



IMPLANT OSSEOINTEGRATION IN THE ABSENCE OF PRIMARY BONE ANCHORAGE: A CLINICAL REPORT

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The authors identified no report describing implant primary stability obtained by external fixation as a means to achieve osseointegration in craniofacial settings. This article describes a situation in which an implant was placed without direct contact with the resident bone; primary stability was provided by an external device. An edentulous patient was restored with 5 endosseous titanium implants to support a mandibular fixed prosthesis. An implant placed in the right central incisor position was removed after 48 hours and replaced with a shorter and narrower implant without contact with resident bone. Thus, primary stability for the implant was provided by rigid fixation to the prosthesis rather than by bone anchorage. At recall examinations after 6 and 27 months, all implants, including the implant in the right central incisor position, showed clinical and radiographic signs of osseointegration. Resonance frequency analysis indicated acceptable stability and osseointegration for all implants. Observations of this patient suggest that implant osseointegration can be achieved by providing primary stability using a fixed complete denture. Primary bone anchorage/contact does not appear to be critical to the osseointegration process. (*J Prosthet Dent* 2010;104:282-287)

Brånemark et al¹ first demonstrated direct bone anchorage of titanium using animal models. Schroeder et al² confirmed this phenomenon, later accepted as osseointegration, using newly developed techniques to section undecalcified bone and titanium implants. Brånemark et al³ first documented the clinical application of osseointegration when he reported a 10-year oral implant case series. Since then, development of endosseous titanium implants, including features such as macrodesign and surface texture, has resulted in improved biocompatibility, handling characteristics, and ultimately, clinical acceptance. Currently, endosseous titanium implants are widely used to support single tooth, partial and complete dental arch, and maxillofacial reconstruction. Surgical placement is primarily governed by the prosthetic design and, secondarily, by the morphology and quality of the alveolar bone.

Similar to fracture healing, osseointegration requires certain biological

conditions, including precise fit, a bioactive or biocompatible implant, primary stability, and adequate loading during the healing period.⁴ Primary stability in alveolar bone remains the most common surgical condition positively influencing short- and long-term outcomes of implant therapy. Clinical observations suggest that the absence of primary stability is associated with imminent implant failure.⁵⁻⁹ These observations have been corroborated in a histological study investigating bone-healing dynamics at the bone-implant interface in the absence of primary stability.¹⁰

Studies have shown that successful implant placement into extraction sockets presenting a marginal gap defect between resident bone and the implant is a clinical and biological possibility.¹¹⁻¹³ From a clinical perspective, a precise fit of the implant to the alveolus is not always possible due to the variable anatomy of extraction sockets. In such situations, a gap defect between the implant sur-

face and the resident bone remains. Even though clinicians commonly use autogenous bone, biomaterials, and membrane devices to fill or cover the residual gap with the intent to stimulate bone formation, preclinical studies suggest that, within certain limits, spontaneous resolution of the gap is possible without the use of such regenerative techniques.¹¹⁻¹³

Clinical data indicate that primary stability of the implant in alveolar bone is the most critical prognostic clinical condition to achieve osseointegration, as new bone formation fills the marginal gap defect exclusively in the absence of micromovements.¹⁰ Evidently, in the absence of micromotion, the stable blood clot in the bone-implant interface can mature into bone, effectively integrating the implant surface.¹⁴⁻¹⁷ In general, using immediate implant placement techniques, implant primary stability is achieved by providing anchorage for the implant in resident bone.¹⁸ Biomechanics and the biology of fracture

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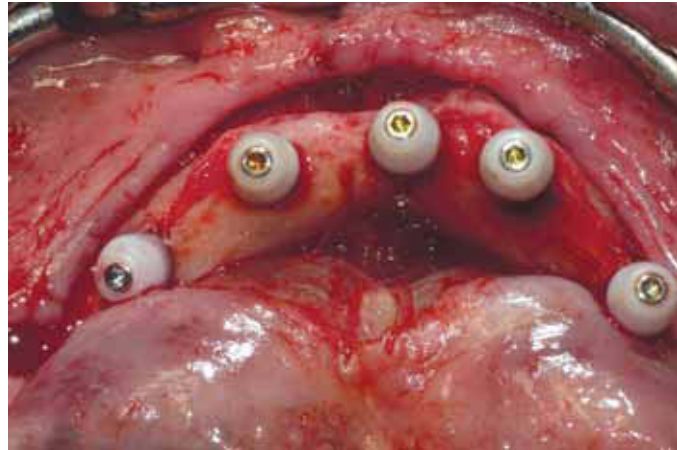
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repair using external fixation devices have been investigated.^{19,20} A large body of evidence expounded upon the benefits of external fixation systems for fracture fixation.²¹⁻²⁷

This report describes the application of this orthopedic principle to implant dentistry. An endosseous titanium dental implant was placed without immediate contact with the resident bone; primary stability was exclusively provided by a fixed complete denture. The authors identified no study investigating the role of primary implant stability provided by external fixation.

