ACP
AMERICAN COLLEGE OF PROSTHODONTISTS

"All-on-Four" Immediate Function Concept and Clinical Report of Treatment of an Edentulous Mandible with a Fixed Complete Denture and Milled Titanium Framework

Amir H. Khatami, DDS[1] & Christopher R. Smith, DDS, FACP[2]

[1]Assistant Professor, Department of Restorative Dentistry and Prosthodontics, The Ohio State University, Columbus, OH
[2]Associate Professor, Department of Surgery, Section of Dentistry, The University of Chicago Hospitals, Chicago, IL

Keywords
"All-on-Four"; immediate function; conversion prosthesis; tilting dental implants; milled titanium framework.

Correspondence
Amir H. Khatami, Department of Restorative Dentistry and Prosthodontics, The Ohio State University, College of Dentistry, 305 W. 12th Ave, Columbus, OH 43210.
E-mail: akhatami@msn.com

Presented at the Table Clinic Session, American College of Prosthodontists 2005 Annual Session, Los Angeles, CA.

Accepted August 2, 2006.

doi: 10.1111/j.1532-849X.2007.00246.x

Abstract

The "All-on-Four" concept—tilting the distal implants in the edentulous arches improves the prosthetic support—increases the inter-implant distance and provides better implant anchorage in the bone by using longer implants. Computer milling of a solid block of titanium also provides frameworks with improved fit and fewer technical challenges than conventional cast or noncast approaches. This clinical report describes a method of restoring an edentulous mandible with the "All-on-Four" immediate function concept and a milled titanium framework. The patient in our clinical report has reported for follow-up visits for 1 year and is satisfied with the outcome of the treatment. No discernable clinical and radiographic changes were noted around the dental implants. To date, there have been no prosthetic complications. The patient is scheduled for quarterly follow-ups to determine the effectiveness of home care.

Immediate loading of implant-supported dental prostheses is documented in the literature with a high and predictable success rate for the edentulous mandible.[1–4] The development of new protocols for immediate loading of dental implants has switched from placing multiple implants and loading a few to placing only four implants as an optimal number to restore a completely edentulous mandible.[5] Rehabilitation of the posterior edentulous mandible can at times be hindered by bone atrophy distal to the mental foramen and bite forces that are more posterior in the dentition.[6] Traditionally, and according to the original concept of the Branemark system, implants are placed in a fairly upright position in the anterior edentulous mandible. Therefore, it is often necessary to fabricate a bilateral cantilever, which is sometimes up to 20-mm long, to provide the patient with good chewing capacity in the molar region. Clinical studies have demonstrated that the distal tilting of implants may be advantageous, with reduction of cantilever length about 6.5 mm in the mandible and 9.3 mm in the maxilla.[7,8] More recently, a concept was developed to restore the completely edentulous arches with immediately-loaded, tilted distal implants and the use of an "All-on-Four" guide (Nobel Biocare, Yorba Linda, CA) (Fig 1).[8,9] This clinical report describes a method of restoring an edentulous mandible with the "All-on-Four" immediate function concept and milled titanium framework.

Clinical report

A 59-year-old African–American female presented to the Section of Dentistry at the University of Chicago Hospitals with the desire to have "new dentures." Her medical history included a kidney transplant due to glomerulonephritis, and she was on a daily dose of corticosteroids. On clinical examination the patient presented with maxillary and mandibular partial edentulism. She was wearing removable partial dentures (RPDs) in both arches. The patient was advised to replace the RPDs; however, she chose extraction of the remaining maxillary and mandibular teeth and receiving immediate complete denture (ICD) prostheses instead. Maxillary and mandibular ICDs were made, and after 6 months were relined for a better prosthetic fit (Fig 2). Despite all the effort to make her comfortable with the

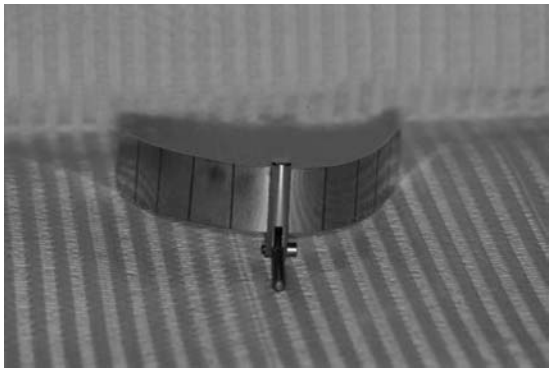

Figure 1 "All-on-Four" guide.

