

# A Technique for Restoring Severely Resorbed Edentulous Mandible with a Computer-aided Design and Computer-aided Manufacturing Surgical Guide and an Implant-supported Fixed Dental Prosthesis in Two Days

Ilser Turkyilmaz<sup>1</sup>, Sila C Isler<sup>2</sup>, Ahu Uraz<sup>3</sup>

## ABSTRACT

**Aim:** The aim of this report is to describe a technique, in which a severely resorbed edentulous mandible was restored with computer-aided design/computer-aided manufacturing (CAD/CAM) surgical guide and an implant-supported fixed dental prosthesis in two days.

**Background:** The quality of life of edentulous patients is generally restricted due to functional and psychosocial problems associated with complete dentures. These issues become worse over time due to ongoing bone resorption. Implant-supported prostheses have been utilized to overcome these problems.

**Case description:** A 79-year-old patient with a severely resorbed edentulous maxilla and mandible presented to our clinic. After the cone beam computed tomography (CBCT) scans were performed, five implants were virtually placed via a 3-dimensional software. Then, a CAD/CAM surgical guide was fabricated with a stereolithographic method. Her mandible was restored with five implants by using the CAD/CAM surgical guide and the implant-supported prosthesis with CAD/CAM titanium framework in 2 days.

**Conclusion:** The severely resorbed edentulous mandible was successfully restored with five dental implants, and the implant-supported fixed dental prosthesis via the CAD/CAM milled titanium framework.

**Clinical significance:** The technique using software and hardware portrayed in this report may be a feasible option to restore similar patients if it is executed by trained restorative dentists adhering to strict guidelines.

**Keywords:** Computer-aided design/computer-aided manufacturing, Cone beam computed tomography, Implant, Mandible, Surgical guide  
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## INTRODUCTION

Most edentulous patients using complete dentures suffer from functional, esthetic, and psychosocial problems.<sup>1-3</sup> Some patients with extremely resorbed mandibles report intensive electric shock-like pain during eating as the mental foramina are located on the alveolar crest, therefore, the mental nerve is crushed between the alveolar bone and the denture base. Implant-supported fixed dental prostheses (FDP) are utilized to overcome those issues.<sup>2</sup> However, in today's world, the long waiting period for osseointegration and several appointments for prostheses are not easily accepted by patients.

Dentistry has recently been influenced by several digital technologies such as cone-beam computed tomography (CBCT), computer-aided design and computer-aided manufacturing (CAD/CAM), stereolithography (SLA), and 3-dimensional (3D) implant planning software for virtual implant treatment planning.<sup>4-11</sup> These advancements have already changed the way we treat our patients, providing better outcomes in shorter periods of time.<sup>4-6</sup>

The goals of this clinical report are to illustrate the technique, in which a severely resorbed edentulous mandible was rehabilitated with a CAD/CAM surgical guide and an implant-supported fixed dental prosthesis in two days, and to present the 2-year outcomes of this patient.

## CASE DESCRIPTION

A 79-year-old female patient with severely resorbed edentulous maxilla and mandible was presented to our faculty practice. She stated that she had been using complete dentures about 35 years, and also had

<sup>1</sup>Department of Prosthodontics, New York University College of Dentistry, , New York, NY, USA

<sup>2,3</sup>Department of Periodontology, Faculty of Dentistry, Gazi University, Ankara, Turkey

**Corresponding Author:** Ilser Turkyilmaz, Department of Prosthodontics, New York University College of Dentistry, , New York, NY, USA, Phone: +1-212-992-7181, e-mail: ilserturkyilmaz@yahoo.com

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been having electric shock-like pain in the mandible while eating for 5 years; therefore she desired an implant-supported FDP as soon as possible. Because certain levels of deviations from the digital plan to the surgical field were reported, some clinicians tend to plan implants away from the nerve. The close proximity of the distal implant locations to the mental nerves and insertion of the definitive prosthesis using CAD/CAM titanium frameworks in two days are the main differences between the present case and the cases in other reports.

## Day 1

The patient signed informed consent before the surgery. The existing mandibular denture was converted to a radiographic guide after incorporating fiducial markers. Then, it was placed into

the mouth with an accurate bite-registration record, and the first CBCT scan was obtained. The second CBCT scan was acquired after placing the radiographic guide on the scanning table of the CBCT machine. Five implants were virtually designed according to the final prosthesis (Nobel Clinician, Nobelbiocare, Yorba Linda, CA) (Fig. 1), and the surgical guide is fabricated by using a CAD/CAM method (Nobel Forte, Nobelbiocare, Yorba Linda, CA).

