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THE MANAGEMENT OF A COMPLEX IMPLANT CASE USING CAD-CAM TECHNOLOGY: A CLINICAL REPORT

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INTRODUCTION

CAD/CAM (computer-aided design/computer-aided manufacturing) in implant dentistry has broadened their application areas into treatment planning, implant placement and restorations. Due to the multitude and complexity of developing techniques, it is challenging to choose the optimal method for each patient. Therefore, this clinical report describes a method of restoring an edentulous maxilla by means of a combination of several computer-aided tools, such as SimPlant, SurgiGuide (Materialise, Leuven, Belgium) and Procera (Nobel Biocare, Göteborg, Sweden), as an approach to manage complex clinical cases.

CASE PRESENTATION

A 47 year-old female patient having fully edentulous maxilla and partially edentulous mandible presented to the Harvard School of Dental Medicine with the desire of a fixed type of dental prosthesis. She presented with poorly fitting maxillary and mandibular removable prostheses, which lost retention even during normal conversations. Furthermore, her remaining dentition was severely compromised by periodontal disease and carious lesions. The patient has been treated for hypertension for several years, and it is currently controlled with Atenolol. She does not present with any contraindications for elective surgical procedures. A CT scan with a radiographic template and the SimPlant software (Fig. 1) revealed severe generalized alveolar ridge resorption in the maxilla, leaving minimal space for implant placement. On the basis of the clinical and radiographic evaluation, this patient was classified as a Class IV partial edentulism (ACP PDI: American College of Prosthodontics Prosthodontic Diagnostic Index).[1]

SURGICAL TREATMENT

The ideal treatment plan represents the most comprehensive and desirable option of therapy and - in this case at hand - includes implants and fixed prosthetic restorations. In the first step, a radiographic template was fabricated according to the diagnostic wax-up and a CT was taken. Using the SimPlant software, future implant positions and sizes were pre-planned taking anatomical landmarks and the position of future prosthetic restorations into account. The data were then sent via internet to Materialize Inc. in Belgium, where bone supported surgical guides (SurgiGuides) were fabricated according to the sent SimPlant plan. SurgiGuide is produced on a 3-dimensional stereolithographic model of the jaw. Sleeves in different diameters are built in later serving as a precise 3-dimensional guide for implant placement (Fig. 2). Four 3.75 × 13 mm, one 5 × 11.5 mm, one 5 × 13 mm, and one 3.3 × 11.5 mm implants (MkIII TiU, Nobel Biocare, Göteborg, Sweden) were placed under two stage surgical protocols. An implant could not be placed on the left central incisor area due to insufficient bone width even though it was expected to certain degree at the time of planning. After uneventful healing stage, the prosthodontic phase of treatment began approximately 4 month post-implant placement.

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PROSTHETIC TREATMENT

The protocol for this CAD/CAM prosthesis is basically same with the conventional method for implant retained prosthesis[2] except that the framework was going to be milled from a one-piece block of titanium by means of a computer numeric controlled (CNC) milling technique (Procera Implant Bridge, Nobel Biocare, Göteborg, Sweden).[3] The master cast was fabricated from pick-up type impression at the fixture level using open tray made with individual verification indices luted together in patient's mouth using autopolymerizing resin (GC Pattern resin, GC America, Inc., Alsip, IL, USA) and polyether (Impregum, 3M ESPE, St. Paul, MN, USA).[4] One additional step to get better precision and more predictability was to make an accurate scan model served as the basis for the fabrication of a titanium framework. This could be accomplished by direct dipping of another luted verification indices into the least expansion dental stone (0.08 % setting expansion, Mounting Stone, Whip Mix, Louisville, KY, USA) without taking impression (Fig. 3). A jaw relation record was made for mounting the master cast, and the wax denture was tried in patient's mouth after tooth set up (Fig. 4-A). After making stone index for tooth set-up (Fig. 4-B), prototype for titanium framework was fabricated with pattern resin within the space of boiled-out waxes (Fig. 5). The fitness of this prototype was verified on scan model, and then scanned (Procera Forte Scanner, Nobel Biocare, Göteborg, Sweden) for sending information to a milling center of Nobel Biocare Headquarters at Sweden via internet. Once a milled titanium framework was received, the passive fit was verified on the scan model (Fig. 6) and in the mouth with the recommended screw test.[5-7] Subsequent to the denture tooth setup, esthetics, phonetics, and occlusion were evaluated and final prosthesis was processed after titanium surface treatments including mechanical retention groove, and silicoating. The final rehabilitation of the edentulous maxilla was rendered in the form of a screw-retained maxillary metal-reinforced resin-based complete prosthesis. For verification of seating, panoramic radiograph was taken (Fig. 7).

