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CLINICAL REPORT

Optimal placement of the two anterior implants for the mandibular All-on-4 concept

Jean-Philippe Ré, DDS,[a] Bruno Foti, DDS, PhD,[b] Jean-Marc Glise, DDS,[c] and Jean-Daniel Orthlieb, DDS, PhD[d]

ABSTRACT

The novelty of the All-on-4 concept for a mandibular implant-supported fixed dental prosthesis is the inclination of the posterior implants. Typically, the anterior implants are placed lingually relative to the canine/incisor teeth and perpendicular relative to the occlusal plane. According to the laws of elementary biomechanics, the long axis of the implant unit should be aligned to the axis of the occlusal loading forces during clenching in the maximal intercuspal position. When several implants are connected by a prosthesis, the mean axis of the overall occlusal loading must be taken into account. The objective of this report was to propose a different position for anterior implants by tilting them labially to counterbalance the distal inclination of the posterior implants. (J Prosthet Dent 2015;114:17-21)

A mandibular implant-supported fixed dental prosthesis is often used to rehabilitate an edentulous mandible. Initially, implants were positioned almost perpendicular to the occlusal plane; however, in the early 2000s, Maló et al[1] advocated tilted posterior implants. Varying the inclination of anterior implants could be mechanically more favorable.

Implants are usually inserted anterior to the mental foramina to avoid vital structures, lingually to the anterior teeth to improve appearance and perpendicularly to the occlusal plane to improve biomechanics.[2-4] The major disadvantage of such placement is the use of bilateral posterior cantilevers, which are required for adequate occlusion. Cantilevers have been identified as a cause of failure as they exert harmful pressure on the distal-most abutment and on the framework and must therefore always be as short as possible.[5,6]

In 2003, Maló et al[1] proposed the All-on-4 concept, a complete prosthesis supported by 4 implants. Two implants are inserted into the anterior region, and 2 posterior implants are placed just anterior to the mental foramina to avoid the mandibular nerve. The All-on-4 concept is based on the distal inclination (approximately 45 degrees to the occlusal plane) of the posterior implants. This approach has 3 advantages: an increased implant surface area for osseointegration, a shorter cantilever, and a large interimplant distance.[1] The use of tilted implants has been validated by Krekmanov et al[7] and investigated by the finite element method.[8]

Carlsson[9] has expressed doubts about studies based on biomechanical calculations or clinical experience in the absence of strong scientific evidence that highlights occlusal risk factors. No clinical study involving randomized controlled trials, meta-analyses, cross-sectional studies, or well-documented follow-up studies has shown that an implant-prosthetic unit subjected to excessive occlusal forces results in more or less long-term failure of osseointegration. However, for more than 20 years, numerous publications based on studies of mathematical models, the finite element method, and geometric demonstrations have warned of occlusal risk factors and excessive nonaxial forces.[10-15] Nonaxialized occlusal constraints could generate screw loosening and prosthesis or implant fractures and could even lead to loss of osseointegration.[16,17] Even so, no, or few, biological complications have been reported with regard to bone stability or loss of implant in the anterior mandible; indeed, high success rates have been reported with the conventional approach, that is the placement of implants lingual to the incisors.[18]

[a]Associate Professor, Faculty of Odontology, Aix-Marseille University, Marseille, France.
[b]Professor, Faculty of Odontology, Aix Marseille University, Marseille, France.
[c]Consultant Periodontist, Faculty of Odontology, Aix Marseille University, Marseille, France.
[d]Professor, Faculty of Odontology, Aix Marseille University, Marseille, France.