CLINICAL REPORT

A 63-year-old edentulous white woman presented to a private dental practice for treatment. The patient expressed a desire to have a fixed rather than a removable prosthesis in the mandible. The patient had a removable complete denture in the maxilla. An intraoral evaluation that included impressions, radiographs, and photographs was performed to establish a treatment plan. Two treatment options were presented to the patient. The first option included placement of 2 dental implants in the canine regions to support a removable implant-retained overdenture. The second option involved placement of 4 dental implants to support a mandibular fixed complete denture. The advantages and disadvantages of each treatment option were explained and discussed with the patient. The patient opted for the fixed complete denture. Also, the patient agreed to participate in a clinical protocol evaluating the effect of primary stability on implant osseointegration and signed an informed consent statement giving authorization for the placement of one additional implant without primary stability in bone. Stability would be exclusively provided by the mandibular fixed complete denture. All clinical procedures were performed in the private dental office in accordance with the Declaration of Helsinki and



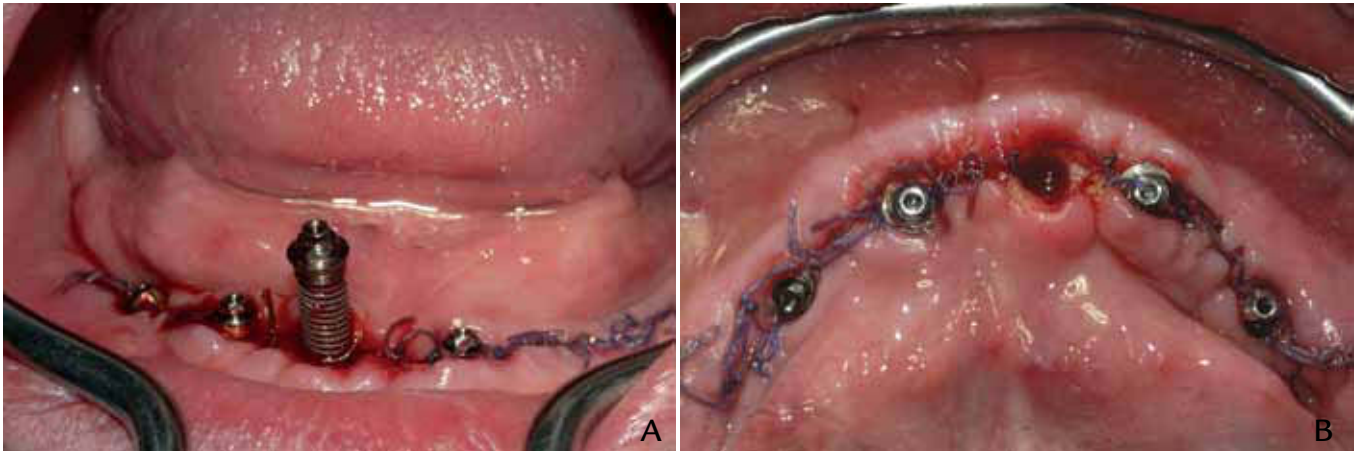
1 Surgical placement of 5 implants in mandible, including provisional implant in right central incisor position.