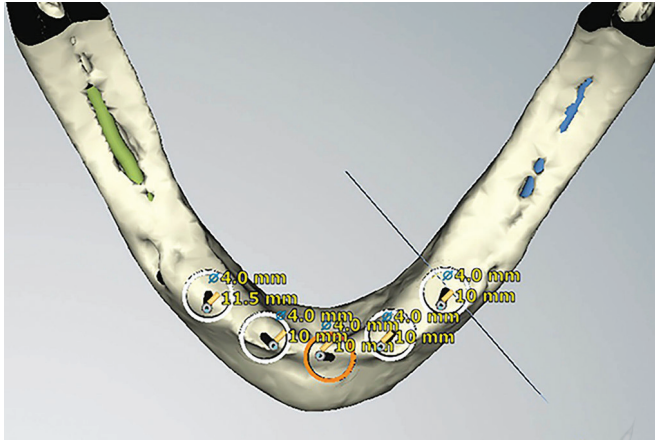


Fig. 1: Occlusal view after five implants were virtually placed

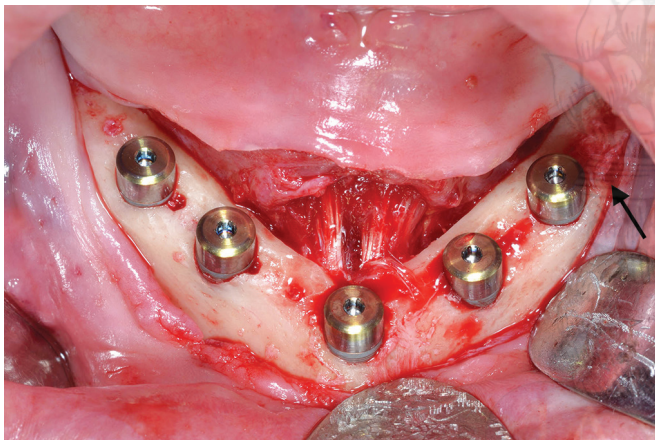


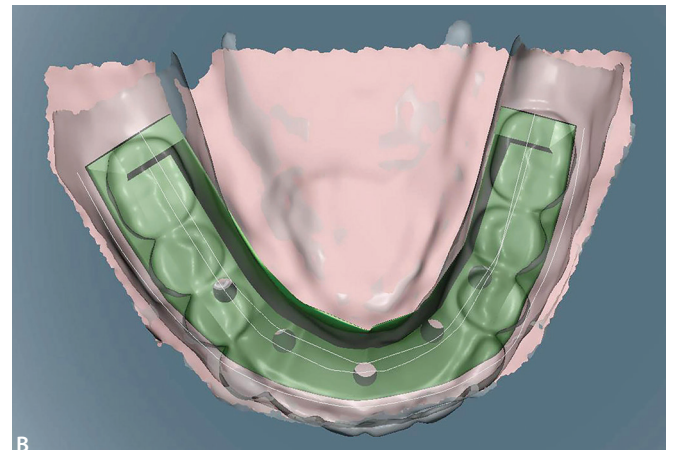
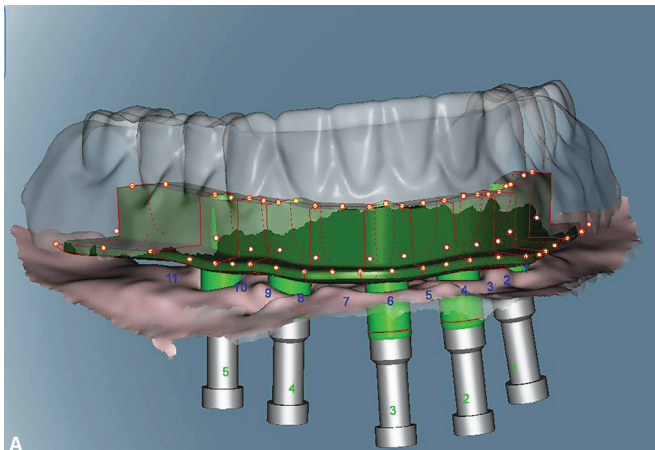
Fig. 2: Intraoral view of the patient immediately after implant placement. Note minimum distance between left distal implant, and foramen mentalis and mental nerve

After the CAD/CAM surgical guide was seated in the mouth, the implant sockets were prepared, and then five implants (4 × 10 mm, Nobel Replace Groovy, Nobel Biocare, Yorba Linda, CA) were placed through the metal sleeves in the surgical guide (Nobel Guide, Nobel Biocare, Yorba Linda, CA). A soft tissue flap was elevated because it was crucial to visualize both the mental foramina and the nerve as the implants were placed very close to them (Fig. 2) and to maintain keratinized soft tissue around the implants.