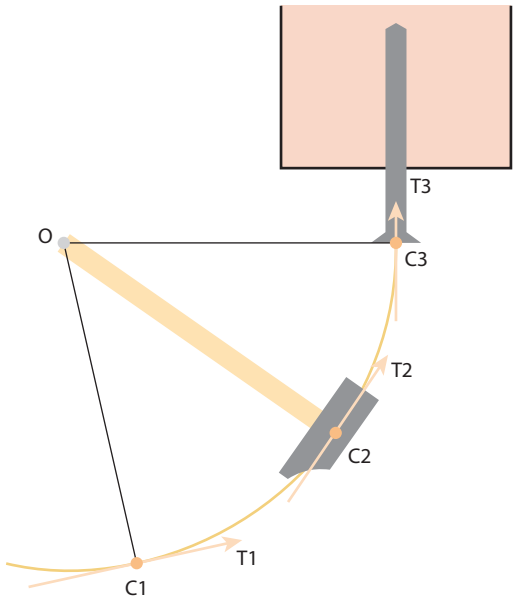

Figure 1. Mandibular closure until occlusal contact, comparable with hammer rotating around hinge axis (O) when hitting nail. According to tangent law, resulting strength is perpendicular (T3) to closing radius at contact (C3). Nail sinks strictly vertically. Tangent (T3) represents loading axis to which implant-prosthetic unit constraint axis should be oriented. Geometrically ideal axis is able to distribute pressure resulting from impact.

Although connecting the implants limits the effects of excessive occlusal forces, the axis of the implant unit should be aligned to the axis of the occlusal stress generated during clenching in the maximal intercuspal position.[19,20] If biomechanical stress is reduced, prosthetic complications (screw loosening or fracture, veneer material chipping or fracture, framework fracture) related to material fatigue may also be reduced, resulting in fewer repairs, less maintenance, and savings in time and cost for both the clinician and patient.[21]

The All-on-4 concept involves reorienting the implants. However, the posterior angulation is not compensated by an opposite anterior angulation to maintain a vertical resultant constraint perpendicular to the occlusal plane. This is because the axes of the anterior implants are perpendicular to the occlusal plane.

Page[22] in 1952 and Orthlieb[23] in 1997 proposed that teeth should be perpendicular to the closing radius to align the direction of constraints along the long axis. This law of tangents states that the distribution of mandibular teeth should follow this ideal axis, which is able to distribute pressure resulting from occlusal loading (Fig. 1). The geometric model of the tangent law does not correspond to the reality of closing movements but may explain the application of forces in maximal intercuspal position. The forces of intensity and duration in clenching are mainly evident in the maximal intercuspal position.

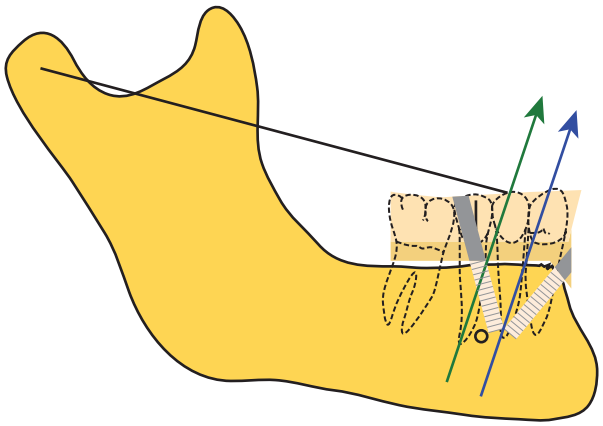

Figure 2. Same direction of loading axis (*green arrow*) and constraint axis (*blue arrow*).

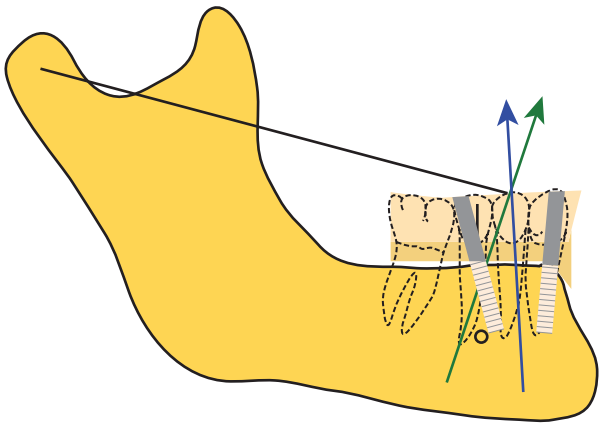

Figure 3. All-on-4 concept: loading axis (*green arrow*) and constraint axis (*blue arrow*) lie in different directions.

The same arrangements could therefore be used in implant-prosthetic rehabilitation to resist the forces applied during clenching. The global axis of the unit, or constraint axis, should agree with the geometrically ideal axis or loading axis (Figs. 2, 3).