guidelines for good clinical practice (GCPs).²⁸

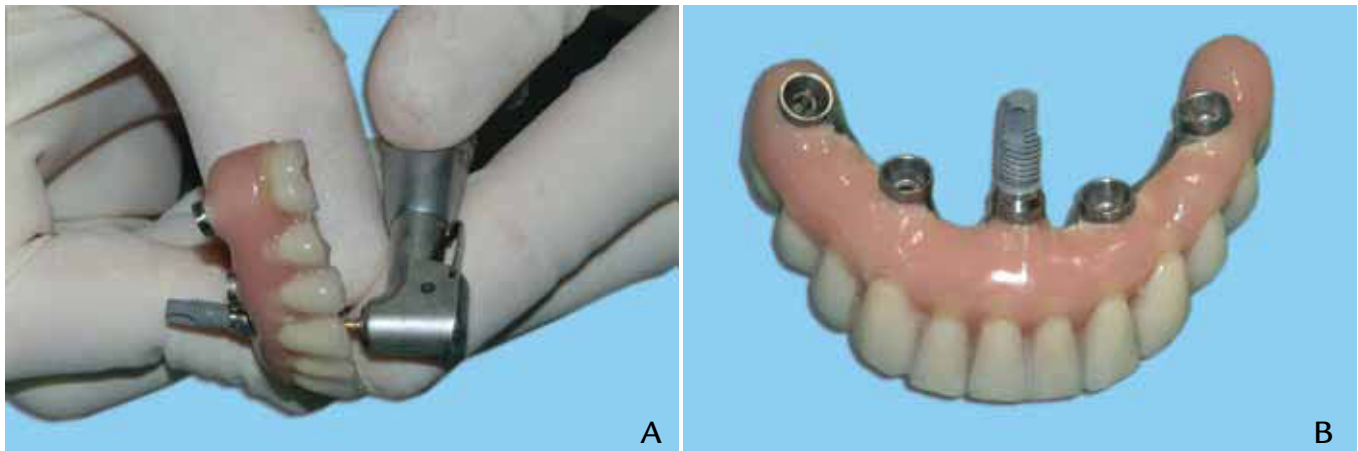
In November of 2004, 4 dental implants with a microporous surface texture²⁹ shown to enhance osseointegration (Brånemark TiUnite MKIII; Nobel Biocare AB, Göteborg, Sweden) were placed in the interforaminal area with high primary stability (insertion torque, 50 Ncm).³⁰⁻³⁸ One additional osteotomy site in the right central incisor position was prepared with a length of 15 mm in such a way that the osteotomy provided 2 different diameters: a narrower diameter of 3.2 mm in the most apical part (from 13 to 15 mm) and a wider diameter of 4.2 mm in the coronal part (from 1 to 12 mm). A 4 x 15-mm implant (Brånemark TiUnite MKIII; Nobel Biocare AB) was provisionally inserted. Obviously, this implant engaged only the the most apical part of the osteotomy site due to its narrow diameter. The objective of this implant was to serve as a placeholder for a shorter, narrower implant during the manufacture of a provisional implant-supported mandibular fixed prosthesis (Fig. 1).

The interim complete fixed denture was processed within 48 hours. The interim mandibular fixed complete denture had a gold metal substructure with acrylic resin denture base material, centric occlusion contacts, group function, and anterior guidance. The implant previously

placed in the right central incisor position was gently removed, leaving a bleeding osteotomy site (Fig. 2). A 3.75 x 10-mm implant (Brånemark TiUnite MKIII; Nobel Biocare AB) was attached to the prosthesis in the right central incisor position using a multi-unit abutment and a torque of 20 Ncm. Then, the prosthesis with the attached implant was inserted and attached to the 4 previously placed implants (Fig. 3). The implant attached to the prosthesis and inserted into the osteotomy site had no primary stability in or contact with the resident bone, due to site overpreparation and because of the implant's reduced diameter and length, which were determined clinically and radiographically (Fig. 4). The patient was prescribed a 0.2% chlorhexidine oral rinse for use twice daily for 2 weeks. After this time period, the patient was asked to resume normal oral hygiene procedures, including the use of a small interproximal brush and floss. The implant-supported mandibular fixed complete denture was temporarily removed following a 6-month healing interval, and the right central incisor position and adjacent implants were evaluated for osseointegration and stability using resonance frequency analysis (RFA) (Osstell Mentor and SmartPeg; Osstell AB, Göteborg, Sweden).³⁹⁻⁴¹ Implant stability quotients (ISQs) for implants inserted in the left lateral incisor, right canine, and cen-



2 Provisional implant in right central incisor position, gently unscrewed from osteotomy site at 48 hours postsurgery (A), and osteotomy site after implant removal (B).



