Case Report

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Trans-sinus dental implants, for immediate placement when insufficient alveolar height is present: an alternative to zygomatic implants – surgical case series

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Abstract

Low maxillary bone density associated with physiological bone remodeling and resorption accelerated by the presence or history of periodontal disease can prevent implant placement without either ridge and/or sinus augmentation in atrophic maxillary edentulous cases. As an alternative to avoid bone grafting and provide immediacy in restorative treatment care for the patient, remote anchorages to the basal bones of the maxilla of the patient are being used with zygomatic or pterygoid implants. The trans-sinus implant, when indicated can offer a reliable alternative to the zygomatic dental implant in that treatment of the severely edentulous maxilla. This approach is suggested in Bedrossian zones I and II atrophy and when an 'L' (or concave) anterior sinus wall anatomy is present. This approach will be discussed utilizing two case examples on how trans-sinus implants may be considered in treating the maxillary arch.

Keywords: Bedrossian zones, implant, maxillary sinus, ridge resorption, sinus pneumatization, transnasal

Low maxillary bone density associated with physiological bone remodeling and resorption accelerated by the presence or history of periodontal disease can prevent implant placement without either ridge and/or sinus augmentation in atrophic maxillary edentulous cases. As an alternative to avoid bone grafting and provide immediacy in restorative treatment care for the patient, remote anchorages to the basal bones of the maxilla of the patient are being used with zygomatic or pterygoid implants. Bedrossian has proposed a classification helping the practitioner to identify the different remaining osseous structures of the maxilla and has divided them into four zones (Fig. 1)[1,2]. The maxilla is divided into different zones with Zone I – canine to canine, Zone II – the bicuspids, Zone III – the molars and Zone IV – the zygomatic area. The Bedrossian classification provides a guideline for which surgical approach may be utilized on that patient by reviewing their panoramic radiograph.

When bone is available only in the zone 1, meaning that the premolar and molar zones (II and III) are deficient and only bone is available in the intercanine zone, Zygomatic dental implants are indicated.

Even that recently, their clinical utilization has steadily increased, zygomatic implant surgery is a complex process that must be performed by experienced and trained practitioner. They are technique sensitive and can be associated with significant morbidity and often do not allow revision in treatment in case of complication[3–5].

For those limiting factors, practitioners have been looking into alternative treatment modality allowing for immediacy in restorative treatment care while providing adequate anterior posterior spread of the dental implants and avoid the delayed and

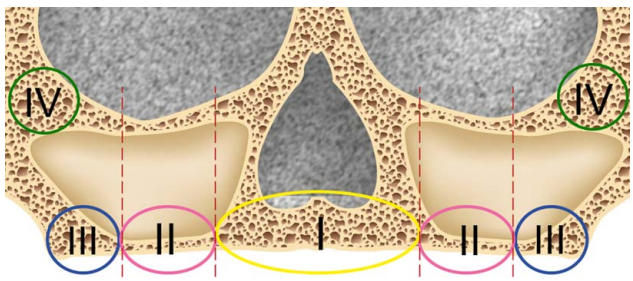

Figure 1. The Bedrossian zone classification of the maxilla (zone I = premaxilla, zone II = premolars, zone III = molars, and zone IV = zygomatic process).

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This article is to educate practitioners on an alternative to zygomatic implants in the resorbed maxilla using two cases to demonstrate its use.

Sponsorships or competing interests that may be relevant to content are disclosed at the end of this article.

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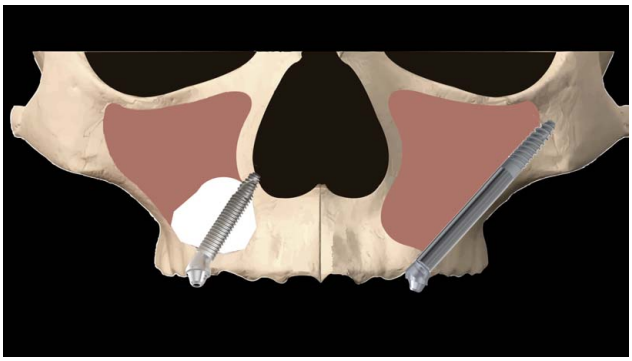