The steps below were followed to fabricate the implant-supported screw-retained FPD. A final impression using a polyvinyl siloxane impression material (Aquasil, Dentsply Intl, York, PA) was made immediately after the soft tissue closure. Implant replicas were attached to the impression copings, and the definitive cast was made (Resin Rock, Whip Mix Corp, Louisville, KY). Three scanning procedures (the definitive cast with and without scanning abutments, and trial denture) were performed accurately (Figs 3 and 4), then the 3D planning software superimposed these three different scans without any problems. Based on the scan of the trial denture, contour and dimension of the framework were determined. The final design was sent electronically to the production center, where the complete-arch titanium framework was milled from a titanium block in the same day (Fig. 5).



Fig. 3: Occlusal view of the trial denture before scanning in order to determine the design of the framework



Figs 4A and B: Frontal (A) and occlusal; (B) views of the final design of the framework according to the positions of the implants and denture teeth



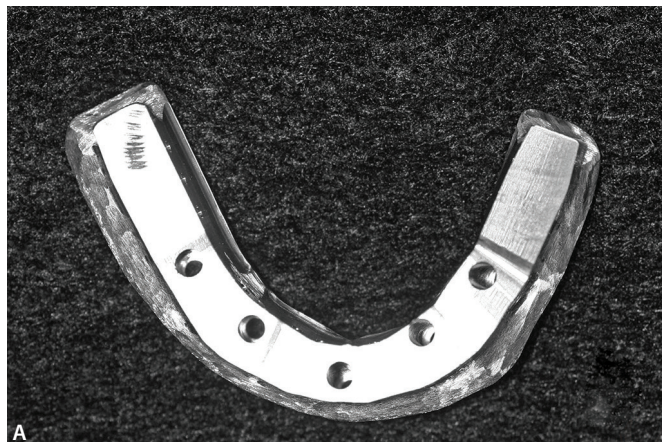
## Day 2

After the intraoral fit of the CAD/CAM titanium framework was verified, the denture teeth (Ivoclar Vivadent Inc, Amherst, NY) were transferred from the trial denture onto the framework. The centric occlusion, esthetics, phonetics, and occlusal vertical dimension were confirmed. In the afternoon, the implant-supported screw-retained FPD was processed, finished, and polished in the laboratory

and then screwed on the implants in the clinic (Figs 6 and 7). The patient was followed up for two years and no major complications with the implants and prostheses were observed (Fig. 8).

## DISCUSSION

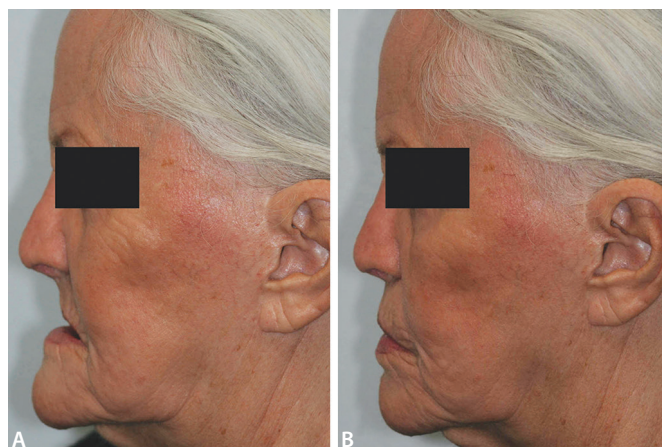
Computer-guided implant placement by using the CBCT imaging, 3D implant planning software and stereolithographic surgical guide



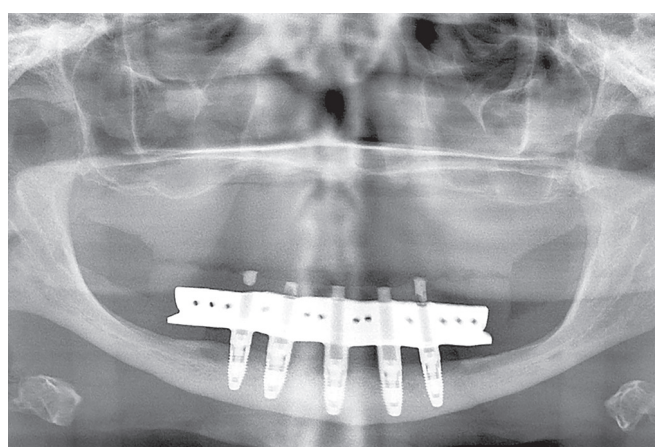
**Figs 5A and B:** Occlusal (A) and intra-oral (B) views of the fabricated framework