CLINICAL REPORT

A 67-year-old woman presented with 2 conventional removable complete dental prostheses. The patient's chief complaint was that she was unhappy with her prostheses, especially with the mandibular prosthesis because of its instability during mastication. She was also somewhat concerned about esthetics. The patient said that she no longer wanted a removable mandibular prosthesis and informed us that it had fractured several times in recent years. The patient was in good health and demonstrated powerful masticatory muscles.

Her dental history revealed that she had not implemented good dental hygiene or oral care and that her teeth had been removed in her 40s because of periodontal disease, apical periodontitis, and caries; she had

Figure 4. Surgical guide showing different directions of anterior and posterior implants.

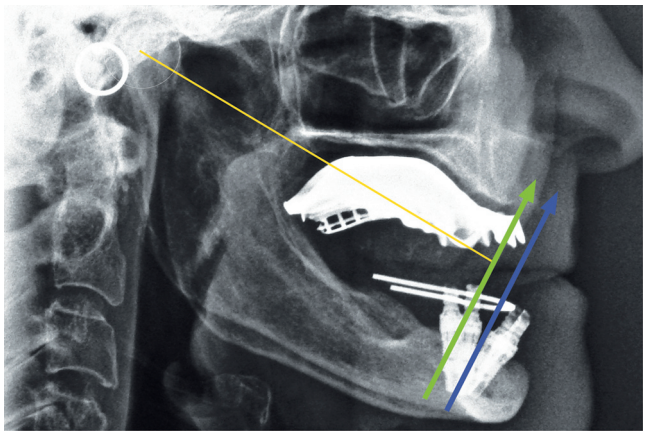

Figure 5. Lateral radiograph with implants and interim prosthesis. Loading axis (*green arrow*) and constraint axis (*blue arrow*) lie in same direction, perpendicular to closing radius according to tangent law. One to 2 mm of cortical bone left at anterior mandible lingual plate in apical area of anterior facially tilted implants.

worn complete dentures ever since. The treatment objectives for the patient were the fabrication of a new maxillary removable complete dental prosthesis and an implant-supported mandibular fixed prosthesis. The decision was made to use only 4 dental implants because of lack of space between the mental foramina. The All-on-4 technique was proposed, but with the position of the anterior implants modified in accordance with the tangent law, that is, a mandibular complete dental prosthesis with bilateral posterior cantilevers fixed on 4 implants, but with 2 anterior implants tilted labially to counterbalance the posterior implants.

The occlusal plane was determined and evaluated with the interim restorations in place.[24] The first step was to determine the optimal inclination of the implants from the sagittal view from the median point of the occlusal surface of the future prosthesis. The radius of closure was then set between this occlusal median point and the mandibular condylar center, which was adjusted to the condylar axis. The second step was to determine a geometric axis perpendicular to the radius of closure. This loading axis was drawn where the radius of closure crossed the occlusal median point of the future prosthesis (Figs. 2, 3). Finally, the orientation of the 2 angled implants was determined so that the perpendicular bisector of an angle whose sides are represented by the posterior and anterior implants was the loading axis.

The dental implant planning software allowed the visualization of the condylar center, and a loading axis consistent with the tangent law could be drawn. Except for the positioning of the 2 anterior implants, the concept of this prosthesis is similar to that of Maló et al.[1] In this patient's treatment, the length of the cantilevers was equivalent to 1 premolar and 1 molar. Framework fracture was not anticipated because the antagonist was a removable complete dental prosthesis, which generated less mechanical stress.[25]

In a treatment such as this, wherein a practitioner places implants with a facial inclination, the use of a 3-dimensional surgical guide fabricated from computed tomography (CT) data is strongly recommended. Indeed, this surgical technique poses the risk of perforating the lingual plate, especially at the apical portion of the mandibular symphysis, and could be life-threatening.[26] The fabrication of a surgical guide (NobelGuide; Nobel-Biocare) offers more precise implant placement, diminishing the risks of complications and providing valuable assistance.[27]

The various implant drills were passed through the guide sleeve of the surgical guide according to the selected implant plan (Fig. 4). The definitive prosthesis was delivered after 4 months with an interim fixed prosthesis on a regular implant platform measuring 4×10 mm anteriorly and 4×11.5 mm posteriorly (Brånemark System Mk III Groovy; NobelBiocare) (Fig. 5). The prosthesis comprised a precious metal framework (Pala 80; Company Loat), resin denture teeth (SR Orthotyp; Ivoclar Vivadent AG), and pink acrylic resin (ProBase; Ivoclar Vivadent AG) (Fig. 6).