Figure 2. Illustration of trans-sinus implant placement (left) compared to zygomatic implant placement (right) and the associated anatomy.

grafting procedure for the patient. The trans-sinus implant (Ole Jensen, Paolo Malo, etc.) when indicated properly can offer a reliable alternative to the zygomatic dental implant in that treatment of the severely edentulous maxilla. This approach is suggested in Bedrossian zones I and II atrophy and when an 'L' (or concave) anterior sinus wall anatomy is present[6]. This approach does require a minimum of 3–5 mm of crestal bone height for initial stabilization of the implant at placement. Cross arch stabilization with other implants in the maxilla is required so this is a consideration for full arch cases when treatment planning as an alternative to use of zygomatic implants[7]. This may also be considered as a rescue implant when a standard tilted implant has failed in the premolar region.

The trans-sinus implant angles the implant from the crest in a mesial direction, through the sinus to have its apical portion anchored in the piriform rim of the lateral nasal wall bone (Fig. 2). A lateral sinus window is created and the Schneiderian membrane is elevated in the anterior aspect of the maxillary sinus prior to osteotomy creation in preparation for implant placement. The osteotomy will transverse the elevated sinus so that upon insertion of the implant, the apical portion is within bone as well as the crestal portion of the implant. Osseous graft material is then placed over the exposed implant within the sinus prior to site closure.

This technique should be considered as the first choice of treatment option when indicated due to some clinical advantages to utilization of zygomatic implants. There is less

Figure 3. Panoramic radiograph pretreatment with floor of the maxillary sinus outlined (red) demonstrating insufficient alveolar height to support implant placement without sinus augmentation and delayed implant placement.

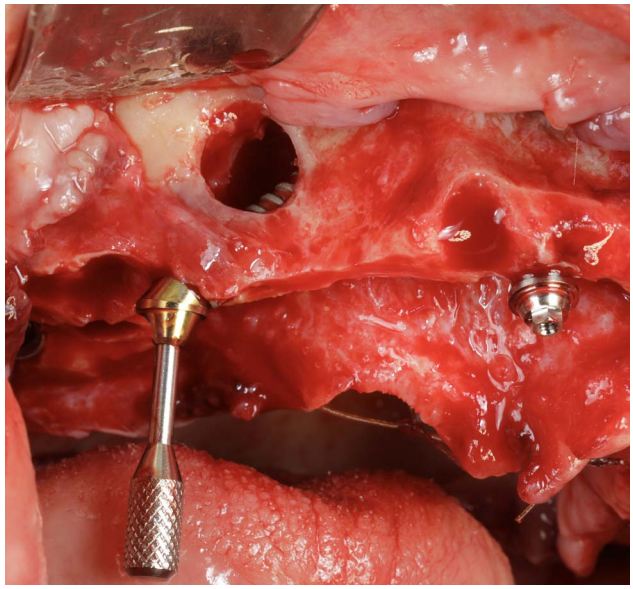

Figure 4. Placement of the implant with a trans-sinus approach following a lateral window approach and Schneiderian membrane elevation.

surgical morbidity and is similar to a standard lateral sinus approach[8]. Potential complications compared to zygomatic implants are reduced as is surgical trauma to the patient during surgery and during the postoperative period[9,10]. The implant platform can be positioned at the mesial portion of the first molar or at the second premolar depending on the A-P spread required for proper posterior support. The trans-sinus implant crestal position also can provide better posterior support between a pterygoid implant and one placed at the canine area on a full arch reconstruction. Additionally, the apical portion of the trans-sinus implant is fixated into the nasal rim allowing good primary stability of the implant at placement with engagement of the implant into three cortexes (crestal, sinus wall, and nasal wall). This permits immediate function as a preferred treatment modality when splinted to implants in the full arch. The trans-sinus technique does require implants with an average length of 20–25 mm so that the apical is able to engage the nasal wall. The surgical technique does require surgical experience/skill and is restricted due to specific anatomical requirement based on the shape of the sinus.

