was then sent to a dental CAD software program (Exocad Dental CAD, Darmstadt, Germany) (Fig. 4). With this software, the dental technician designed an abutment and a provisional crown conforming to the virtual implant position and its surrounding gingival tissue, after which the definitive titanium abutment and the polymethyl methacrylate-based temporary crown were fabricated using the CAM milling process (Fig.5) and prepared for the surgery.

After atraumatic extraction of the retained root, the tooth-supported stereolithographic surgical guide was verified in the patient's mouth for the seating position and stability. An osteotomy was performed following the drilling protocol of the surgical guide, then a pre-planned 4.2x13 mm implant (AB Dental, Ashdod, Israel) was immediately placed via the surgical guide (Fig. 6). After good primary stability (over 35N/cm) was achieved and confirmed, the customized definitive titanium abutment was connected to the implant after filling the gap between the implant and extraction socket with alloplastic grafting material (SinBoneHT, Purzer Pharmaceutical, Taipei, Taiwan). Due to the relatively proper implant position, the CAD/CAM abutment was well fitted, with only the finishing line of the buccal margin requiring some adjustment (Fig. 7). The provisional crown was then relined and set on the abutment with temporary cement. All the centric and eccentric occlusal contacts were removed to prevent overloading on the implant (Fig. 8).

Fig. 7 : After some adjustment of the buccal surface and finishing line, the definitive titanium abutment was placed on the implant.

Fig. 8 : Provisional crown was relined and set on the abutment.

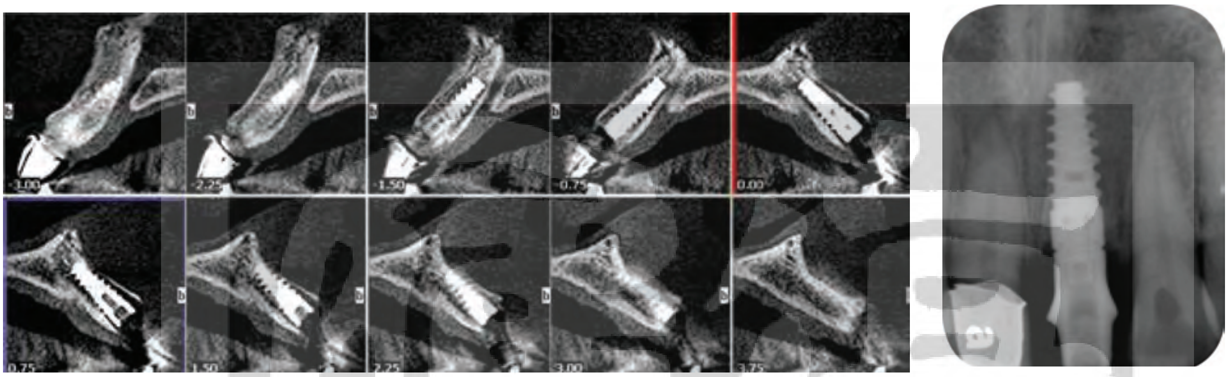

Fig. 9 : Post-operative CBCT and the periapical film showed that the implant was placed very close to the planned position, with slight buccal deviation.

With the approval of the hospital's ethics committee, the corresponding author of this report was conducting a clinical research study regarding the accuracy of implant positioning with the stereolithographic surgical guide. The patient agreed to enroll in the study, so a post-operative CBCT image and periapical film were taken (Fig. 9). The radiographs showed that the implant was placed very close to the planned position, with only slight buccal deviation. One day after the surgery, the wound exhibited good healing (Fig. 10), and the patient complained of neither pain nor swelling. At the two-month follow-up appointment, the buccal margin of the abutment was modified again and the provisional crown was relined for the remodeling of the gingival tissue. Six months after the implant placement, the gingival tissue showed excellent remodeling (Fig. 11), and a zirconia crown was fabricated using the conventional impression method without taking out the abutment. At the two-year follow-up appointment, the implant restoration exhibited satisfying outcomes in terms of esthetics and function (Fig. 12).

Discussion

Because it can be easily adjusted to match the gingival height and contour after implant placement, a provisional abutment is usually utilized for an immediately placed anterior implant. However, to fabricate the final restoration after osseointegration of the implant, such a provisional abutment would have to be removed and reinstalled several times during the prosthetic procedure. This repeated abutment removal could lead to more bone loss than would be seen with the use of a non-removable abutment[8, 9]. A definitive, non-removable abutment is therefore beneficial for the maintenance of the marginal bone and the surrounding gingival tissue, especially for thin-biotype patients. Moreover, a digitally designed and milled definitive abutment mimicking the root shape of the extracted tooth can be effectively molded to the peri-implant soft tissue to duplicate the gingival contour of the natural tooth. However, unless the surgeon can insert the implant properly in the planned position, using definitive customized abutments in such situations is very challenging. Any substantial angular or spatial deviation of

Fig. 10: The next day after surgery. Healing was good, neither pain nor swelling complained.

Fig. 11: Six-month recall. Modified provisional crown with excellent gingival remodeling.

Fig. 12 : Two-year recall. Satisfying outcome regarding esthetics and function.

the inserted implant would necessitate extensive modification of the abutment in order to fit the abutment into the proper position.

