Misfit of Implant Fixed Complete Denture Following Computer-Guided Surgery

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Recently, computer technology has made it possible to simulate implant placement, fabricate a precise surgical template based on the simulated implant locations, and fabricate a prosthesis prior to surgical placement of implants. Many successful patient treatments have been reported using this process, but little has been published regarding complications. This article reports on the misfit of an immediately loaded definitive fixed complete denture that had been fabricated prior to implant surgery. The prosthesis was designed and fabricated using computerized implant data. A surgical template was fabricated (Nobel Guide) from the computer data to guide implant placement using an "All-on-Four" design concept. Management of the prosthesis misfit is discussed along with subsequent clinical complications. Int J Oral Maxillofac Implants 2009;24:124–130

Key words: *all-on-four, computer-guided surgery, dental implants, fixed complete denture, immediate loading, misfit, nobel guide*

The immediate loading of implant-supported fixed complete dentures has been well documented, with appropriate success rates being reported for edentulous maxillae and mandibles.[1–5] Recently, an "All-on-Four" concept has been advocated and similar success rates have been reported.[6,7] The "All-on-Four" concept involves placing the most distal implants with a tilted trajectory to optimize the anteroposterior separation of the implants,[8] minimize cantilever length, and increase implant length.[9]

With the advent of three-dimensional computer technology, simulated ideal implant locations can be transferred intraorally via a stereolithographic surgical template. Since the stereolithographic template has the ability to precisely control implant positions three-dimensionally, an implant prosthesis (provisional or definitive) can be fabricated prior to implant surgery.[10] The published data on this process have demonstrated good initial success with few complications.[11–15]

The purpose of this article is to report on a prosthesis misfit encountered during the placement of a definitive fixed complete denture following computer-guided surgery (Nobel Guide, Nobel Biocare, Göteborg, Sweden) using the "All-on-Four" concept. Management of the misfitting prosthesis is described and potential causes of the complications are discussed.

PATIENT TREATMENT REPORT

A 63-year-old male patient was referred to the Center for Implant Dentistry, Loma Linda University School of Dentistry, for treatment. Clinical and radiographic examinations revealed an edentulous maxilla and a poor periodontal prognosis for the mandibular right second molar. A treatment plan was developed that included an implant-supported maxillary fixed complete denture and extraction of the mandibular right second molar, which would be

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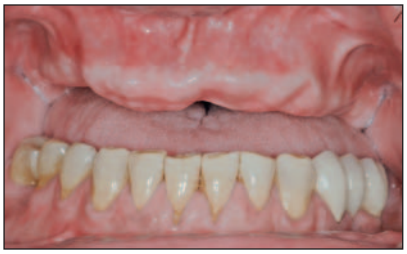


Fig 1 Frontal view of the edentulous maxilla before surgery.

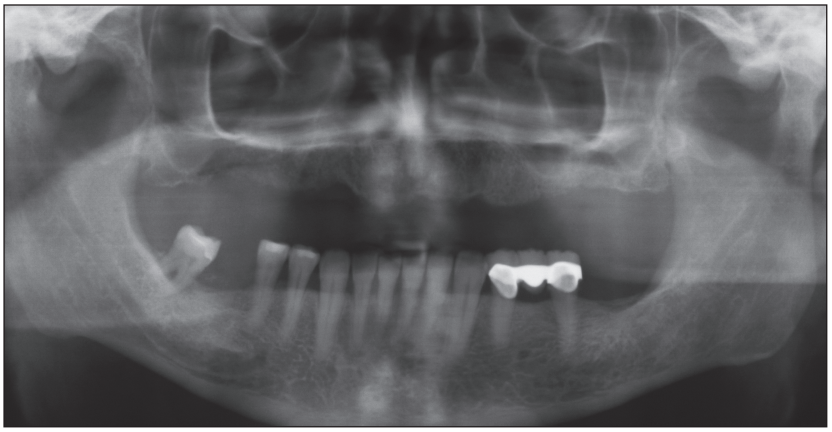


Fig 2 Preoperative panoramic radiograph of edentulous maxilla.

