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CLINICAL RESEARCH

Maxillary V-4: Four implant treatment for maxillary atrophy with dental implants fixed apically at the vomer-nasal crest, lateral pyriform rim, and zygoma for immediate function. Report on 44 patients followed from 1 to 3 years

Ole T. Jensen, DDS, MS,[a] Mark W. Adams, DDS, MS,[b] Caesar Butura, DDS,[c] and Daniel F. Galindo, DDS[d]

ABSTRACT

Statement of problem. The V-4 implant placement technique is important for restoring patients with maxillary atrophy, but little has been documented on the outcomes of these treatments.

Purpose. The purpose of this study was to evaluate the outcome of immediate function after 1 year when implants were placed without vertical bone augmentation in Cawood-Howell Classes IV-VI maxillary atrophy (Class C-D by the "all-on-four" site classification) with the nasal crest, lateral pyriform rim, and sometimes the zygoma for apical implant fixation.

Material and methods. Function of implants that had been immediately loaded were studied retrospectively after 1 year in 44 patients from 2 different clinics. For each patient studied, 2 angled implants were placed in the midline in the nasal crest/vomer area, and typically, 2 implants were engaged apically in the lateral pyriform rim bilaterally. All 4 of the implants used were angled toward the midline in a V formation, termed "V-4" implant placement. Insertion torque, anterior-posterior spread, implant diameter, implant length, and posterior cantilever were recorded. Implant survival and bone stability were assessed after 1 year. When the lateral pyriform was highly deficient (Class D), zygomatic implants were used posteriorly.

Results. A total of 179 implants were placed in 44 patients followed for 1 to 3 years. Six implants were lost, all in 1 patient. Anterior-posterior spread averaged 16 mm, with an average cantilever of 7.5 mm. Except for the lost implant sites, bone levels were stable throughout treatment for all patients.

Conclusions. The use of 4 implants angled toward the midline, including 2 implants placed into a V-shaped point at the nasal crest and 2 implants placed into an M-shaped point at the pyriform rim bilaterally, showed good stability after 1 year despite gross absence of bone mass as a result of severe maxillary atrophy. The V-4 placement pattern is important for patients with deficient bone mass between the sinus and nasal cavities. In Class D situations where lateral nasal rim bone mass is nearly absent, zygomatic implants can be used. (J Prosthet Dent 2015;114:810-817)

For moderate to severe maxillary atrophy, apical implant fixation can be obtained commonly at the lateral pyriform rim with 4 implants placed in an M-shaped configuration, termed "M-4," for immediate function.[1-5] Most maxillary edentulous jaws can be treated with four 30-degree angled fixtures placed in what is largely a biomechanical effort to gain at least 15 mm of anterior-posterior (A-P) spread as well as to derive a 4-implant composite insertion torque sum of at least 120 Ncm for immediate loading.[2,3,6,7] A second 4-implant scheme, termed "V-4" placement, consists of 4 implants that are directed toward the midline in a V-shaped pattern with the 2 anterior implants apically engaged in midline bone. The V-4 pattern can be used in most situations but becomes an important technique as atrophy progresses and becomes more severe.

Typical all-on-four treatments have been divided into 4 categories (Classes A, B, C, and D) according to the extent of atrophy and cortical bone available for apical

[a]Private practice, Greenwood Village, Colo.
[b]Private practice, Greenwood Village, Colo.
[c]Private practice, Phoenix, Ariz.
[d]Private practice, Phoenix, Ariz.

Clinical Implications

This classification will improve the treatment of patients who undergo complete arch implant restoration with immediate function.

fixation for immediate function (Fig. 1).[8] Class A sites have A-P spreads of 20 mm or more, with all implants well fixed into cortical bone. Class B sites have a more anterior sinus location with less available bone height, resulting in an A-P spread of approximately 15 mm. For a Class C site, in order to obtain adequate A-P spread, posterior implants must pass in a trans-sinus path. Because of a lack of lateral pyriform rim bone mass, Class C anterior implants are directed to midline bone stock, often passing into the nasal crest. A Class D situation has little or no bone available and requires sinus grafting, trans-sinus placement with Bone Morphogenetic Protein and Acellulan Collagen Sponge (BMP-2/ACS) grafting, or zygomatic implants. Class D patients are difficult to load with immediate function, especially if midline bone is absent, unless quad zygomatic implants are placed.

As atrophy progresses from Cawood-Howell Class IV to Class VI (Classes C and D in the all-on-four site classification), the absence of alveolar bone is compounded by the loss of basal bone.[6,8-10] Even though there may be significant dimensional contraction of jaw bone mass, isolated islands of maxillofacial bone often persist at the midline (nasal crest), the lateral pyriform, the zygomas, and sometimes the pterygoid plates.[4,7,8] Four implants spaced in these disparate locations can still obtain favorable A-P spread and adequate implant stability so that immediate function can proceed.[1,7,11,12]