Figure 2 Preoperative view of ICDs.

Figure 3 Maxillary and mandibular edentulous ridges.

mandibular denture, her chief concern was prosthesis stability in the mouth during function. With the advent of the "All-on-Four" concept, the patient was presented with the option of placing four implants in the mandible and immediately loading the implants with a conversion prosthesis.[8] In preparation for the procedure and due to her medical status, her physician was consulted. She was instructed to increase the daily dose of her orally administered corticosteroid (Prednisone, Deltasone®, Kalamazoo, MI) to 20 mg, the day prior to surgery and the day of surgery. She was also prescribed Penicillin-VK starting 2 days prior to surgery, 2 g per day, for 10 days.

Upon clinical and radiographic evaluation, the mandible was classified ACP PDI for Complete Edentulism Class I (Figs 3 and 4).[10]

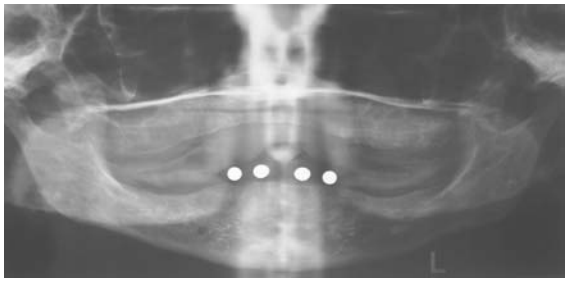

Figure 4 Preoperative panoramic radiograph.

Figure 5 Surgical template try-in.

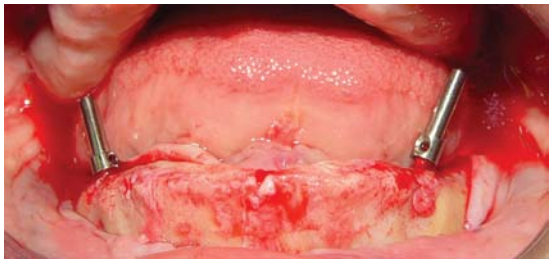

Figure 6 Angulated guide pins.

Alginate impressions (Jeltrate, Dentsply International, York, PA) of the edentulous arches were made, and the patient's mandibular denture was duplicated. This duplicate denture was used as a guide to fabricate the radiographic and surgical templates (Fig 5). A supra-crestal incision was made from the second mandibular molar area extending to the contralateral side. The mental foramina were located bilaterally to serve as landmarks for placement of the most distal implants. Implant placement was assisted by the "All-on-Four" guide. The guide was placed into a 5-mm deep osteotomy site made at the midline of the mandible, and its titanium band was adjusted to follow the mandibular arch shape. The guide is used to find the optimal position and inclination of the implants (Fig 6). Four 4.3 × 13 mm^2 implants (Replace Select Yorba Linda, CA) were placed following the Replace Select protocol and torqued to 45 Ncm (Fig 7). The platforms of the most distal implants were angled about 30° distally with the use of the "All-on-Four" guide. Multi-Unit Abutments(tm) (4-mm height) (Nobel Biocare) were connected to the most anterior implants, and 17° angled Multi-Unit Abutments(tm) (4-mm height) were connected to the distal implants to bring the screw access holes to the occlusal surface of the prosthesis

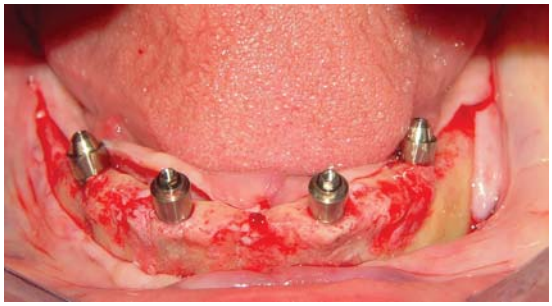

Figure 7 Connected straight and angulated abutments.

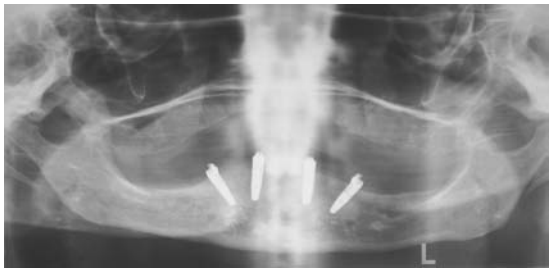

Figure 8. Panoramic radiograph after implant placement.

