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Pterygoid Implant-Based "VIV" Design for Rehabilitation of Extreme Maxillary Atrophy

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Abstract: Rehabilitation of severe maxillary atrophy using implant-supported fixed prostheses is challenging due to limited bone volume. Although the all-on-4 concept offers a potential treatment option, sufficient residual bone in the anterior region remains a prerequisite for these prostheses. Pterygoid implants have been used in conjunction with the all-on-4 technique to eliminate the cantilevered prosthetic design, with good long-term results reported. However, when the bone volume in the anterior region is limited or the bucco-palatal dimension is insufficient, use of the traditional all-on-4 approach is problematic. This article describes the clinical management and good short-term success achieved in the treatment of severe maxillary atrophy with a novel "VIV" design, using a combination of 3 anterior and 2 pterygoid implants.

Key Words: "VIV" design, maxillary atrophy, pterygoid implants

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With the advent of implant dentistry, graftless solutions for the rehabilitation of severe maxillary atrophy are widely accepted.[1] In comparison to traditional methods, including alveolar reconstruction with bone blocks,[2] graftless solutions significantly reduce treatment costs and patient morbidity, and can be used to shorten the duration of edentulous conditions through immediate loading.

The all-on-4 concept introduced by Malo[3] was the most popular graftless solution for the rehabilitation of extremely resorbed jaws. Placement of 4 implants in the anterior region of each jaw could help achieve fixed restoration for edentulous patients. Characteristics of the all-on-4 concept include angled implants, a cantilevered prosthetic design, and immediate loading in the presence of adequate primary implant stability.[4] Numerous papers have reviewed the high long-term success rate associated with this technique.[5] However, a predictable result using the all-on-4 concept relies on sufficient bone in the anterior region to restrict the length of the distal cantilever.[6] A longer cantilever increases the risks for both biological and mechanical complications.[7] To reduce the length of the cantilever, a prosthetic design based on the shortened dental arch concept was proposed[8]; however this, could adversely affect chewing efficiency and is poorly accepted by some, particularly younger patients.[9] To account for insufficient anterior bone and eliminate the need for a cantilevered restoration, the placement of supplemental zygomatic[10] or pterygoid implants[11] is required.

Pterygoid implant placement is far less invasive than zygomatic implant placement. Pterygoid implants are longer than conventional dental implants as they need to be inserted through the maxillary tuberosity and pyramidal process of the palatine bone to engage with the pterygoid process of the sphenoid bone.[12] When used to complement the all-on-4 technique, 1 pterygoid implant placed in the posterior region of each half of the maxilla eliminates the need for distal cantilevers, extends the range of the posterior occlusion, allows for full-arch rehabilitation, and minimizes complications of the prosthetic design.

Despite the predictable long-term results observed in the restoration of a full dental arch using a 6-implant-supported fixed bridge,[13] for some patients presenting with extreme bone resorption, the bucco- palatal bony dimension in the maxillary anterior region is insufficient to allow for implant insertion, including that with the smallest diameter.[14] Further, the residual bone in the anterior region may fail to meet the critical between-implant distance for 4 implants.

Thus, herein, we describe the use of a novel "VIV" implant placement design concept for the full-arch rehabilitation of severely atrophic maxillae using a combination of 3 anterior and 2 pterygoid implants.

MATERIALS AND METHODS

Unintentional "VIV" Design

A 60-year-old male patient required a fixed prosthetic solution for his maxilla and demanded immediate loading. He presented with no remarkable systemic problems and medical history. Clinical examination showed a terminal maxillary dentition and cone beam computed tomography (CBCT) revealed severe alveolar resorption and progression of maxillary sinus pneumatization. Despite sufficient bone height in the anterior region, CBCT revealed a limited bucco-palatal bone width (Fig. 1A).