Under conditions of severe bone deficiency, primary fixation sites for apical fixation at the lateral nasal rim and midline nasal crest are still frequently obtainable.[9,12] However, the 4 implants must be angled forward at 30-degree angles in an upside down V-shaped formation, termed the V-4 placement strategy.[4,13] A typical Class C designation directs that the 2 posterior implants pass trans-sinus to anchor into relatively deficient pyriform rims, whereas the 2 anterior implants be inserted into the nasal crest where substantial cortical bone usually remains available. Thirty- degree angulations provide greater length, increased insertion torque, and secondary stabilization for immediate loading.[5,6,14] This V-4 pattern contrasts with M-4 placement, which has enough bone mass at the lateral pyriform rim for apical fixation of 2 implants on each side of the nose at the so-called M point, which is defined as the point of maximum bone mass available lateral and superior to the nasal fossa.[1,3]

Midline implants are sometimes termed "vomer" implants, as the implant may extend superiorly to the suture of the vomer in the midline.[4,6,14] However, the implants are actually directed at the maximum available bone mass within the nasal crest, a point termed the "V-point."[8,13] Typically, the V-point has enough bone mass into which 2 implants may be fixed apically,[4,14] but when either the nasal crest or pyriform bone mass is highly deficient or absent, zygomatic and sometimes pterygoid implants are placed, unless immediate function is deferred by a delayed loading strategy, including sinus floor bone grafting.[4,6,12,15]

This article presents the findings for 44 patients consecutively treated in 2 separate clinics with a V-4 implant placement strategy for moderate to highly atrophic maxillae, in which immediate function proceeded on the same day as implant placement. The patients were followed for a period of at least 1 year.

MATERIALS AND METHOD

Two clinics retrospectively reviewed 44 patients treated with at least 2 vomer implants in a V-4 treatment strategy, recalling patients after 1 year, in function. All patients had been immediately loaded. Treatment was done according to an all-on-four site classification scheme as follows: Class B V-4 placement, Class C V-4 placement with posterior trans-sinus implants, or Class D with 2 vomer and 2 posterior zygomatic implants. All but 2 patients were treated using a 4-implant scheme and were then immediately loaded.

Insertion torque values, A-P spread, cantilever length, and implant dimensions were recorded. The implants used were Nobel Active, Nobel Speedy, or Noble Zygomaticus implants (Nobel Biocare), with most implants being tilted at 30-degree angles. Implant survival, morbidities, and prosthesis stability were recorded. All participants consented to the study. Institutional approval was not required.

RESULTS

Table 1 shows an overall success rate of 96.6% for a total of 179 implants placed, and 6 implant failures, all occurring in 1 patient. A total of 42 patients had 4 implants placed. There was 1 patient with 5 implants and 1 with 6 implant treatments. For the 44 patients, all of the implants were loaded on the day of placement.

The patient with the failed implants required retreatment with a submerged approach and reversion to a denture prosthesis for a 6-month period; otherwise, all patients remained in function throughout the treatment period. Except for minor acrylic resin repair events, all but 1 prosthesis remained stable throughout the study period.

The average cantilever was 7.5 mm, and the average A-P spread was 16 mm. Insertion torques for the vomer