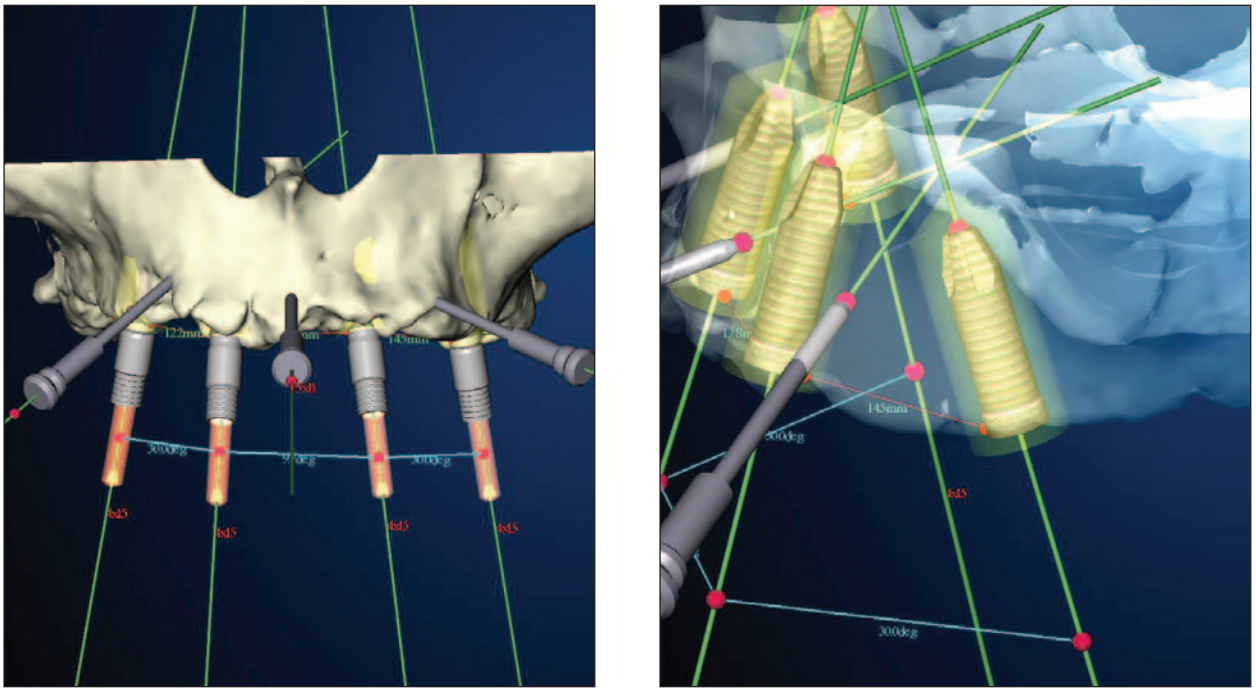


Fig 3 Simulation of implant and anchor pin placement with the computer-guided software. (*Left*) Frontal view; (*right*) lateral view.

replaced by a single crown on an implant. The patient agreed and consented to the treatment plan (Figs 1 and 2).

A definitive maxillary denture was fabricated with the appropriate function and esthetics to serve as a template for the computer-guided surgery. Ten radiopaque markers (gutta-percha, Hygenic Temporary Dental Stopping; Coltene/Whaledent, Cuyahoga Falls, OH) of 1.5 mm in diameter and 1.0 mm in depth were placed in the facial flange of the maxillary denture. A centric occlusion index made of a rigid polyvinyl siloxane interocclusal record material (Exabite II NDS; GC America, Alsip, IL) was fabricated to stabilize the denture against the opposing dentition during a computerized tomography (CT) scan.

The patient was referred to a radiology center for the CT scan (LightSpeed VCT; GE Healthcare, Waukesha, WI), where a double-scan technique was performed.[16] The first scan involved the patient wearing the maxillary denture with the radiopaque markers, and the second scan involved scanning of the denture alone. The double-scan technique relates the denture position to the underlying bone, which is essential for accurate planning of the implant positions. The DICOM (Digital Imaging and Communication in Medicine) data were transferred to the three-dimensional Procera Software Planning program (Nobel Biocare), where the number, length, position, and angulations of implants and anchor pins were determined (Fig 3). Four implants were

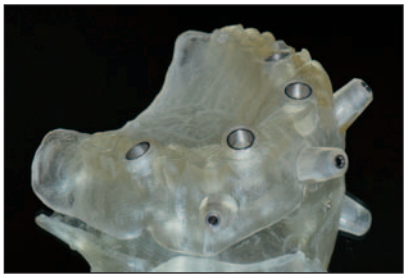


Fig 4 Stereolithographic surgical template.