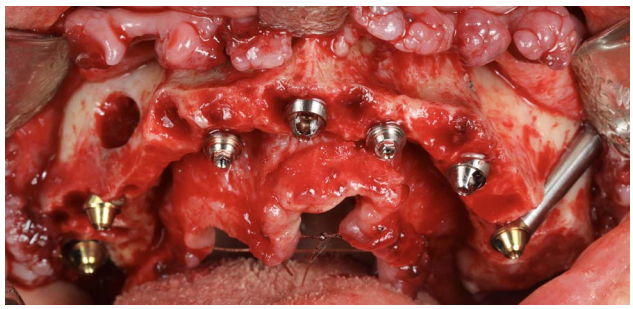

Figure 5. Following trans-sinus implant placement on the right quadrant and zygomatic implant placement in the left quadrant.

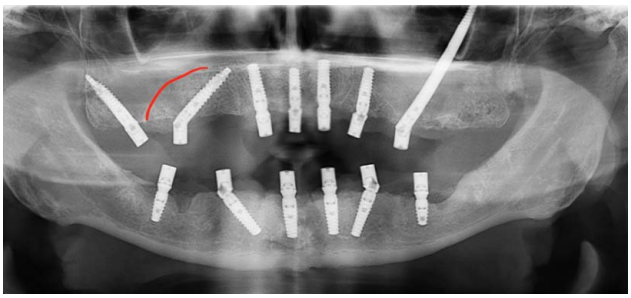

Figure 6. Panoramic radiograph following implant placement with a pterygoid implant in the posterior right, trans-sinus implant in the right quadrant (sinus augmentation outlined in red), anterior implants in the premaxilla and zygomatic implant in the left quadrant.

Case 1I

A 75-year-old male American Society of Anesthesiologists II patient presented with terminal dentition related to periodontal and structural conditions of the remaining dentition. The patient presented requesting a fixed approach to replacing the failing dentition in both arches and wished to avoid anything removable during the healing period. Upon radiographical examination (panoramic and cone beam computed tomography evaluation), only Bedrossian zone I and partially zone II had sufficient bone to receive dental implants without extensive sinus augmentation and delayed implant placement. Remote anchorage implantology was indicated to provide the patient with immediacy of treatment care and avoid removable provisionals during treatment. The right quadrant radiographically presented with a 'L' concave shape of the anterior wall of the sinus and suited for use of a trans-sinus implant (Fig. 3). The left quadrant had a greater volume of bone on the medial aspect of the sinus and was treatment planned for a zygomatic implant to be placed in its ZAGA 2 bone.

Consent forms were reviewed and signed by the patient. Local anesthetic was administered to the maxillary arch from tuberosity to tuberosity in the buccal vestibule and palatal aspects of the arch. The remaining dentition were extracted and a crestal incision made and a full thickness flap was elevated to expose the buccal ridge to the inferior border of the zygomas bilaterally. A lateral sinus window was created on the right and the boney window was carefully removed while keeping the Schneiderian membrane intact without any perforation. The membrane was dissected from the osseous walls of the sinus then lifted anteriorly to the mesial border of the canine pillar, medially to the osseous border and distally to the first molar area (Fig. 4). The extended

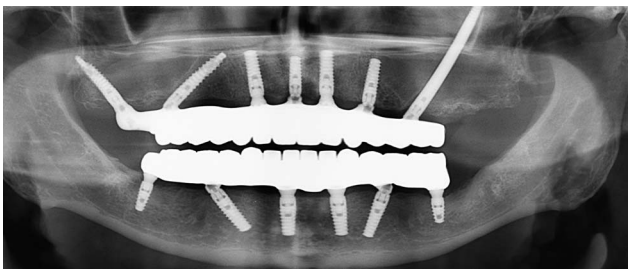

Figure 7. Panoramic radiograph following restoration with final hybrid prosthesis.