3 New implant attached to multi-unit abutment with insertion torque of 20 Ncm (A), and attached to prosthesis (B).

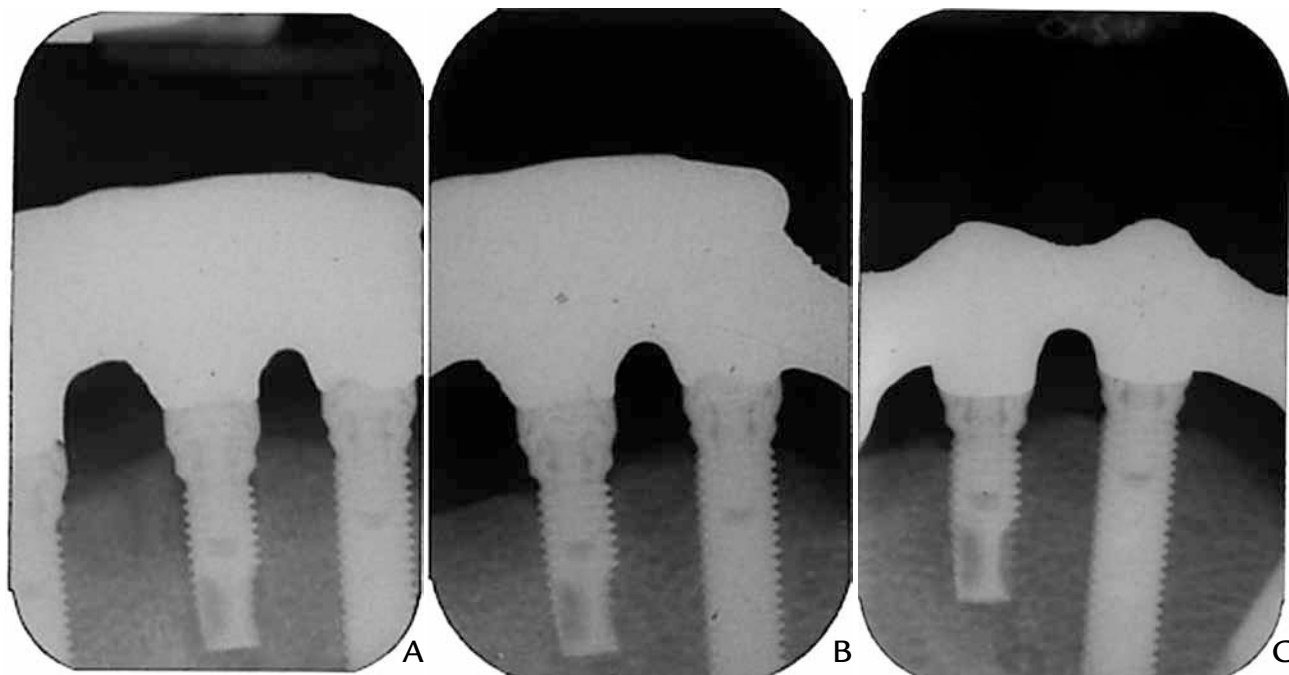


4 Positioning of prosthesis and insertion of right central incisor position implant into oversized osteotomy site.

tral right incisor positions were 76, 61, and 58, respectively. Periapical radiographs suggested periimplant bone formation for the central right incisor position implant (Fig. 5). The corresponding ISQs at 18 and 27

months were 74, 59, and 58, and 67, 62, and 61, respectively, when additional periapical radiographic recordings were made (Fig. 5), all suggesting clinically relevant osseointegration of the implant in the central right incisor

position. Clinical recordings, including plaque index, bleeding on probing, and probing depths obtained at recalls, showed values within normal limits (Fig. 6). The interim prosthesis was replaced by the definitive pros-



5 Periapical radiographs from prosthesis insertion and placement of right central incisor position implant. Implant has no apparent contact with resident bone due to its reduced length and diameter compared with previous provisional implant (A). Periapical radiograph at 6 months (B) and 27 (C) months postsurgery showing evidence of new bone formation around right central incisor position implant.



6 Right central incisor position implant at 27 months postsurgery. View of all implants (left) and close up (right).

thesis 12 months after surgery. The definitive prosthesis had a gold metal substructure with acrylic resin denture base material, centric occlusion contacts, group function, and anterior guidance.