One of the advantages of computer-guided implant surgery is the accuracy of the implant position in comparison to that achieved with non-guided surgery[10]. In a systematic review regarding the accuracy of static computer-guided implant surgery published by Van Assche et al.[11], an overall mean deviation of 0.99 mm at the entry point (standard error: 0.12 mm; range: 0–6.5 mm) and a mean angular deviation of 3.81 degrees (standard error: 0.32°, range: 0–24.9°) were reported. Those authors concluded that the accuracy of computer-guided implant placement was significantly better than that of non-guided implant placement (that is, guided drilling with free-hand implant placement), a finding which was also reported in other review papers[12-14]. In the case reported herein, computer-guided implant placement in a fresh extraction socket with a stereolithographic surgical guide was utilized. The surgical guide not only helped to prevent the drilling direction from deviating to the extraction socket but also helped to place the implant correctly in the planned position. Thus, the prefabricated definitive abutment could be effectively applied in the immediate restoration procedure.

Although the mean deviation of static computer-guided implant placement has been found to be reasonably low, relatively high maximum deviations have been reported in the literature[15]. Testori et al.[16] suggested that a safe distance of at least 2 mm is needed between implants and anatomic structures when planning computer-guided implant surgery. With the consent of the patient and the approval of the ethical committee, the deviations between the planned and real implant positions for the case reported herein were analyzed by overlapping the digital treatment plan and the post-operative CBCT data (Fig. 13). The horizontal and vertical deviations at the implant shoulder were 0.71 mm and 0.22 mm, respectively, and the angular deviation was 2.92 degrees. The deviation analysis resulting from the overlapping with the CBCT data could have potential errors due to the inaccuracies in the CBCT scan reconstruction and the interference of metallic streaking artifacts. Nevertheless, the analytic measuring method used in this report was consistent with the method used in other studies, so the results of this report could still be useful as references. It seems that the deviations in this case were comparable with the mean value derived from the other studies of computer-guided implant placement.

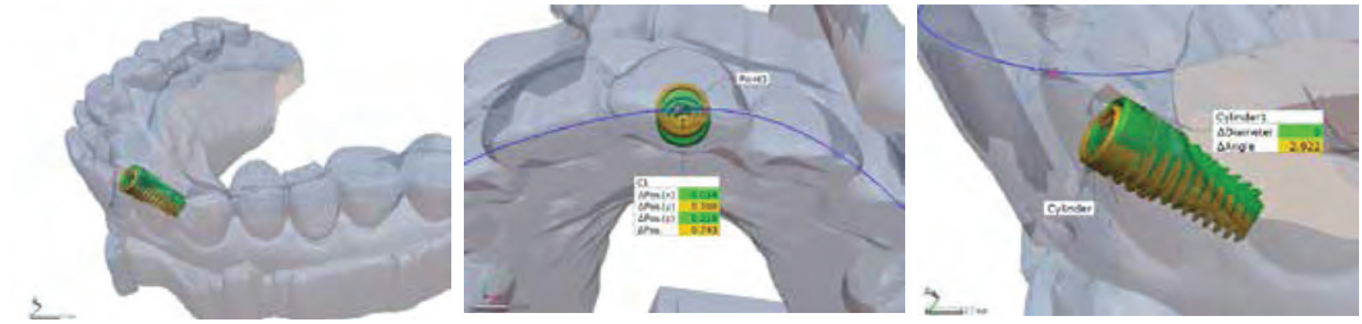

Fig. 13: Deviations between the planned and real implant position were analyzed by overlapping the digital treatment plan and the post-operative CBCT data.

At present, from the acquisition of the patient's clinical data to the execution of the guided surgery, computer-guided implant placement via stereolithographic surgical guide remains a complicated procedure involving many steps[13]. The quality of the CBCT images and the digital model, the registration of the CBCT data and model surface scan[17], the precision of the surgical guide production, the mechanical tolerance between surgical instruments and the surgical guide[18], and the positioning of the surgical guide during implant surgery can all affect the accuracy or inaccuracy of computer-guided implant placement. Initially, a radiographic scan prosthesis was needed to plan the computer guide using the so-called "double scan" or "dual scan" technique[13]. Nowadays, a new technique is advocated in which a CBCT scan is mapped with the optical scan of the dental cast in partially edentulous patients. Errors resulting from the fabrication and scanning of a radiographic scan prosthesis can be avoided in this technique[19]. The case reported herein also implemented this new technique, except that an intraoral scan instead of a dental cast scan was used in the computer planning procedure. This digital work-flow is probably more accurate in addition to being cost- and time-saving[20]. Further studies are needed, however, to examine the accuracy of guided implant surgery based on matching the CBCT scan with the intraoral scan.

In this case report, the implant deviated mainly to the buccal side. Although the sleeve of the surgical guide had confined the implant direction during the implant placement, the implant still tended to be driven towards the space of the extraction socket. A surgeon should thus always keep in mind that great deviations of the implant could still occur even with the help of the computer surgical guide. Nonetheless, this report presents a technique that saved a lot of chair time. The clinical outcomes were good, and the postsurgical discomfort of the patient was extremely low; therefore, implementation of the technique in similar clinical situations may well be appropriate.

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