The maxillary removable prosthesis and the mandibular screw-retained fixed prosthesis were placed, taking into account the determinants of occlusion: adequate posterior support with a stable intercuspal position, and anterior guidance to avoid posterior interference during mandibular movements. They were fabricated with an appropriate occlusal vertical dimension, centric relation position, function, and esthetics.

To date, the patient has been monitored for a period of 5 years. During this period, no issues have been reported, although the occlusal surfaces show signs of attrition.

Figure 6. A, Frontal and B, sagittal views. Mandrels demonstrate different implant axes.

Figure 7. Treatment after 5 years. Anterior prosthetic screw holes restored with pink resin imitating gingival tissue.

DISCUSSION

The support for an All-on-4 type prosthesis can be optimized by changing the labial inclination of the 2 anterior implants, positioning them to best absorb clenching loading. The main disadvantage of this approach is that the prosthetic screw access holes of the anterior implants are visible on the anterior flange; however, esthetic problems can be avoided by using pink resin (Unifast Trad; GC Dental Products Corp) to cover the facial screw access holes (Fig. 7).

The labial inclination in the mandibular symphysis of the anterior implants does not appear to be a contraindication. However, a prospective clinical study is needed to validate the use of the technique and should measure both the biological outcome of the implants and the prosthetic complications.

SUMMARY

With the All-on-4 concept, the distal inclination of the posterior implants of a mandibular complete arch fixed prosthesis supported by osseointegrated implants can be counterbalanced by a labial inclination of comparable size to the anterior implants. The biomechanical objective is to align the implant-prosthetic unit axis of constraint to the ideal biomechanical loading axis according to the tangent law.

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Corresponding author:
Dr Jean-Philippe Ré
71, Place de la Liberté
83 000 Toulon
FRANCE
Email: jeanphilippe.re@free.fr

Noteworthy Abstracts of the Current Literature

Fixed prosthodontics treatment outcomes in the long-term management of patients with periodontal disease: A 20-year follow-up report

Febo GD, Bebendo A, Romano F, Cairo F, Carnevale G

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Purpose. The aim of this long-term cohort study was to evaluate the efficacy and complications of fixed partial dentures in a convenience sample of 100 patients with periodontal disease who were treated and maintained periodontal patients after 20 years.

Materials and Methods. After active treatment, including periodontal surgery and endodontic and prosthetic treatment, patients were enrolled in a supportive periodontal care (SPC) program with 3- to 6-month recalls. All patients showed clinical data recorded at (1) the original consultation (T0), (2) the first SPC visit following the completion of prosthetic treatment (T1), and (3) at the latest SPC clinical session 20 years after T1 (T2). Multivariate analyses were performed to investigate the influence of clinical variables on the risk of prosthetic abutment (PA) loss after 20 years' visits.

Results. The final sample comprised 100 patients. At T1, a total of 948 PAs represented the original sample of experimental teeth. At the 20-year follow-up, a total of 854 PAs (90.1%) were still in function, while 94 (9.9%) PAs in 41 patients (41%) were lost during SPC; 98% of lost PA were endodontically treated. Vertical root fracture (48%) was the major cause of PA loss, while progression of periodontitis caused 31% of PA loss. Age ($P = .002$), Full-Mouth Plaque Score ($P < .0001$), Full-Mouth Bleeding Score ($P = .0002$), and oral parafunctions ($P = .0083$) were associated with increased probability of PA failure. Among clinical-related factors, endodontic treatment ($P = .0082$), root resection/amputation ($P < .0001$), multi-rooted teeth ($P = .0005$), and abutment associated with parafunction ($P < .0001$) were associated with increased risk of abutment loss after 20 years.

Conclusions. Perioprosthetic treatment in compliant patients is highly successful after 20 years of SPC.