Following discussion with the patient, a treatment plan involving the placement of 6 implants was proposed, incorporating the use of 2 pterygoid implants in conjunction with the all-on-4 approach for full-arch rehabilitation and immediate loading. Due to the limited bone width, 2 narrow-diameter

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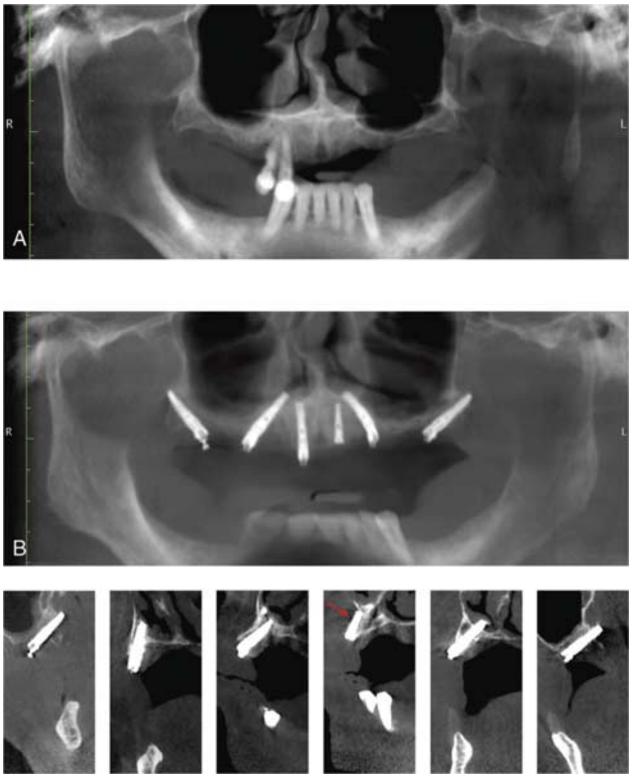

FIGURE 1. (A) Preoperative CBCT depicting severe resorption of all alveolar maxillary bone and substantial pneumatization of the maxillary sinus. The volume of the residual bone was inadequate to accommodate standard implants. (B) CBCT immediately post-surgery. All implants were well positioned, excluding #B2. The red arrow indicates the buccal bone loss associated with this implant. CBCT, cone beam computed tomography.

implants were planned in the anterior-most region to avoid bone grafting and reduce morbidity.

Under local anesthesia, the remaining maxillary teeth were extracted. Once the gingival flap was raised, the alveolar bone was exposed and flattened. Two types of implants were used in this case, including NobelActive (Nobel Biocare AB, Göteborg, Sweden) and I5 (AB Dental Implants, Ashdod, Israel). The implants were inserted as planned (ie, from the upper right posterior region to the upper left posterior region as follows: #A7, NobelActive 4.3*18; #A5, I5 4.2*16; #A2, I5 3.5*16; #B2, I5 3.5*13; #B5, I5 4.2*16; #B7, NobelActive 4.3*18). However, 1 implant in the middle anterior region did not achieve ideal primary stability. Cone beam computed tomography demonstrated a loss of buccal bone surrounding this implant (Fig. 1B). Immediate loading was fulfilled using an acrylic resin restoration supported on only 5 implants (Fig. 2A). Healing progressed uneventfully during the provisional restorative phase. The final, fixed dental bridge, which was designed to be supported on the 5 implants and constructed with a pure titanium substructure, achieved perfect passive fit before occlusal adjustment (Fig. 2B). Follow-up after 2 years of functional loading demonstrated ideal peri-implant bone stability (Fig. 2C).

Intentional "VIV" Design

Since the short-term success of the "VIV" design was confirmed in the previous case, we applied this concept in other clinical cases.