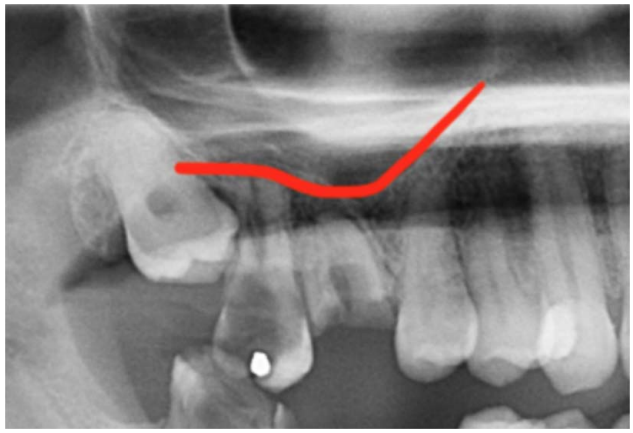

Figure 8. Pretreatment radiograph demonstrating pneumatization of the maxillary sinus with failing dentition.

sinus reflection allows for safe osteotomy preparation without the risks of tearing the membrane. Standard sinus augmentation with an allograft or other appropriate osseous graft material can take place. An effort to reach as distal as possible with the augmentation is performed. This allows grafting of the remaining sinus cavity subsequent to placement of the implant into the osteotomy in order to develop the edentulous area for the placement of future implants in the case of failure or revisions that may be needed in the future.

The implant osteotomy follows the long axis of the canine pillar, through the crest, transversing the sinus cavity, engaging the cortex of the anterior wall of the sinus and finally anchoring into the cortex of the nasal floor. With engagement of the three cortexes primary stability for the implant is provided, allowing for placement of multiunit abutments (MUAs) to correct the angulation of the angled trans-sinus implants and fabrication of an immediate load provisional prosthesis. Typically, 30° MUA are the most common size used in this technique.

Trans-sinus placement followed with primary stability exceeding 50 Ncm, and implants were placed at the other planned sites on the arch (Fig. 5). MUAs were connected to the implants and the patient was restored with an immediate screw retained

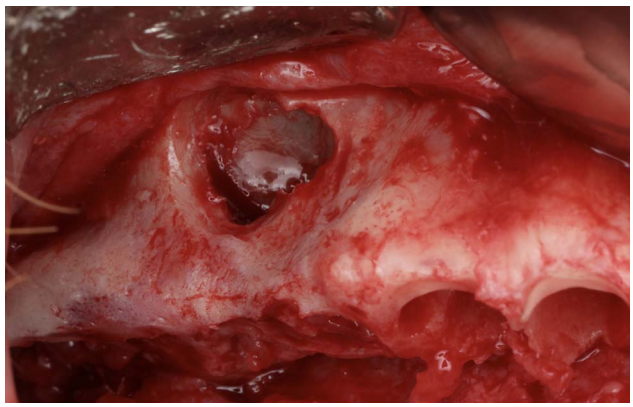

Figure 9. Following extraction of the failing dentition and placement of a lateral window into the maxillary sinus with elevation of the Schneiderian membrane in preparation for immediate trans-sinus implant preparation.

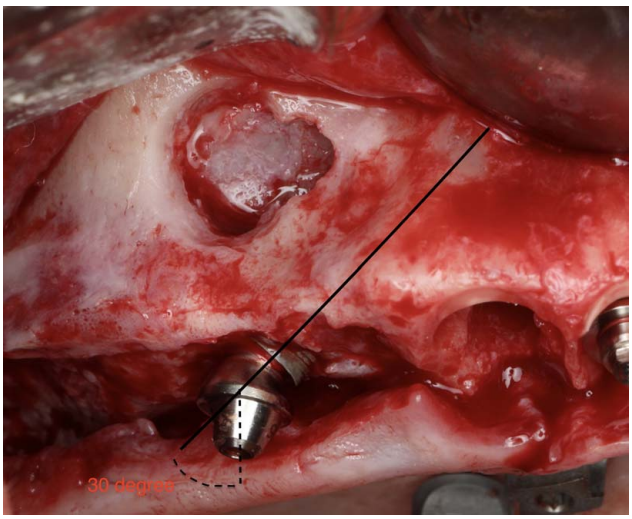

Figure 10. Line indicating the angulation of the implant placed to transverse the mesial of the sinus and have its apex engage the medial nasal wall with an angled multiunit abutment on the implant to parallel it to the other implants that had been placed.

provisional prosthesis (Fig. 6).