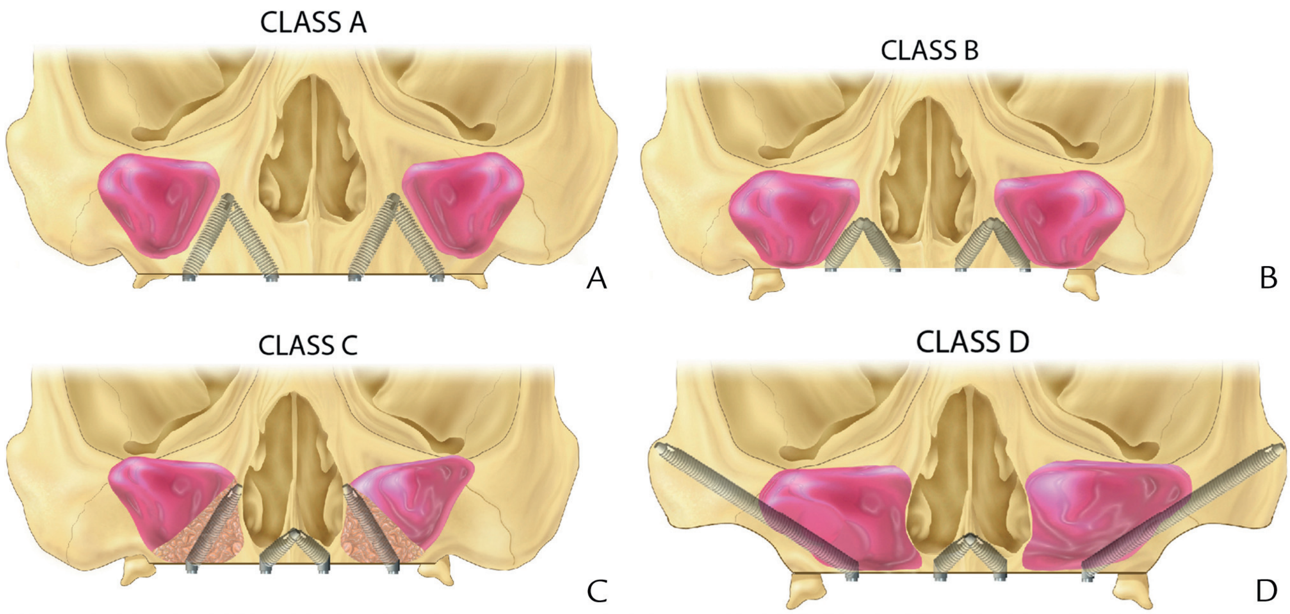

Figure 1. A, Class A sites for maxilla have adequate bone beneath sinus and thick palatal walls so first molar located angled implants can be placed bilaterally. Two anterior implants are placed near canine extraction sites. Implant lengths are usually 15 mm or more. Anterior-posterior spread is 20 mm or more with interimplant arch span of 60 mm or greater. Definitive restorations have little or no cantilever. B, Class B sites have more prominent sinus cavities but with a few millimeters of bone below sinuses. Posterior implants are generally placed in second bicuspid zone to avoid sinus penetration. Two anterior implants placed in bone between canine and lateral incisors. Anterior-posterior spread is 15 mm or more with interimplant arch span of 45 to 50 mm. C, Class C sites have very prominent sinus cavities and minimal bone beneath sinus with sinus relatively anterior. Posterior implants pass trans-sinus to gain fixation point of maximum cortical bone mass. Anterior implants placed lateral incisor locations angle toward midline maximum bone mass of nasal crest (V point). D, Class D site absence of M point, sometimes V-point bone mass. Large sinus cavities, absence of basal bone. Paranasal bone mass beneath nasal fossa, at pyriform, and nasal crest is minimal. Class D site treated with immediate function using zygomatic implants posterior, vomer-nasal crest implants anterior. When absence of V-point bone delays placement, strategy with sinus grafting or quad zygomatic is considered.

implants were 45.5 Ncm, on average, and 42.2 Ncm for the posterior implants. Total insertion torques exceeded the minimum requirement of 120 Ncm in all situations. No instances of gross bone loss were recorded, except in the patient for whom implantation failed. Eight patients received bilateral zygomatic implants for a total of 16 zygomatic implants placed, all of which remained in function. Vomer implants ranged in length from 8.5 to 18 mm with an average length of approximately 14.6 mm.

Patient treatment 1

A 64-year-old woman presented with an edentulous maxilla with minimal bone beneath the maxillary sinuses (Fig. 2A). The sinuses were in close proximity to the nasal cavity. The all- on-four site classification was determined to be Class C, indicating that trans-sinus implant placement could be done in the posterior and vomer implants in the anterior in a V-4 treatment configuration to obtain adequate A-P spread for immediate function. The surgical procedure proceeded with the elevation of buccal and lingual mucoperiosteal flaps from a crestal incision, followed by elevation of the sinus membranes bilaterally from lateral antrostomies. Posterior implants were inserted starting at palatal entry points near the second premolar locations and then passing trans-sinus to engage the lateral nasal wall apically above the nasal fossa. The insertion torque was 10 Ncm for both of the posterior implants. (These 2 implants could be hand-turned after placement, although they were vertically stable.) Due to the deficiency of M-point bone mass, vomer implant were angled toward the midline to enter the nasal crest (Fig. 2B). The insertion torque for these implants was 50 Ncm each for a total insertion torque of 120 Ncm for the 4 implants. Sinus was grafted with BMP-2/ACS and autogenous particulate in a 50:50 ratio. The A-P spread following 30-degree abutment placement was 16 mm. The sinuses were grafted around the trans-sinus implants, a membrane was placed, and the wound was closed. The implants were then immediately loaded with an interim prosthesis (Fig. 2C) and subsequently restored with a definitive prosthesis with a bar cantilever less than 5 mm.

Patient treatment 2

A 70-year-old edentulous woman had worn maxillary and mandibular dentures for more than 15 years. Her intraoral examination revealed a severely atrophic edentulous maxilla (Class D). A cone beam computed

Table 1. Forty-four patients underwent treatment, with 42 patients having only 4 implants placed[a]