Figure 9 Hollowed mandibular ICD.

(Fig 8). Subsequent to suturing the soft tissue, temporary abutments were connected, and the hollowed-out mandibular denture (Fig 9) was indexed using denture repair resin (Natureryl, GC America, Inc., Alsip, IL). The mandibular denture was modified to an implant-supported interim fixed prosthesis in the dental laboratory. Following occlusal adjustment, the prosthesis was inserted with prosthetic retaining screws (Fig 10).

The patient was given oral hygiene instructions and placed on Peridex (Zila Professional Pharmaceutical, Phoenix, AZ) for 2 weeks. At the 2-week follow-up appointment, sutures were removed, and an open tray abutment level impression was made with transfer copings (Nobel Biocare) and vinylpolysiloxane (Aquasil, Dentsply International, York, PA). The impression was poured in die stone (Die-keen, Heraeus-Kulzer, Armonk, NY), and its accuracy was verified with the passively fitting existing implant-supported interim fixed prosthesis (Fig 11). The maxillary denture duplicate cast and the mandibular cast with the attached interim fixed prosthesis were mounted using

Figure 10 Implant-supported interim fixed prosthesis.

Figure 11 Accuracy verification of the master cast with interim prosthesis.

the arbitrary facebow transfer and interocclusal records. A putty jig (Lab Putty, Coltene, Cuyahoga Falls, OH) was made to register the 3D relationship of the interim prosthesis to the mandibular cast. Suture removal, final mandibular impression, and the laboratory procedures were completed in one clinic session.

Using the temporary abutments (Nobel Biocare) and the putty jig, the resin pattern was fabricated with autopolymerizing resin (GC Pattern resin, GC America, Inc.) (Fig 12). The pattern was sent to Nobel Biocare Headquarters in Sweden to fabricate a milled titanium framework. Once received, the titanium framework was tried intraorally for passivity with the recommended screw test[11–13] (Fig 13). Subsequent to the denture tooth setup, esthetics, phonetics, and centric relation occlusion were evaluated intraorally.

Necessary adjustments were made, the prosthesis was processed with acrylic resin wrap around the framework design, and occlusion was adjusted intraorally. The finished prosthesis was inserted by torque tightening the prosthesis retaining screws to 10 Ncm (Figs 14 and 15). The patient was given oral hygiene instructions and scheduled for follow-up every 3 months. At the 3-, 6-, 9-, and 12-month follow-up appointments, there were no discernable clinical or radiographic changes around the dental implants. The patient was instructed on better prosthetic care of the gingival and lingual surfaces of the prosthesis at the 12-month follow-up appointment.

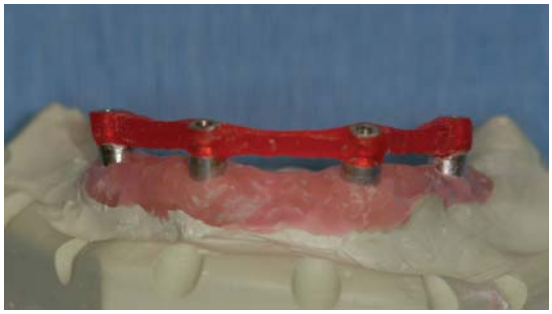

Figure 12 Resin pattern guide.

Figure 13. Milled titanium framework try-in.

Figure 14 Final prosthesis.

Discussion

In some completely edentulous patients, implant-supported prosthetic treatment is almost impossible without complex techniques, such as nerve transposition and grafting in the posterior mandible. Moreover, upright placement of implants in the anterior edentulous mandible necessitates cantilever lengths from 10 to 20 mm to provide the patient with esthetics and function. When cantilever spans exceeding 7 mm are planned, regardless of the number of implants, an optimal biomechanical environment should exist.[14,15] In a biomechanically compromised environment, such as poor quality bone, the strain transmitted to the crestal bone can be reduced by increasing the anterior–posterior spread of the implants, placement of longer implants, and maximizing the number of implants.[16–18] The method of tilting the distal implants in the edentulous arches represents an alternative technique, which leads to placement of longer implants, improved prosthetic support with a shorter cantilever