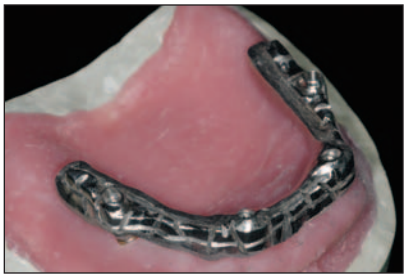


Fig 5 The titanium framework on the study cast.

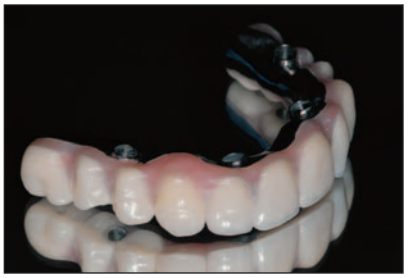


Fig 6 The presurgical definitive fixed complete denture with titanium framework.

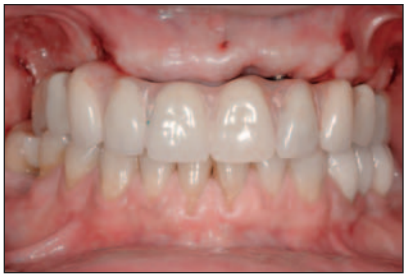


Fig 7 Definitive fixed complete denture with titanium framework in place immediately following implant placement.

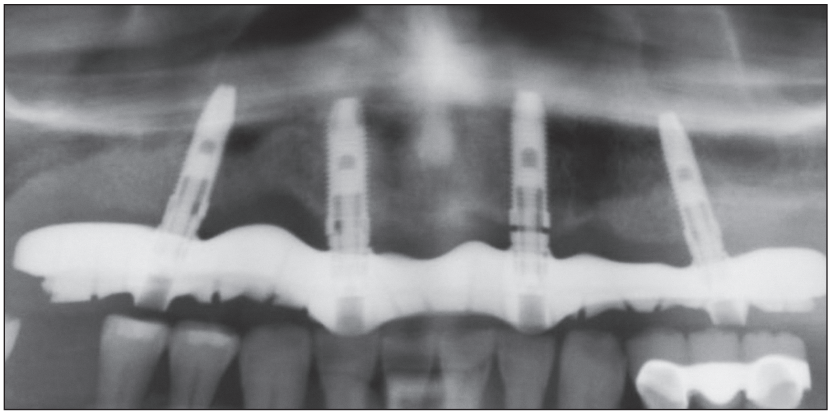


Fig 8 Panoramic radiograph obtained immediately following computer-guided surgery and prosthesis placement. Note the misfit at the implant-abutment interface of the maxillary left lateral incisor implant.

planned in the positions of the maxillary right first premolar, right lateral incisor, left lateral incisor, and left first premolar (NobelSpeedy Replace RP 4 × 15 mm; Nobel Biocare, Yorba Linda, CA) in which the two posterior implants would be intentionally tilted distally to avoid the maxillary sinuses ("All-on-Four" concept). Three guided anchor pins (Nobel Biocare) were planned in a tripod configuration between the maxillary right first premolar and right lateral incisor, right and left lateral incisor, and left lateral incisor and left first premolar. The data were then sent digitally to a laboratory (Procera, Nobel Biocare) for fabrication of a stereolithographic surgical template (Nobel Guide) (Fig 4) and a duplicate denture for the interocclusal record.