Sex	Age (y)	Insertion Torque for Each Implant (Ncm)	A-P Spread (mm)	Implant Diameter for Each Implant (mm)	Implant Length for Each Implant (mm)	R/L Cantilever Length (mm)
F	75	45, 45, 45, 45	16	4.0, 4.0, 4.0, 4.0	18, 13, 13, 18	2.9/3.6
M	78	45, 45, 45, 45	15	4.0, 4.0, 4.0, 4.0	18, 15, 15, 18	3.5/5.1
F	66	35, 40, 45, 45	14	4.0, 4.0, 4.0, 4.0	18, 15, 15, 18	3.2/7.2
M	42	45, 45, 45, 45	17	4.0, 4.0, 4.0, 4.0	18, 15, 15, 18	3.8/2.3
F	60	45, 45, 45, 45	14	4.0, 4.0, 4.0, 4.0	15, 15, 15, 15	8.8/8.3
F	59	45, 45, 45, 45	16	4.0, 4.0, 4.0, 4.0	15, 13, 13, 15	9.4/8.9
M	71	45, 45, 45, 45	15	4.0, 4.0, 4.0, 4.0	15, 13, 13, 15	8.5/8.5
M	88	45, 45, 45, 45	11	4.0, 4.0, 4.0, 4.0	15, 13, 13, 15	11.4/8.8
M	72	45, 45, 45, 45	12	4.3, 4.0, 4.0, 4.0	18, 15, 15, 18	6.3/8.2
F	77	45, 45, 45, 45	13	4.0, 4.0, 4.0, 5.0	18, 15, 15, 18	5.5/3.2
F	53	45, 45, 45, 45	18	4.0, 4.0, 4.0, 4.0	18, 15, 15, 18	0.5/0.5
F	56	45, 45, 45, 45	20	4.0, 4.0, 4.0, 4.0	18, 15, 15, 18	6.1/4.5
F	82	60, 45, 45, 60	13	Z, 4.0, 4.0, Z	40, 10, 10, 45	2.8/1.7
M	73	70, 45, 45, 70	17	Z, 4.0, 4.0, Z	52.5, 15, 15, 52.5	9.1/7.4
F	56	60, 45, 45, 60	11	Z, 4.0, 4.0, Z	40, 15, 15, 35	6.8/7.0
M	74	45, 45, 45, 45	12	Z, 4.0, 4.0, Z	40, 15, 15, 42.5	7.6/8.6
M	63	60, 45, 45, 60	15	Z, 4.0, 4.0, Z	45, 13, 13, 45	7.4/6.4
M	51	60, 45, 45, 70	15	Z, 4.0, 4.0, Z	35, 13, 13, 35	3.4/2.1
M	64	45, 45, 45, 45	17	Z, 4.0, 4.0, Z	40, 13, 13, 45	4.3/4.1
F	83	45, 45, 45, 45	15	4.0, 4.0, 4.0, 4.0	15, 15, 15, 15	4.0/4.4
M	46	45, 45, 45, 45	17	4.0, 4.0, 4.0, 4.0	18, 15, 15, 18	5.1/4.8
F	64	45, 45, 45, 45	17	4.0, 4.0, 4.0, 4.0	18, 15, 15, 18	4.3/3.2
M	65	45, 45, 45, 45	19	4.0, 4.0, 4.0, 4.0	18, 13, 13, 18	7.4/5.9
M	65	45, 45, 45, 45	21	4.0, 4.0, 4.0, 4.0	18, 18, 18, 18	1.4/1.4
M	63	45, 45, 45, 45	13	4.0, 4.0, 4.0, 4.0	18, 15, 15, 18	7.1/8.2
F	60	45, 45, 45, 45	15	4.0, 4.0, 4.0, 4.0	18, 15, 15, 18	5.2/7.2
F	52	45, 45, 45, 45	18	4.0, 4.0, 4.0, 4.0	15, 13, 13, 15	5.6/7.4
F	70	45, 45, 45, 45	15	5.0, 4.0, 4.0, 4.0	15, 15, 15, 15	8.2/7.6
F	62	45, 45, 45, 45	17	4.0, 4.0, 4.0, 4.0	15, 15, 15, 15	9.3/6.5
F	56	45, 45, 45, 45	15	4.0, 4.0, 4.0, 4.0	15, 15, 15, 15	11.7/5.3
M	78	45, 45, 45, 45	19	4.0, 4.0, 4.0, 4.0	18, 15, 15, 18	6.8/5.4
F	58	45, 35, 45, 45	16	4.0, 4.0, 4.0, 4.0	18, 15, 15, 18	11.3/7.2
M	56	45, 45, 45, 45	20	4.0, 4.0, 4.0, 4.0	18, 18, 18, 18	3.8/5.4
M	68	50, 50, 50, 50	15	4.3, 4.3, 4.3, 4.3	11.5, 11.5, 11.5, 11.5	10.2/10.1
M	72	35, 40, 40, 35	15	4.0, 4.0, 4.0, 4.0	15, 13, 13, 15	7.5/4.2
F	54	30, 40, 50, 30	14	4.3, 3.5, 3.5, 4.3	13, 11.5, 13, 13	4.0/5.5
F	66	30, 40, 50, 50	22	4.0, 4.0, 4.0, 4.0	11.5, 11.5, 11.5, 15	0.0/5.2
M	71	50, 50, 50, 50,	16	4.3, 4.3, 4.3, 4.3	11.5, 11.5, 11.5, 11.5	7.0/4.1
F	64	10, 50, 50, 10	16	4.3, 4.3, 4.3, 3.5	13, 11.5, 11.5, 15	2.0/3.2
F	66	50, 30, 50, 30	12	4.3, 4.3, 4.3, 4.3	10, 8.5, 8.5, 8.5, 11.5	12/4/9.5
F	58	40, 40, 40, 40	18	4.0, 4.0, 4.0, 4.0	15, 11.5, 11.5, 15	0.0/0.0
F	65	30, 40, 40, 30	13.5	4.0, 4.0, 4.0, 4.0	13, 11.5, 13, 13	8.5/3.2
F	59	35, 40, 40, 35	16	4.0, 4.0, 4.0, 4.0	13, 11.5, 11.5, 13	8.5/6.1
M	68	20, 50, 50, 50, 30, 25	15	4.0, 4.0, 4.0, 4.0, 4.0, 4.0	13, 40, 10, 10, 42.5, 13	0.0/0.0

R/L, right/left.
[a]Average anterior-posterior (A-P) spread was 16 mm. Cantilever average was 7.5 mm. Vomer insertion torques averaged 45.5 Ncm. Posterior implants averaged 42.2 Ncm. Eight bilateral zygomatic implants were required. Overall success rate at 1- to 3-year follow-up was 96.6%.

tomography (CT) study revealed pneumatized sinuses and limited bone availability.