Figure 15 Occlusal view of final prosthesis.

arm, improved inter-implant distance, and improved anchorage in the bone. In vitro studies and theoretical calculations on single implants have shown that tilted implants may increase the stress to the bone. Tilted single implants may also be subjected to bending during function, which may lead to increased marginal bone stress[19–21]; however, if such implants are part of a multiple implant-supported prosthesis, the spread of the implants and rigidity of the prosthesis will reduce or change the nature of bending forces.[22] In a retrospective clinical study of tilted, immediately-loaded implants of 44 patients, Malo et al reported 96.7% and 98.2% implant survival rates for the developmental (more than four implants placed) and the routine group (four implants placed), respectively.[8] They reported a 100% prosthetic survival rate and concluded marginal bone loss values comparable to values for early loading of the mandibular full arch prostheses.[23]

The first patients with fixed complete dentures were provided with Cr–Co alloy frameworks with resin teeth. This protocol was modified over time, and gold-alloy casting was introduced to provide a more stable occlusion in metal and to allow porcelain veneering of the framework; however, in many cases, like severe bone resorption, large amounts of gold alloy had to be cast. Some of the inherent problems with the conventional lost-wax technique were distortion related to arch curvature and the amount of casting alloy. To avoid problems with casting, a few noncasting approaches, such as premachined gold-alloy cylinders/bars and laser-welded titanium frameworks, were introduced. These noncasting approaches were technically demanding and time consuming.[16,24,25]

More recently, a new protocol based on using computer numeric-controlled (CNC) milling of a solid block of titanium was developed and is free of the technical challenges involved with the previous approaches. The intraoral precision of the prosthesis in this method is completely dependent on the accuracy of the master cast and therefore necessitates verifying impression accuracy with a jig or a well-fitting interim prosthesis.[26,27]

Ortorp and Jemt, in a 5-year clinical follow-up of 129 edentulous patients, compared the clinical and radiographic performance of implant-supported prostheses with milled titanium frameworks and conventional cast gold-alloy frameworks. They found lower levels of fracture associated with milled titanium framework prostheses and also found improved framework fit compared to that of conventional castings.[28] When using gold

screws, milled titanium frameworks have preloads similar to those of gold-alloy frameworks, and the preloads were also similar before and after veneering the milled titanium framework with acrylic resin or porcelain.[29]

Conclusion

The patient in our clinical report has been treated with four dental implants placed with the "All-on-Four" concept in the mandible and a fixed complete denture with a milled titanium framework. She was followed up for 12 months and thus far remains satisfied with the outcome of the treatment. There were no discernable clinical and radiographic changes around the dental implants. At the time of this writing, there have been no prosthetic complications, and the patient is scheduled for quarterly follow-ups, mainly to determine the effectiveness of home oral care.