A maxillary working cast was fabricated from the stereolithographic surgical template and mounted with the opposing cast in a semiadjustable articulator (Hanau Modular Articulator; Water Pik International, Newport Beach, CA). With the duplicated denture as a guide, a pattern for a fixed complete denture metal framework was fabricated using autopolymerizing acrylic resin (Pattern Resin; GC America). The resin pattern was sent to the Procera laboratory (Nobel Biocare), where a titanium framework was milled (Fig 5). The definitive titanium–acrylic resin prosthesis was completed on the working cast, where fit and occlusion were verified (Fig 6). A surgical occlusion index (Exabite II NDS; GC America) was made between the surgical template and the opposing cast on the articulator to ensure accurate seating of the surgical template during the surgery.

A flapless surgical procedure was performed using local anesthesia. The surgical template was positioned using the surgical occlusion index. Osteotomies were made for the Guided Anchor Pins (Nobel Biocare) so they could secure the surgical template to the maxilla. Site preparation and placement of all the implants were completed in accordance with the manufacturer's protocol. Vertically self-adjusting guided abutments (Guided Abutment NobelReplace RP; Nobel Biocare) were then placed into the cylinders of the definitive implant-supported complete denture, and the prosthesis was seated (Fig 7). The guided abutments consisted of interlocking cylinder sleeves that slide within one another to allow for up to 0.4 mm of vertical discrepancy, should any be present. A vertical framework misfit at the maxillary left lateral incisor implant was noted on the postoperative panoramic radiograph (Fig 8). In an attempt to minimize the vertical misfit, the implant was backtracked from the osteotomy by

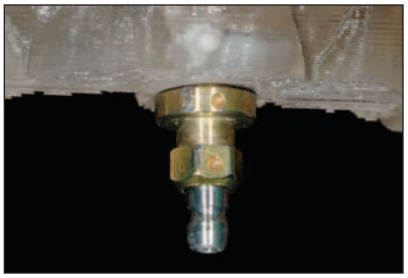


Fig 9 Maxillary left lateral incisor implant (*left*) before and (*right*) after being backtracked in an attempt to improve the framework fit.

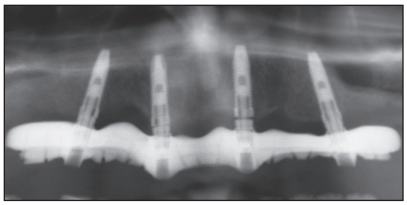


Fig 10 Panoramic radiograph showing misfits on implants in the maxillary right first premolar, right lateral incisor, and left lateral incisor regions after the left lateral incisor implant was backtracked.

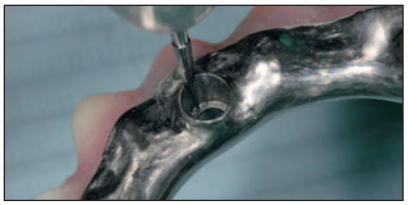


Fig 11 Adjustment was made by enlarging the intaglio surface of the framework-abutment interface at the maxillary lateral incisor implant with a bur. This resulted in a loose fit between the guided abutment and the titanium framework.

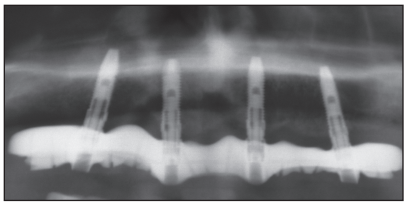
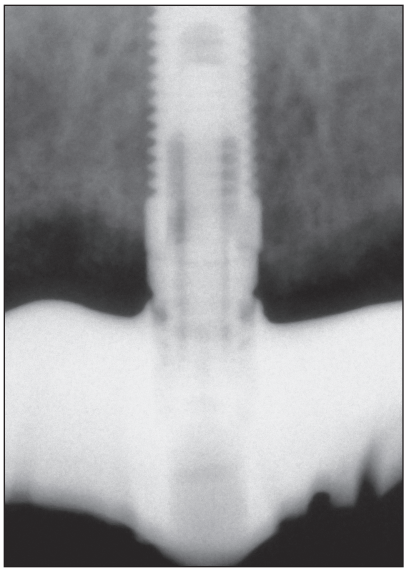


Fig 12 Panoramic radiograph after adjustment of the guided abutment cylinder showing acceptable fit.