A subperiosteal dissection was advanced to the pyriform rims with slight elevation of the nasal floor to keep the nasal membrane intact. A posterior-superior subperiosteal dissection was made to expose the zygoma. Approximately 7 to 10 mm of palatal tissue was also reflected to allow implant site preparation and placement. The all-on-four bone shelf was prepared by eliminating the knife-edge portion of the alveolus to level the bone. Implant angulations and distribution were then established (Fig. 3A). Fifteen-millimeter implants were then placed into the vomer sites at 17-degree angulations. The apical end on the implants engaged but

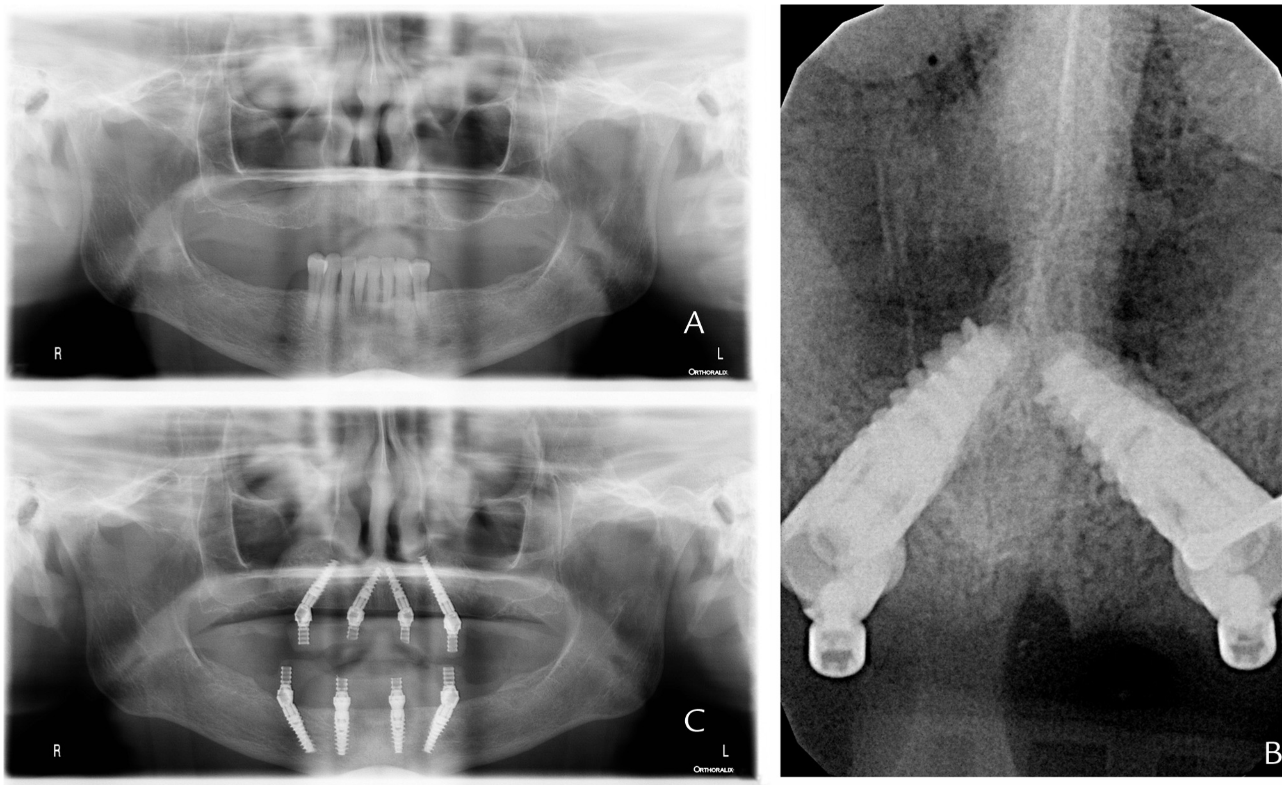

Figure 2. A, Pretreatment panoramic radiograph of patient with edentulous maxilla with minimal bone beneath the maxillary sinuses. B, Periapical radiograph of two 10-mm implants placed at 30-degree angles into nasal crest. Insertion torque of 50 Ncm was adequate for anterior support for immediate function. C, Posterior implant placement elevation in sinus membranes, placement of Bone Morphogenetic Protein and Acellulan Collagen Sponge (BMP-2-ACS) allograft 50:50 mixture. Insertion torques for posterior implants 10 Ncm. Total insertion torque value 120 Ncm, acceptable for immediate function. Cantilever definitive restoration was limited to less than 5 mm using trans-sinus approach, A-P spread of 16 mm.

did not perforate the nasal fossa. The insertion torque was 45 Ncm as measured by a hand-held implant driver for both implants. The zygomatic implant sites were prepared by using a standard technique and received 40-mm fixtures with torque values above 45 Ncm. The patient recovered uneventfully, and the treatment proceeded to a definitive titanium bar-supported restoration with a 45-mm interimplant arch span, a 15-mm A-P spread, and 6- to 7-mm cantilevers (Fig. 3B). A follow-up after 3 years revealed that, despite limited bone stock, the vomer implants remained stable (Fig. 3C and D).