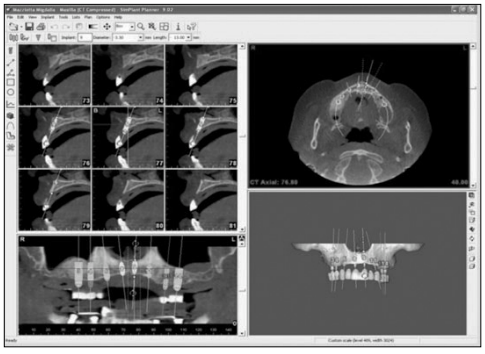

Fig. 1. Computer-aided surgery design.

DISCUSSION

In certain environments, it is almost impossible to fabricate fixed implant-supported prosthesis without major surgery, such as block bone graft and nerve repositioning. If one could place implants without those kinds of surgeries, then most likely face to difficulties in fabricating final prostheses due to the angulations problem.

This patient having slanted occlusal plane, severe generalized horizontal and vertical alveolar ridge resorption in the maxilla is certainly a serious challenge for implant placement and left little room for errors. Augmentative procedures in the form of guided bone regeneration, ridge split techniques, or block grafts would increase the dimensions of the alveolar ridge, but would be associated with multiple and invasive surgical procedures, significantly prolonging treatment time and increasing treatment cost. Surgical planning, converting into the stereolithographic model, and preparing the bone-supported surgical templates allowed the precise placement of 7 out of 8 planned

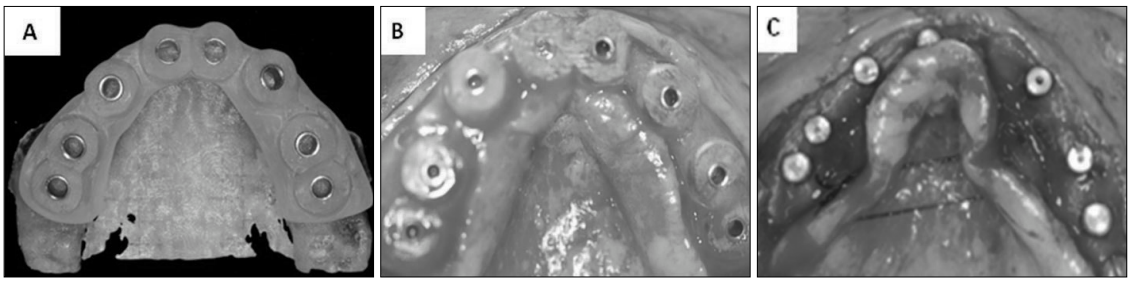

Fig. 2. Stereolithographic model and implant placement using surgical template.

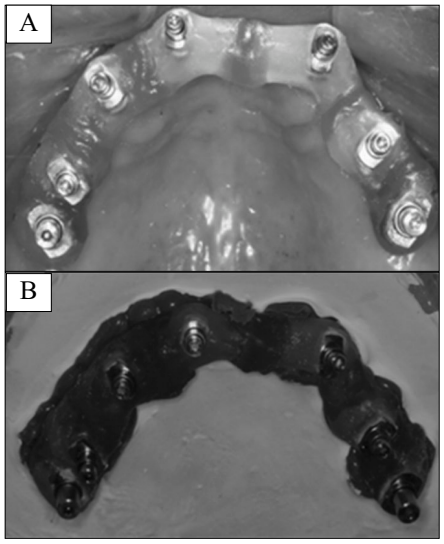

Fig. 3. Scan model fabrication.