DISCUSSION

Five endosseous titanium implants were placed to support a fixed mandibular prosthesis. The implant placed in the right central incisor position was removed after 48 hours. Once this im-

plant was removed, leaving a wide osteotomy site, a shorter and narrower implant was placed without immediate bone contact or bone anchorage, and primary stability was provided by the prosthesis, which functioned as an external fixation device. Healing was uneventful, regularly reviewed clinical parameters showing values within normal limits for the externally stabilized as well as conventionally placed implants. Importantly, radiographic observations and RFA recordings over 27 months indicated functional osseo-

integration of all implants, regardless of conventional or external primary stabilization.

The critical healing phase following implant placement is the formation of direct bone-implant contact. Temporal changes occurring in periimplant hard and soft tissues following implant placement have been described.^{14,15} Such reports suggest similarities between implant osseointegration and fracture healing, including hematoma formation and resolution and osteogenic cell migration.¹⁶ Simi-

lar to fracture healing, osseointegration requires certain biological conditions: precise fit, use of bioactive or biocompatible materials, primary stability, and adequate loading during the healing period.⁵ Among these, accomplishing primary stability by anchorage of the implant in bone appears to be a critical surgical mandate positively influencing the short- and long-term outcomes of implant therapy.¹⁰ While uncontrolled forces, inducing macro-movement, may jeopardize implant stability and ultimately osseointegration, minor forces acting on the bone-implant interface may have positive effects. Gapski and Wang¹⁸ expounded upon the beneficial effects of immediate loading protocols on bone-implant contact. Preclinical studies evaluating the effects of controlled micromotion on healing at the implant interface may be interpreted to corroborate such clinical observations.⁴²⁻⁴⁴ Nevertheless, implementation of primary implant stability appears to be of paramount importance for the positive outcome of implant therapy, as implant movement due to a lack of primary stability results in implant failure.⁵⁻⁹

Different patterns of bone healing at the bone-implant interface have been described. Distance osteogenesis is defined as bone formation originating from the resident bone extending toward the implant surface. Contact osteogenesis occurs when an implant surface has the ability to attract osteoblasts that initiate bone formation on the implant surface without immediate resident bone contact. Preclinical studies have elucidated and confirmed this hypothesis and have assigned a fundamental role to rough surfaces for their contribution in inducing distance osteogenesis.^{14,15} In addition, distance osteogenesis is believed to enhance and accelerate the rate of bone formation, making it useful for immediate loading protocols.⁴⁵⁻⁴⁸ In the present report, an implant with a rough titanium, porous oxide surface with specific surface characteristics was used.²⁹ A large

body of evidence suggests this surface is osteoconductive and therefore particularly beneficial in the practice of immediate loading.³⁰⁻³⁸

One possible limitation of this report is the use of clinical, radiographic, and RFA recordings to evaluate osseointegration. However, even if the use of RFA as an index for implant osseointegration remains controversial under specific clinical conditions, at the present time, ISQ readings represent the most reliable clinical assessment available.³⁹⁻⁴¹

The implant without primary bone anchorage displayed uneventful clinical healing and osseointegration. This observation suggests that bone anchorage or bone contact is not essential if primary stability is otherwise provided. The use of an implant surface exhibiting a potential to promote distance osteogenesis may have added to the observed outcome. Obviously, when the gap distance between the implant and the resident bone is relatively narrow (in this report, a 3.75-mm-diameter implant was placed into a 4.2-mm osteotomy), healing may proceed undisturbed, and wound maturation may support bone formation, bridging resident bone and the implant in the absence of bone anchorage, with primary stability provided by a fixed complete denture. It is the authors' opinion that this represents a principle that, carefully investigated, may advance therapeutic options to positively influence clinical outcomes. This technique may potentially represent an approach to the management of integration loss of a single implant as part of a fixed implant complete denture, without requiring the framework to be remade. If the osteotomy site could be reprepared and another implant could be placed in the same position, without the necessity for initial primary stability, a streamlined approach could be offered to patients for retreatment.

SUMMARY

The patient presented had 4 implants placed in the interforaminal area with high primary stability. One additional implant was provisionally inserted with low primary stability. The implant-supported mandibular fixed denture was processed within 48 hours. The implant with low primary stability was gently removed, leaving a bleeding osteotomy site, and a smaller implant, attached to the prosthesis, was inserted into the osteotomy site. This implant had no primary stability and no contact with the resident bone due to site overpreparation and the implant's reduced diameter and length. The interim prosthesis was temporarily removed following a 6-month healing interval. Implant stability quotients (ISQs), periapical radiographs, and clinical recordings suggested peri-implant bone formation for all implants, including the implant placed without primary bone anchorage.

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