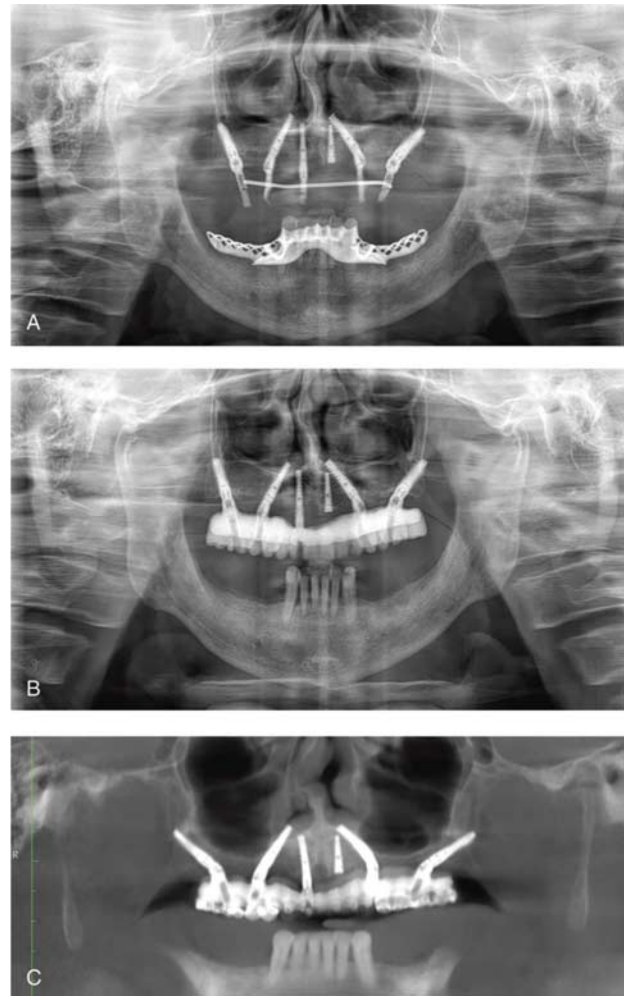

FIGURE 2. (A) At immediate restoration delivery, a panoramic x-ray showed good fit of the implant-prosthetic connections. (B) At final restoration delivery, a panoramic x-ray showed good fit of the implant-prosthetic connections and crestal bone stability. (C) Two years after placement of the final restoration and functional loading, CBCT demonstrated ideal crestal bone stability and no bone loss. CBCT, cone beam computed tomography.

A 58-year-old male patient with a terminal maxillary dentition requested a fixed prosthetic replacement. The patient reported no surgical contraindications and had previously received dental implants in his mandible. Cone beam computed tomography identified inadequate bone volume in the right anterior region, indicating a high risk of implant failure. The treatment plan included the placement of 3 implants in the anterior region and 2 pterygoid implants (I5; AB Dental Implants, Ashdod, Israel). Under local anesthesia, the residual maxillary teeth were extracted, and a full-thickness gingival flap was raised to expose the alveolar bone. The poor condition of the alveolar bone in the right anterior region was evident. Five implants were inserted, excluding the right anterior region (ie, from the upper right posterior region to the upper left posterior region as follows: #A7, I5 4.2*16; #A5, I5 3.75*16; #B2, I5 3.75*13; #B5, I5 4.2*16; #B7, I5 4.2*16). The 3 anterior implants were placed according to the bone morphology, whereas the 2 pterygoid implants were inserted at approximately 70° relative to the occlusal plane (Fig. 3A). All implants achieved primary stability >45 N cm, and an immediate prosthesis was fitted on the 5 implants (Fig. 3B-C). After 4 months, a composite resin,