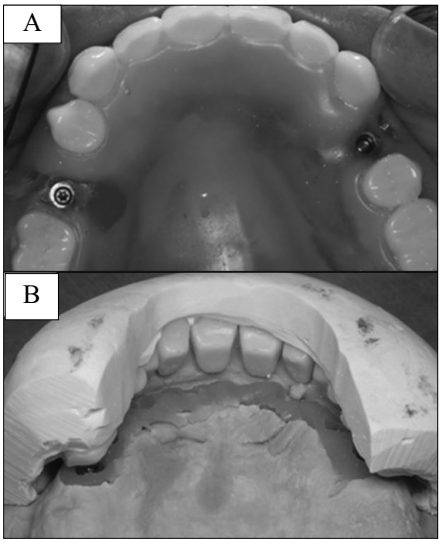

Fig. 4. Tooth set-up and stone index.

Fig. 5. Prototype for Ti framework.

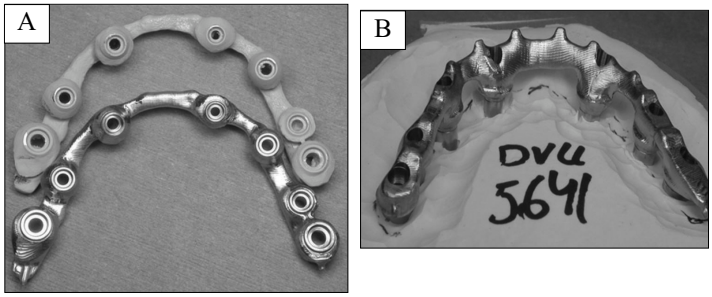

Fig. 6. Ti framework.

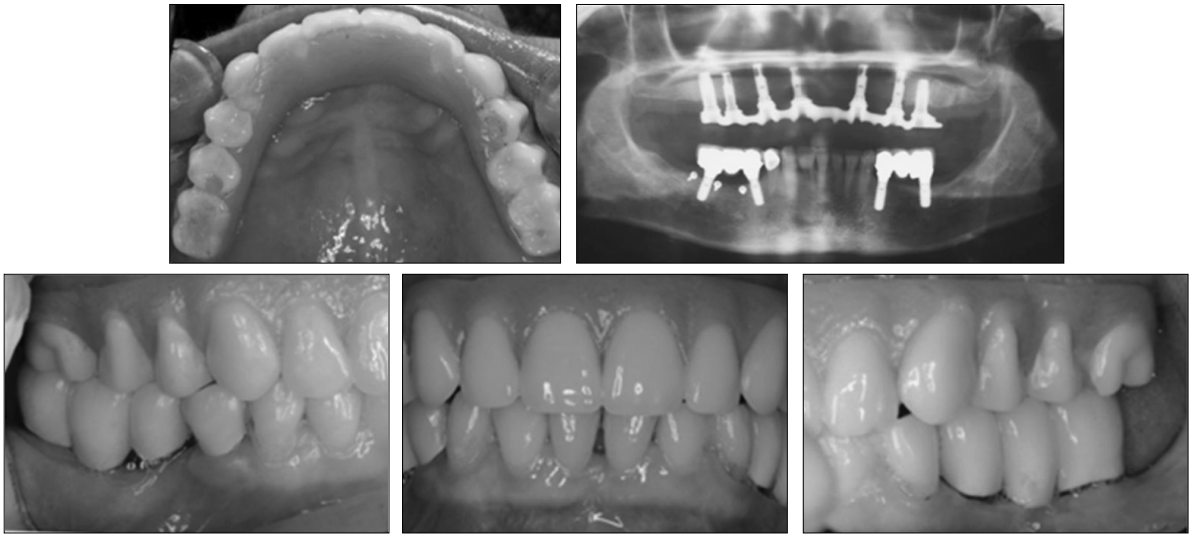

Fig. 7. Final Prostheses.