PATIENT TREATMENT 3

A 53-year-old woman who had worn maxillary dentures for more than 20 years presented with a failing mandibular dentition and combination syndrome. Her intraoral examination revealed a severely resorbed anterior maxilla with a narrow ridge. Her maxilla was classified as Class D in the all-on-four site classification. The cone beam CT study revealed severe maxillary atrophy, with a Cawood-Howell Class III relationship as shown in the lateral cephalometric view.

Zygomatic implant placement was done for the posterior maxilla with conventional implants placed anteriorly using the vomer technique. Palatal angulations were used to avoid possible fracture of the infranasal bone mass. Both of the sites received 4-×10-mm implants, which achieved a torque of 45 Ncm. Two 40-mm zygomatic implants also achieved 45 Ncm of insertion torque (Fig. 4A). The mandibular teeth were extracted, and a standard all-on-four procedure was performed for the mandibular arch. The definitive prostheses were delivered approximately 6 months after initial implant placement. A 2-year follow-up radiograph of the vomer implants revealed stable osseointegration (Fig. 4B).

DISCUSSION

Demonstrated in this short-term study is the possibility that implants engaged apically into the maxillary midline, sometimes extending superiorly into the nasal crest, may be a viable strategy for immediate function despite severe bone atrophy. The technique has been previously described in implant loss settings for the M-4 implant placement pattern, where an anterior implant has failed and retreatment is best accomplished by a midline-directed "vomer" implant to avoid the previous failed implant site. The midline approach is also optimal for use