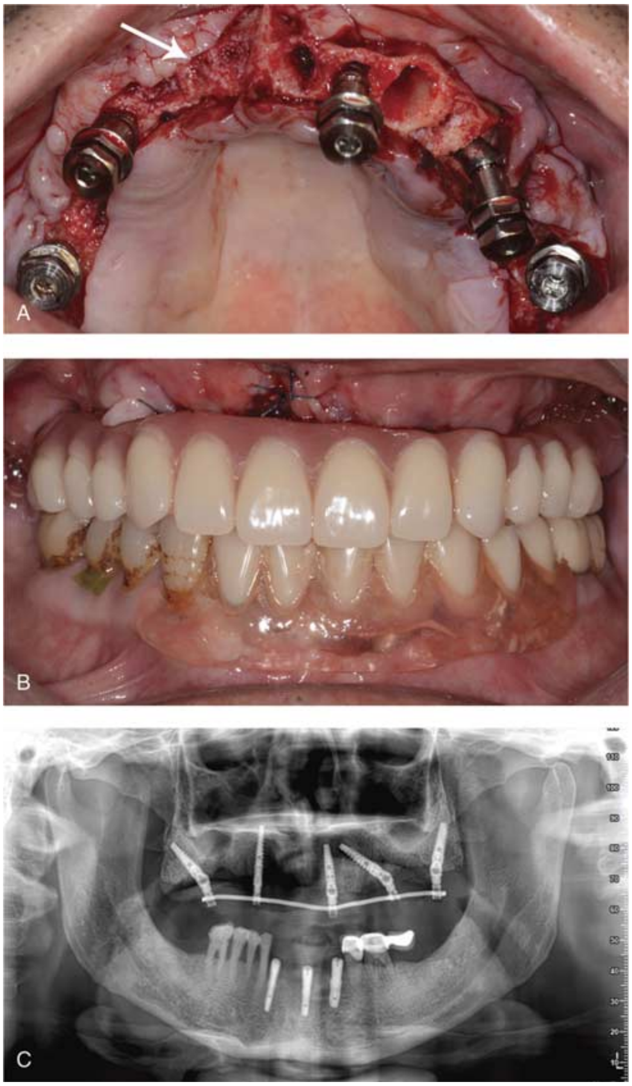

FIGURE 3. (A) All implants were inserted as outlined in the treatment plan. The 70° angulation of the pterygoid implants relative to the occlusal plane is clearly evident. The white arrow indicates the region of poor bone volume. (B) Intraoral photograph depicting immediate loading of the implants with a provisional, fixed prosthesis. (C) At immediate restoration delivery, a panoramic x-ray showed good fit of the implant-prosthetic connections.

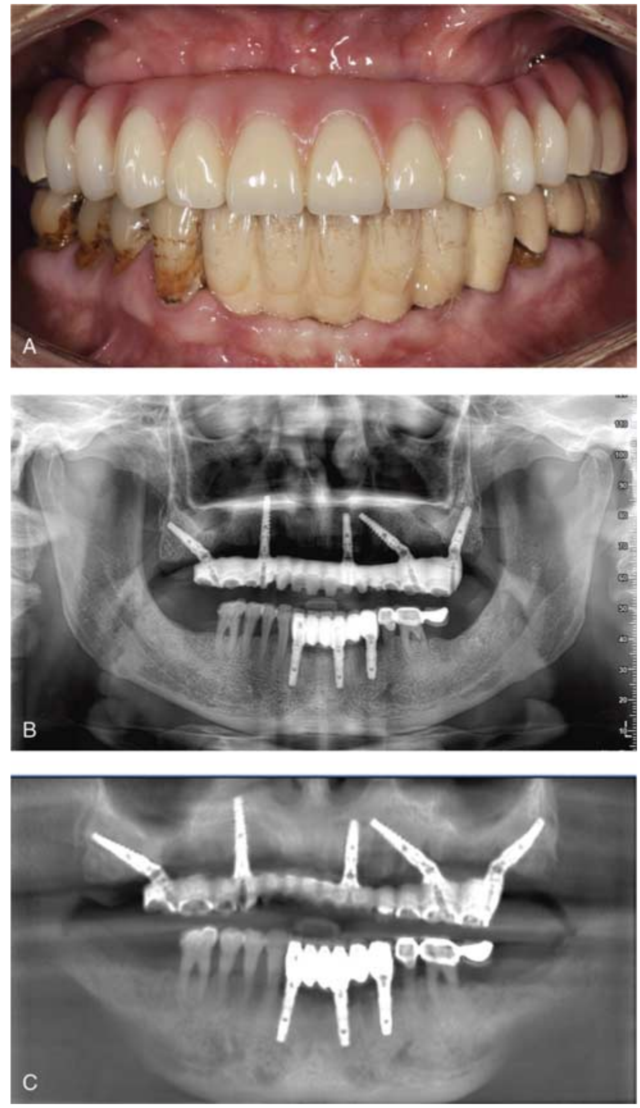

FIGURE 4. (A) Intraoral photograph of the final restoration at delivery to the patient. (B) At final restoration delivery, a panoramic x-ray showed good fit of the implant-prosthetic connections and crestal bone stability. (C) One year after placement of the final restoration and functional loading, CBCT demonstrated ideal crestal bone stability and no bone loss. CBCT, cone beam computed tomography.