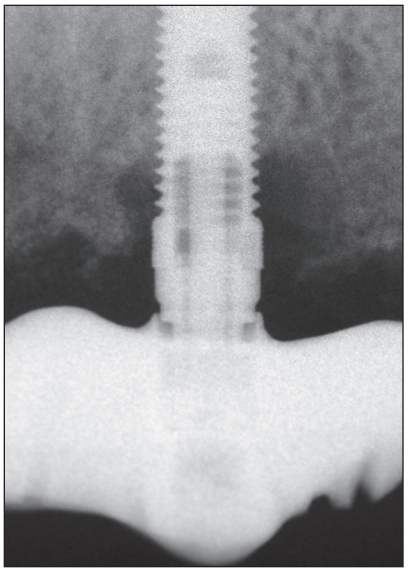
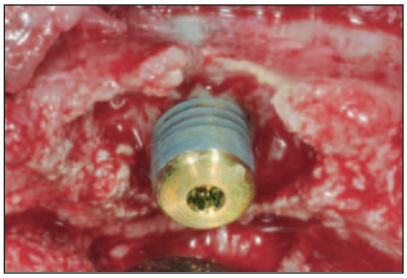


Fig 13 Periapical radiographs of maxillary left lateral incisor implant (*left*) at placement and (*right*) at the 6-month postplacement appointment. Note the significant marginal bone loss over time.

several turns (Fig 9). Unfortunately, that resulted in an even greater magnitude of misfit (Fig 10). The implant was then threaded back into its original position. Radiographic framework fit was eventually achieved by enlarging the intaglio surfaces of the framework-abutment interface of the implant with a bur. The definitive prosthesis was hand-tightened and the occlusion was adjusted to eliminate any centric and eccentric interferences (Figs 11 and 12).

The patient did not experience any discomfort after the implant surgery and prosthesis placement. However, at 5 months after the procedure, the patient complained of mobility of the prosthesis. Clinical examination revealed screw loosening at all implant-abutment interfaces. The screws were retightened and torqued to 35 Ncm.

All implants were stable and osseointegrated at the 6-month follow-up. However, substantial periimplant bone loss was apparent around the maxillary left lateral incisor implant (Fig 13). Marginal bone loss of 3.3 mm and 4.1 mm was noted at the mesial and distal aspects of the implant, respectively, through standardized periapical radiographs. Plaque accumulation was noted on the intaglio aspect of the guided abutment connection. Upon removal of the prosthesis, a misfit was noted between the



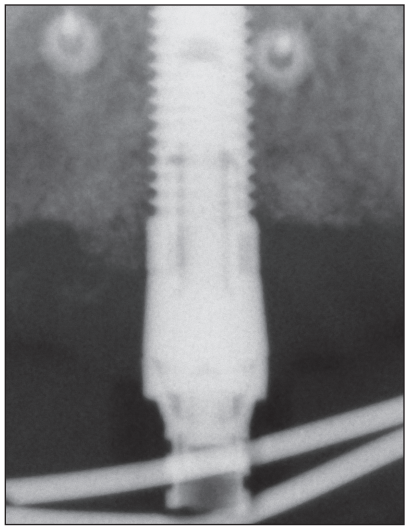


Fig 14 Exploratory surgery was performed on the maxillary left lateral incisor implant. Significant bone loss was confirmed.

Fig 15 Periapical radiograph of maxillary left lateral incisor implant at 5 months after guided bone regeneration showing uneventful healing.

guided abutment and the metal framework despite the radiographic appearance of adequate fit.

A guided bone regenerative procedure was performed around the maxillary left lateral incisor implant (Fig 14). The bony defect was first débrided mechanically (hand instrumentation and Prophy-Jet [Cavitron; Dentsply, York, PA]) and chemically (tetracycline). Mineralized allograft (Puros Particulate Allograft; Zimmer Dental, Carlsbad, CA) was then placed and covered with a resorbable collagen membrane (Bio-Gide; Osteohealth, Shirley, NY). The implant was completely submerged, and a conventional removable complete denture was used during the healing phase. At 5 months, after successful guided bone regeneration had been verified (Fig 15), the implant was uncovered, a new final impression made, and a new fixed complete denture fabricated and placed.