implants having primary stability achieved at 35 Ncm in a severely resorbed edentulous maxilla, without bone augmentation. Although the fit of the several guides on the bone surface was somewhat problematic and required a wide extension of the mucoperiosteal flap, the SurgiGuide provides an excellent tool for mastering challenging implant cases. Nowadays, SAFE system from the same company, which dosen't need to be changed according to the drill

size, is available and more accurate surgery is possible. Also, this system can be used for any kind of implant system. In the case at hand, implant planned for left central incisor area could not be inserted due to insufficient bone width. Furthermore, implant on right central incisor presented with relatively severe peri-implant bone loss several months after insertion. The latter may have occurred due to the severely resorbed alveolar ridge, leaving only minimal bone width bucco-palatally to implant, and/or due to biomechanical overload. However, the implant was completely supported by bone both mesially and distally at the time of placement owing to precise position guide by SurgiGuide, and it could survive successfully by splinting with other implants in passive way by means of PIB. Though continuous follow-up is required, the implant presents without bleeding on probing or signs of marginal inflammation at prosthesis delivery.

Once the surgery part is finished, still there remains prosthetic challenges such as waxing, casting, soldering, and/or laser welding associated with their technologies. By applying CAD/CAM technique to fabricate the final prosthesis, those kinds of challenges have been eliminated. This method can lower the prices of casting metal and component, and the risk of oral corrosion is lowered since it is the same material as used in implant fixture. Furthermore, the fabrication process is less sensitive to manual technique.[3,8] The intraoral precision of the prosthesis in this method is completely dependent on the accuracy of the master cast. Therefore, it is very important to verify impression accuracy, and in this case, scan model separate to the master cast was made and used for confirming the fitness of the framework. Since no impression material was involved and the least expansion dental stone was used, this scan model could be the most accurate reproduction of the oral environment. Orthop *et al*. compared the clinical and radiographic result of implant-supported fixed prostheses with conventional lost wax technique and CNC milled titanium framework, and found better fracture resistance and fitness on titanium framework in a 5-year clinical follow-up.[9] Both of the frameworks have similar preload on gold screws, and the preloads of the milled titanium framework with acrylic resin or porcelain showed similar preloads before and after veneering.[10]

To summarize, the CAD/CAM technologies in this article have improved the implant surgery process by reducing graft procedures, shortening the total treatment period, and decreasing cost and surgery time. Meanwhile, the restorative process has shown more accurate and efficient result comparing with the conventional lost-wax technique. Further clinical and laboratory research is required for long-term result.

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PURPOSE: The application of computer-aided technology to implant dentistry has created new opportunities for treatment planning, surgery and prosthodontic treatment, but the correct selection and combination of available methods may be challenging in times. Hence, the purpose of this case report is to present a combination of several computer-aided tools as approaches to manage complicated implant case. **MATERIAL AND METHODS:** A 47 year-old female patient with severe dental anxiety, high expectations, financial restrictions and poor compliance presented for a fixed rehabilitation. A CT scan with a radiographic template obtained with software (SimPlant, Materialize, Leuven, Belgium) was used for treatment planning. The surgical plan was created and converted into a stereolithographic model of the maxilla with bone-supported surgical templates (SurgiGuide, Materialise, Leuven, Belgium), that allowed for the precise placement of 7 implants in a severely resorbed edentulous maxilla. After successful osseointegration, an accurate scan model served as the basis for the fabrication of a one-piece milled titanium framework using the Procera (Nobel Biocare, Gothenburg, Sweden) technology. The final rehabilitation of the edentulous maxilla was rendered in the form of a screw-retained maxillary metal-reinforced resin-based complete prosthesis. **RESULTS:** Despite challenging circumstances, 7 implants could be placed without bone augmentation in a severely resorbed maxilla using the SimPlant software for pre-implant analysis and the SurgiGuide-system as the surgical template. The patient was successfully restored with a fixed full arch restoration, utilizing the Procera system for the fabrication of a milled titanium framework.

KEY WORDS: Edentulous maxilla, Computer-aided surgery, Milled titanium framework

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