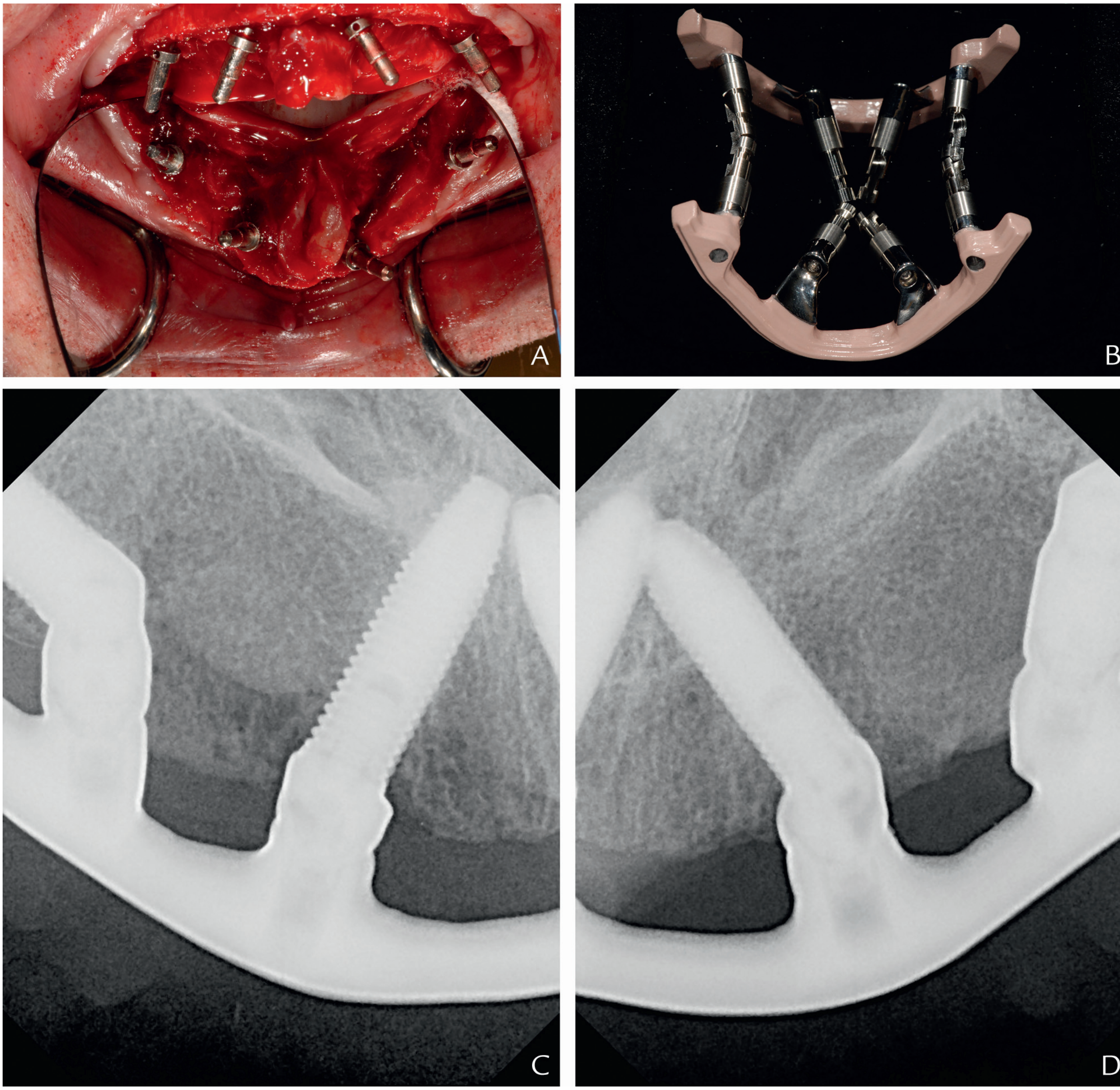

Figure 3. A, Intraoperative bone shelf. Direction indicators demonstrate V-4 angulation. B, Titanium bar (4×4 mm) showing implant replicas, with implant angulations, implant distribution, and bar cantilevers. C, Right vomer implant 3 years after immediate function. D, Left vomer implant 3 years after immediate function.

in settings where there is confluence of the sinus cavity and nasal fossa or in patients with lateral maxillary ablation such as multiple failed implants, failed sinus grafts, or tumor resection.[15-19] In addition, a midline-directed implant can be used in most patients (Classes A-D) as an alternative to M-4 implant placement.

Vomer implants provide an opportunity for clinicians to proceed to immediate loading of an interim prosthesis, which might not be possible otherwise in the higher stages of atrophy. For immediate loading, it is important to keep in mind the principle tenets of immediate function for the atrophic maxilla.

Soft or hard tissue reduction may be needed to create adequate space, approximately 15 mm, for the prosthetic restoration. This provides enough room for abutments, a 4-×4-mm titanium bar, and the prosthesis itself. Even in settings of severe bone resorption, some bone leveling and soft tissue modification are usually required.[2]

Implants must obtain sufficient insertion torque to load. A minimum composite insertion torque of 120 Ncm is recommended (allowing by convention a maximum of 50 Ncm for any 1 implant).[5]

Four implant schemes require that at least 2 implants obtain primary stability with the anterior implant

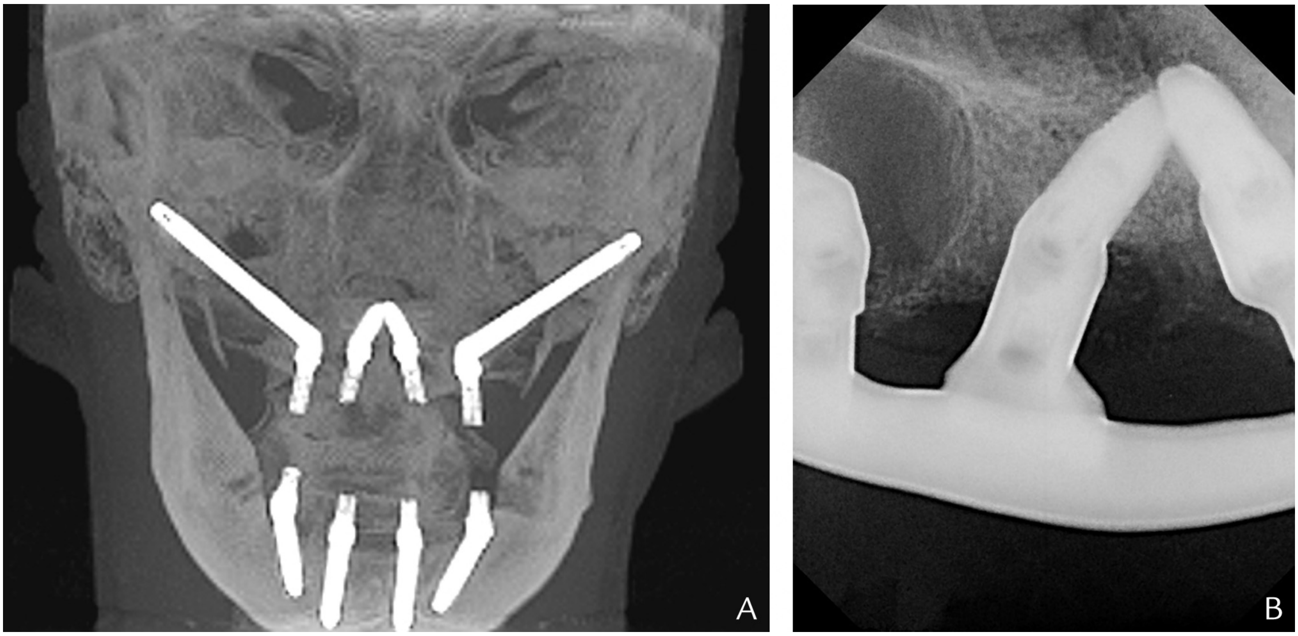

Figure 4. A, Post-treatment radiograph, immediate functional loading. Bilateral vomer implants anterior, zygomatic implants posterior. Anterior posterior spread was 13 mm. B, Vomer implants without observable bone loss 2 years after placement.