**Figs 6A and B:** Occlusal (A) and intra-oral (B) views of the definitive prostheses



**Figs 7A and B:** Lateral views of the patient before (A) and after; (B) both prostheses were inserted



**Fig. 8:** Panoramic radiograph of the patient two years after implant placement. Note significant bone loss in the posterior mandible and the location of both mental foramina and inferior alveolar nerve



has recently become a viable treatment option.<sup>4,5</sup> Stereolithography is an additive manufacturing procedure that works by focusing an ultraviolet laser onto a vat of photopolymer resin.<sup>5</sup> The ultraviolet laser is utilized to draw a previously-designed shape on to the surface of the photopolymer vat by means of a CAM/CAD software. Because photopolymers are sensitive to ultraviolet light, the resin is photochemically solidified and creates a single layer of the desired 3-dimensional object. This procedure is repeated for each layer of the design until the tangible 3-dimensional object is complete.<sup>5</sup>

Computer-guided implant placement is a technique sensitive procedure. It includes a chain of diagnostic and therapeutic events, and the sum of errors throughout the computer-aided implant placement cascade causes a drop in accuracy.<sup>4</sup> Certain levels of vertical and horizontal errors from the digital plan to the surgical field were reported,<sup>4</sup> and major complications such as nerve injury may be caused by untrained and inexperienced clinicians.

In the dental literature, there are a few studies regarding implant placement by using CAD/CAM surgical guides.<sup>12-19</sup> In an *in vitro* study by Turbush and coworkers,<sup>14</sup> 150 implants were inserted with three types of stereolithographic guides. They reported that the mean deviations in the linear distance were 1.18 mm at the implant neck and 1.44 mm at the implant apex for 150 implants. In a clinical study, Ozan and coworkers<sup>15</sup> placed 110 implants by using stereolithographic guides. They noted that the mean linear deviations were  $1.11 \pm 0.7$  mm at the implant neck and  $1.41 \pm 0.9$  mm at the implant apex. They also observed that the angular deviations of the placed implants compared to the planned implants were 2.9, 4.6, and 4.5 degrees for the tooth-, bone-, and mucosa-supported surgical guides respectively.

Valente and coworkers<sup>17</sup> investigated the clinical accuracy of computer-aided, template-guided oral implant surgery by comparing the three-dimensional positions of planned and placed implants. Twenty-five patients received 104 implants by using computerized tomography, software, and CAD/CAM surgical templates. In their study, 89 implants were available for accurate comparisons. They found that mean lateral deviations at the coronal and apical ends of the implants were 1.4 mm and 1.6 mm, respectively. In addition, they noticed that the mean depth and angular deviations were 1.1 mm and 7.9 degrees. Vieira et al.,<sup>18</sup> evaluated the reliability and accuracy of a flapless computer-guided surgical method. They inserted 62 implants in 14 patients by means of stereolithographic surgical guides. When compared to the planned implants, the actual placed implants showed mean linear deviations at the cervical, middle, and apical implant sections of 2.17 mm, 2.32 mm, and 2.86 mm, for the maxilla; and 1.42 mm, 1.42 mm, and 1.42 mm for the mandible, respectively. Although the previous reports regarding guided-implant placement indicated similar deviations,<sup>12-19</sup> it should be kept in mind that implant placement without surgical guides (free-hand) is associated with greater deviations.<sup>9</sup>

A few previous studies have indicated that full-arch titanium frameworks milled by using CAD/CAM method fit better than the ones fabricated by using conventional prosthetic methods.<sup>20-24</sup> Because CAD/CAM method eliminates several traditional prosthetic fabrication steps such as wax-up, metal casting and polishing that may cause inaccuracies in the final framework.<sup>20-24</sup> In the present report, the full-arch CAD/CAM titanium framework fit accurately, and no adjustments were needed.

## CONCLUSION

The technique depicted in this report may be used to restore severely resorbed edentulous arches in two days if it is executed by trained restorative dentists adhering to strict guidelines.

## CLINICAL SIGNIFICANCE

Implants offer many alternative treatments to the edentulous patients that were not possible with traditional prosthetic methods. Digital technologies such as cone-beam computed-tomography, computer-aided design and computer-aided manufacturing, stereolithography, and 3D implant planning software are recently used to restore edentulous arches with promising outcomes in shorter periods.

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