titanium-reinforced definitive prosthesis was delivered to the patient (Fig. 4A-B). No complications occurred during treatment or follow-up. At the 1-year follow-up appointment, the soft-tissue contours and crestal bone levels were stable, with no apparent significant clinical or radiographic changes (Fig. 4C). The patient was satisfied with both the function and aesthetics of the rehabilitation.

RESULTS

The patients are pleased with the good results when receiving "VIV" implant design concept.

DISCUSSION

The pterygoid implant was first introduced in 1974[15] and indicated for rehabilitation of severe maxillary atrophy. However, after their advent, surgeons favored zygomatic implants as the dense bone of the zygoma would allow for more predictable

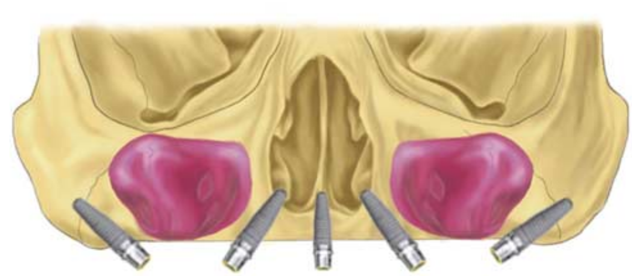

FIGURE 5. Diagrammatic representation of the "VIV" implant placement design for the severely atrophic maxilla.

outcomes compared to those of pterygoid implants that are inserted through and seated predominantly within the maxillary tuberosity with low bone density.[16] Low bone density was thought to decrease the success rate of pterygoid implants. However, numerous studies have reported on the high success rate of these implants.[17,20] Implant engagement with the pterygoid process of the sphenoid bone with the longer pterygoid implants substantially improves implant stability, compared with conventional implants placed in the maxillary tuberosity. The angulated path of insertion used for pterygoid implants maximizes implant-bone contact; these factors contribute to the high success rate of pterygoid implants.

The "VIV" implant design involves the placement of 1 implant in the midline, 2 tilted premaxillary implants (inserted into the M-point)[21] and 2 pterygoid implants in the posterior region (Fig. 5). In contrast to the all-on-4 concept alone, the addition of 2 pterygoid implants when using the "VIV" design eliminates the need for a distal cantilever, whereas the midline implant reduces the number of unsupported medial pontics. Typically, when the maxillary dental arch is reconstructed using 4 or 6 implants, low stress distribution is noted in the region of the 2 anterior implants.[22] Consequently, placing only 1 anterior implant in the midline is unlikely to lead to overloading.

The 2 clinical cases presented herein describe the short-term success of the "VIV" implant placement design in rehabilitation of severe maxillary atrophy. Although this is the first report to document the use of the "VIV" design in the maxilla, the use of 3 implants to restore the edentulous, atrophic mandible has proven successful over the middle-term.[23] These reports provided the foundation on which the novel "VIV" implant design concept was conceived.

From a surgical perspective, implant placement in the anterior maxilla is frequently complicated by inadequate bone width, leading to the use of small-diameter implants with unpredictable results. However, when only 1 implant needs to be inserted in the midline, the incisive canal or surrounding bone could prove ideal for wide-diameter implant placement[24]; this should be investigated further.

CONCLUSIONS

The novel "VIV" implant placement technique is effective in the clinical management of the extremely atrophic maxilla over the short-term. It minimizes complications inherent to the traditional approach, and is well-accepted and minimally invasive.

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