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

Jie Ren, PhD,* and Ling Shu, SMM†

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

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 Malo3 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 proposed8; 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 zygomatic10 or pterygoid implants11 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 implants were placed through the maxillary tuberosity and the pyramidal process of the sphenoid bone. Due to the high risk for biomechanical complications, the pterygoid implants were used in conjunction with 4 conventional implants placed in the anterior region, with implants in the posterior region placed at a 45° angle to engage with the palatine bone to engage with the pterygoid process of the sphenoid bone (Fig. 1B).

The authors report no conflicts of interest.

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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.
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 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 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.

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. 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. 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) 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. 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. 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; 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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REFERENCES
1. Busenlechner D, Maiath-Pokorny G, Haas R, et al. Graftless full-arch implant rehabilitation with interanral implants and immediate or delayed loading-part I: reconstruction of the edentulous maxilla. Int J Oral Maxillofac Implants 2016;31:900–905
2. Hernández-Alfaro F, Sancho-Puchades M, Guijarro-Martínez R. Total reconstruction of the atrophic maxilla with intraoral bone grafts and biomaterials: a prospective clinical study with cone beam computed tomography validation. Int J Oral Maxillofac Surg 2013;28:241–251
3. 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 1:88–894
4. Ho CC, Jovanovic SA. The “All-on-4” concept for implant rehabilitation of an edentulous jaw. Compend Contin Educ Dent 2014;35:255–259
5. Malo P, de Araújo Nobre M, Lopes A, et al. A longitudinal study of the survival of All-on-4 implants in the mandible with up to 10 years of follow-up. J Am Dent Assoc 2011;142:310–320
6. Jensen OT. Complete arch site classification for all-on-4 immediate function. J Prosthodont 2014;112:741.e2–751.e2
7. Kim P, Ivanovski S, Latcham N, et al. The impact of cantilevers on biological and technical success outcomes of implant-supported fixed partial dentures. A retrospective cohort study. Clin Oral Implants Res 2014;25:175–184
8. Fueki K, Baba K. Shortened dental arch and prosthetic effect on oral health-related quality of life: a systematic review and meta-analysis. J Oral Rehabil 2017;44:563–572
9. Manola M, Hussain F, Millar BJ. Is the shortened dental arch still a satisfactory option? Br Dent J 2017;223:108–112
10. Davo R, Felice P, Pistilli R, et al. Immediately loaded zygomatic implants vs conventional dental implants in augmented atrophic maxillae: 1-year post-loading results from a multicentre randomised controlled trial. Eur J Oral Implants 2018;11:145–161
11. Balaji VR, Lambodharan R, Manikanand D, et al. Pterygoid implant for atrophic posterior maxilla. J Pharm Bioallied Sci 2017;9:S261–S263
12. Graves SL. The pterygoid plate implant: a solution for restoring the posterior maxilla. Int J Periodontics Restorative Dent 1994;14:512–523
13. Mertens C, Steveling HG. Implant-supported fixed prostheses in the edentulous maxilla: 8-year prospective results. Clin Oral Implants Res 2010;22:464–472
14. Katsoulis J, Enkling N, Takechi T, et al. Relative bone width of the edentulous maxillary ridge. Clinical implications of digital assessment in presurgical implant planning. Clin Implant Dent Relat Res 2012;14 Suppl 1:e213–e223
15. Linkow LI. The pterygoid extension implant for the totally and partially edentulous maxillae. Int J Orthod 1974;12:9–19
16. Maló P, de Araújo N, Miguel LA. Extramaxillary surgical technique: clinical outcome of 352 patients rehabilitated with 747 zygomatic implants with a follow-up between 6 months and 7 years. Clin Implant Dent Relat Res 2015;17 Suppl 1:e153–e162
17. Riddell A, Gröndahl K, Semmer L. Placement of Branemark implants in the maxillary tuber region: anatomical considerations, surgical technique and long-term results. Clin Oral Implants Res 2009; 20:94–98
18. Candel E, Penarrocha D, Penarrocha M. Rehabilitation of the atrophic posterior maxilla with pterygoid implants: a review. J Oral Implants 2012;38:461–466
19. Rodríguez X, Méndez V, Vela X, et al. Modified surgical protocol for placing implants in the pterygomaxillary region: clinical and radiologic assessment in 454 implants. J Oral Maxillofac Implants 2012;27:1547–1553
20. Curi MM, Cardoso CL, Ribeiro Kde C. Retrospective study of pterygoid implants in the atrophic posterior maxilla: implant and prosthesis survival rates up to 3 years. Int J Oral Maxillofac Implants 2015;30:378–383
21. Jensen OT, Cottam JR, Ringeman JL, et al. Trans-sinus dental implants, bone morphogenetic protein 2, and immediate function for all-on-4 treatment of severe maxillary atrophy. J Oral Maxillofac Surg 2012;70:141–148
22. Bhering CL, Mesquita MF, Kemmoku DT, et al. Comparison between all-on-four and all-on-six treatment concepts and framework material on stress distribution in atrophic maxilla: a prototyping guided 3DFEA study. Mater Sci Eng C Mater Biol Appl 2016;69:715–725
23. Higuchi K, Rosenberg R, Davó R, et al. A prospective singlecenter multicenter study of an innovative prefabricated three-implant-supported full-arch prosthesis for treatment of edentulous mandible: 2-year report. Int J Oral Maxillofac Surg 2020;35:150–159
24. de Mello JS, Faot F, Correa G, et al. Success rate and complications associated with dental implants in the incisive canal region: a systematic review. Int J Oral Maxillofac Surg 2017;46:1584–1591