References

1. Schnitman PA, Wohrle PS, Rubenstein JE, et al: Ten-year results for Branemark implants immediately loaded with fixed prostheses at implant placement. Int J Oral Maxillofac Implants 1997;12:495-503
2. Schnitman PA, Wohrle PS, Rubenstein JE: Immediate fixed interim prostheses supported by two-stage threaded implants: Methodology and results. J Oral Implantol 1990;16:96-105
3. Balshi TJ, Wolfinger GJ: Immediate loading of Branemark implants in edentulous mandibles: A preliminary report. Implant Dent 1997;6:83-88
4. Balshi TJ, Wolfinger GJ: Conversion Prosthesis: A transitional fixed implant-supported prosthesis for an edentulous arch—a technical note. Int J Oral Maxillofac Implants 1996;11:106-111
5. Duyck J, Van Oosterwyck H, VanderSloten J, et al: Magnitude and distribution of occlusal forces on oral implants supporting fixed prostheses: An in vivo study. Clin Oral Implants Res 2000;11:465-475
6. Book K, Karlsson S, Jemt T: Functional adaptation to full-arch fixed prosthesis supported by osseointegrated implants in the edentulous mandible. Clin Oral Implants Res 1992;3:17-21
7. Krekmanov L, Khan M, Rangert B, et al: Tilting of posterior mandibular and maxillary implants for improved prosthesis support. Int J Oral Maxillofac Implants 2000;15:405-414
8. Malo P, Rangert B, Nobre M: "All-on-Four" immediate-function concept with Branemark System implants for completely edentulous mandibles: A retrospective clinical study. Clin Implant Dent Relat Res 2003;5(Suppl. 1):2-9
9. Malo P, Rangert B, Nobre M: All-on-4 immediate-function concept with Branemark System implants for completely edentulous maxillae: A 1-year retrospective clinical study. Clin Implant Dent Relat Res 2005;7(Suppl. 1):88-94
10. McGarry TJ, Nimmo A, Skiba JF, et al: Classification system for complete edentulism. J Prosthodont 1999;8:27-39
11. Jemt T: Failures and complications in 391 consecutively inserted fixed prostheses supported by Branemark implants in edentulous jaws: A study of treatment from the time of prosthesis placement to the first annual checkup. Int J Oral Maxillofac Implants 1991;6:270-276
12. Tan KB, Rubenstein JE, Nicholls JI, et al: Three-dimensional analysis of the casting accuracy of one-piece, osseointegrated implant-retained prostheses. Int J Prosthodont 1993;6:346-363
13. Kan JY, Rungcharassaeng L, Bohsali K, et al: Clinical methods for evaluating implant framework fit. J Prosthet Dent 1999;81:7-13
14. Rodriguez AM, Aquilino SA, Lund PS, et al: Evaluation of strain at the terminal abutment site of a fixed mandibular implant prosthesis during cantilever loading. J Prosthodont 1993;2:93-102
15. White SN, Caputo AA, Anderkvist T: Effect of cantilever length on stress transfer by implant-supported prostheses. J Prosthet Dent 1994;71:493-499
16. Lekholm U, Zarb GA: Patient selection and preparation. In: Branemark P-I, Zarb, GA Albrektson T (eds): Tissue-Integrated Prosthesis: Osseointegration in Clinical Dentistry. Chicago, IL, Quintessence, 1985, pp. 199-209
17. van Steenberghe D, Lekholm U, Bolender C, et al: Applicability of osseointegrated oral implants in the rehabilitation of partial edentulism: A prospective multicenter study on 558 fixtures. Int J Oral Maxillofac Implants 1990;5:272-281
18. Tada S, Stegaroiu R, Kitamura E, et al: Influence of implant design and bone quality on stress/strain distribution in bone around implants: A 3-dimensional finite element analysis. Int J Oral Maxillofac Implants 2003;18:357-368
19. Clelland N, Gilet A, McGlumphy EA, et al: A photoelastic and strain gauge analysis of angled abutments for an implant system. Int J Oral Maxillofac Implants 1993;8:541-548
20. Celland N, Lee JK, Bimbenet OC, et al: A three-dimensional finite element stress analysis of angled abutments for an implant placed in the anterior maxilla. J Prosthodont 1995;4:95-100
21. Rangert B, Sullivan RM, Jemt T: Load factor control for implants in the posterior partially edentulous segment. Int J Oral Maxillofac Implants 1997;12:360-370
22. Daellenbach K, Hurley E, Brusnki JB, et al: Biomechanics of in-line vs. offset implants supporting a partial prosthesis. J Dent Res 1996;75:183
23. Petersson A, Rangert B, Randow K, et al: Marginal bone resorption at different treatment concepts using Branemark dental implants in anterior mandibles. Clin Implant Dent Relat Res 2001;3:142-147
24. Branemark PI: Osseointegrated implants in the treatment of the edentulous jaw. Experience from a 10-year period. Scand J Plast Reconstr Surg Suppl 1977;16:1-132
25. Lundqvist S, Carlsson GE: Maxillary fixed prostheses on osseointegrated dental implants. J Prosthet Dent 1983;50:262-270
26. Jemt T, Back T, Petersson A: Precision of CNC-milled titanium frameworks for implant treatment in the edentulous jaw. Int J Prosthodont 1999;12:209-215
27. Jemt T, Back T, Petersson A: Photogrammetry—an alternative to conventional impressions in implant dentistry? A clinical pilot study. Int J Prosthodont 1999;12:363-368
28. Ortorp A, Jemt T: Clinical experiences of computer numeric control-milled titanium frameworks supported by implants in the edentulous jaw: A 5-year prospective study. Clin Implant Dent Relat Res 2004;6:199-209
29. Ortorp A, Jemt T, Wennerberg A, et al: Screw preloads and measurements of surface roughness in screw joints: An in vitro study on implant frameworks. Clin Implant Dent Relat Res 2005;7:141-149