DISCUSSION

For computer-guided implant surgeries, mean linear and angular transfer errors of up to 0.9 mm and 4.5 degrees between the treatment plan and the surgical phase have been reported.[17–19] When performed in conjunction with immediate loading of a prefabricated prosthesis, these transfer errors could result in prosthesis misfit. In the patient presented, the situation may have been further complicated by the placement of the posterior implant at a distal angulation as well as by the presence of opposing natural teeth. These factors limited surgical access and may have contributed to implant placement inaccuracies, especially by a less experienced graduate student-clinician. As the number of implants supporting the prosthesis increases, the likelihood of a prosthesis misfit also increases,[20] presenting even greater challenges had more than four implants been used.

In the aforementioned computer-guided implant system (NobelGuide, Nobel Biocare), the self-adjusting abutments are designed to be inserted between the prosthesis and the implants to compensate for vertical discrepancies (z-axis) up to 0.4 mm. However, it should be noted that misfits can also occur in the horizontal (x-axis) and/or rotational (y-axis) directions,[21,22] which cannot be compensated for by the guided abutments. In the presented patient treatment, three-dimensional discrepancies were confirmed since the prosthesis misfit increased as the vertical position of the implant was altered in an attempt to correct the misfit. While the prosthesis misfit seemed to have been resolved by adjusting the metal framework, the cervical seal was not adequate, as evidenced by plaque accumulation between the abutment and the implant of the maxillary left lateral incisor region but not in other areas.

While the importance of passive fit with implant superstructures is still debatable,[21,23] mechanical (screw loosening, fractures of screws and framework) and biologic (marginal bone loss and loss of osseointegration) complications have been associated with prosthesis misfit.[24–28] In the treatment presented, both mechanical (screw loosening) and biologic (marginal bone loss) complications were encountered, even though an acceptable framework fit appeared to have been achieved radiographically (Fig 12). The episode of screw loosening at 5 months might have been the result of insufficient torque during prosthesis placement. The marginal bone loss around the maxillary left lateral incisor implant

might be attributed to framework misfit and plaque accumulation induced by an inadequate cervical seal. In fact, the extent of peri-implant bone loss warranted exploratory and corrective surgeries and fabrication of a new prosthesis. The presence of an initially accurate, passively fitting prosthesis would likely have prevented the bone loss.

Misfit of a metal framework can be managed by framework sectioning and soldering or laser welding of the framework.[29-31] However, when the misfit occurs in a definitive metal–acrylic resin or metal-ceramic prosthesis, corrections can be very time consuming and costly. Furthermore, corrections may not be accomplished in a manner that allows for placement of the prosthesis on the same day as the implant surgery. When prostheses are fabricated in advance of the surgical appointment using computer-guided procedures, it is recommended that provisional prostheses be used until sufficient clinical experience is gained to be able to predict success with definitive prostheses.

In the presented patient treatment, no other complications were noted besides the framework misfit, significant bone loss around the maxillary left lateral incisor implant, and mobility of the prosthesis. The marginal bone loss of up to 4.1 mm on the implant reported in this article far exceeded the average marginal bone loss reported on immediately loaded implants for completely edentulous cases (0.7 to 1.3 mm at 1 year).[32–36] On the other hand, in the only published study on a computer-guided "All-on-Four" procedure, Malo et al reported a significant mean marginal bone loss (1.9 mm) at the 1-year follow-up examination.[37] In the authors' opinion, the high mean marginal bone loss might be attributed to the misfit of the framework associated with this procedure.

CONCLUSIONS

Prosthesis misfit can occur when using computer-guided surgery and immediate placement of a prosthesis fabricated prior to implant surgery. In this patient report, the misfit observed after prosthesis placement appeared to have been adequately corrected, as evidenced radiographically. However, subsequent bone loss occurred around the implant where the initial misfit was noted. Surgical intervention was required, along with fabrication of a new prosthesis. It is recommended that provisional prostheses be fabricated until sufficient clinical experience is gained and when it is possible to predict good fit of a definitive prosthesis fabricated prior to surgical implant placement.

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