stability, which is most important for immediate function. For the highly atrophic maxilla, this often requires the use of 2 midline-directed implants in order to gain primary stability anteriorly, as the posterior implants are frequently less stable. However, all 4 implants must be vertically stable to proceed with loading.[5]

The most important biomechanical requirement for immediate function in the highly atrophic maxilla is adequate A-P spread, defined as 12 to 15 mm. Cantilevers should not be present in the provisional prosthesis but can approximate 10 mm in a bar-supported definitive prosthesis.[5,20]

Angulated implants are longer and better able to access islands of cortical bone in highly resorbed states. Angulation also provides internal secondary stabilization, as the sides of the implants add to the resistance form of added length.[5,13,14] Immediate provisionalization provides external secondary stabilization of implants from the provisional prosthesis by cross arch splinting, thereby immobilizing the implants[5]

A "graft-less solution" using available bone for implant placement drives the effort to limit patient morbidity, simplify surgical intervention, and decrease operating time, all inherent strategies for immediate function. By minimizing the number of implants to 4, there are fewer compounding variables for the treatment team, including the surgeon, prosthodontist, and laboratory technician.

At first glance, immediately loading atrophic Class C and Class D maxillae would still be treated with immediate function often with little or no associated bone grafting.[4,6,10] The use of only 4 implants is well founded through the heuristic management of a great number of patients needing complete arch treatment for the maxilla, rendering the use of 6 or 8 implants superfluous in the most patients. This is because the key bone for fixation and the paranasal bone at the pyriform and nasal crest are still commonly present in states of gross atrophy.[4]

The absolute minimum bone mass for vomer implant placement is approximately 5 mm of vertical midline bone, including the nasal crest and basal bone beneath the nose.[13] Angulated implants will be relatively short in this setting at 8 to 10 mm in length, with implants usually touching in the midline near the junction of the vomer and nasal crest. Care should be taken to avoid perforating the nasal fossa more than 1 mm.[4,13]

The clinician must understand the importance of V-angled treatment for the maxilla in the highly atrophic state when immediate function is desirable and alternative sites are largely exhausted for primary fixation of implants. A V-4 approach is also important to consider because often elderly patients can be treated without resorting to greater surgical intervention such as sinus floor grafting followed by placement of multiple implants in a delayed placement strategy.[14] The counterintuitive economy of surgery using the V-4 approach may be difficult to fathom for the surgeon who is well familiar with augmentation bone grafting, but like many other advances in medical science, a small diversion from an accepted paradigm sometimes leads to simpler, less invasive treatment. The question is, will this relatively minimally invasive approach stand up to biomechanical scrutiny as well as provide long-term implant survival?

A biomechanical analysis of the V-4 approach based on increased A-P spread of a 4-implant scheme satisfies the favorable mechanics of the Skalak-Brunski model originally applied to the 6-implant bone-anchored fixed prosthesis. Since the equation was first proposed, it has been applied favorably to angled implant placements and the use of the M-4 distribution for the maxilla.[1] Angulated implants are longer than vertically placed implants and therefore provide greater intraosseous surface area for secondary stabilization, working in conjunction with extraosseous stabilization provided by crossarch splinting.[4] Though the V-4 is slightly different from the M-4, the distribution and positioning of the implants in terms of A-P spread are about the same.[4,12] The recommended A-P spread is approximately 15 mm.[4] By using midline cortical bone, anterior implant positions are well fixed. It is then left for the posterior implants to provide the ultimate spread and distribution.

The use of 2 zygomatic and 2 vomer implants is an excellent way to treat a patient with a Class D maxilla if there is little or no lateral pyriform rim present.[4,6,10] Pterygoid implants can sometimes be added to create a 6-implant scheme: 2 vomers, 2 zygomatic, and 2 pterygoid implants, although this may not be necessary.[6] The use of pterygoid and vomer implants alone results in an excessive span to be serviceable prosthetically.

When both the nasal crest bone mass (V-point) and lateral pyriform rim bone mass (M-point) are absent, quad zygomatic treatment can be considered.[1,3] However, the quad zygomatic implant concept has little exposure at this time in research reports, with only a few surgeons experienced in the technique; as such, it should probably be limited in its use. Surgeons may instead prefer either sinus bone grafting with delayed implant placement and therefore delayed loading or the use of BMP-2/ACS as dependable sinus graft material for trans-sinus implant placement for immediate function.[3]

The findings of the present study are encouraging for settings of moderate to profound maxillary atrophy in which immediate function is desirable. By using midline or nasal crest bone, 2 anterior implants can usually be placed, which largely determines the capacity for immediate function for all-on-four therapy. However, more study of this technique is needed to delineate limitations and long-term stability, particularly for 4 implants placed into highly limited bone mass when immediately loaded.

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Corresponding author:
Dr Ole T. Jensen
Private practice
13 Cherry Hills Farm Drive
Englewood, CO 80113
Email: oletjensen13@gmail.com