The final hybrid prosthesis was placed after 6 months on both arches. At 1-year follow up a panoramic radiograph was taken (Fig. 7). This demonstrated implant integration, crestal bone maintenance at the previous levels and the graft could be visualized distal to the trans-sinus implant that had been placed and induction for the previous year.

Case 2

A 45-year-old male American Society of Anesthesiologists I patient presented with terminal dentition related to severe dental decay of the remaining teeth. He had been referred for placement of dental implants to replace his failing natural dentition.

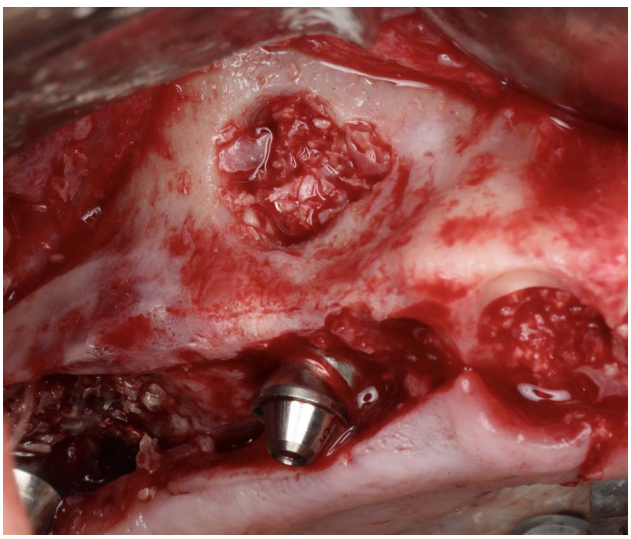

Figure 11. Augmentation of the maxillary sinus to cover the portion of the implant sitting within the sinus not within bone prior to closure, along with socket grafting of the extraction sites.

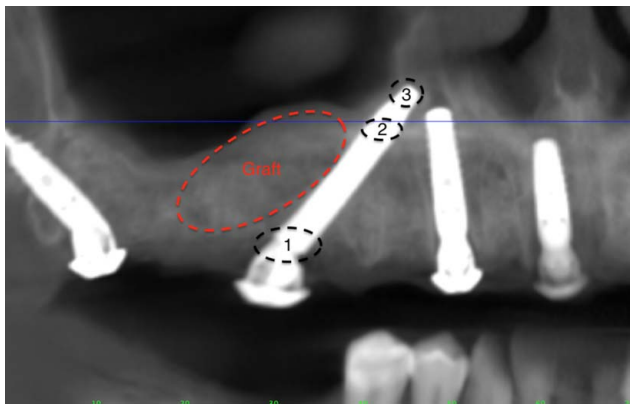

Figure 12. Radiograph of the trans-sinus implant and the associated graft placed within the maxillary sinus with points of engagement with the three cortices.

Upon radiographical examination, he was found to have adequate bone volume in Bedrossian zones I and II. Adequate bone was noted in the left quadrant for placement of a standard tilted implant mesial to the anterior wall of the sinus. In the right quadrant adequate bone volume was available only in the Zone I. Sinus anatomy analysis revealed a deep mesial concavity indicating the use of a trans-sinus as an alternative to usage of a zygomatic implant (Fig. 8). This was the preferred treatment modality chosen principally due to the patients young age and the possible need of revision in the future as the patient reached an older age.

Consent forms were reviewed and signed by the patient. A surgical approach and steps following those used in case 1 were utilized. The lateral sinus window was created to allow access to the mesial portion of the maxillary sinus (Fig. 9). The implant was placed in the posterior right, angled mesially to engage the cortices for a trans-sinus implant (Fig. 10). Allograft was placed into the sinus filling the elevated area, covering the portion of implant transversing the sinus to encase the entire implant in bone once healing had completed (Fig. 11). Additional allograft was placed into the extraction sockets. To achieve wider A-P spread and eliminate cantilever use, pterygoid implants were added bilaterally as well as implants in the anterior (Bedrossian zone I). Radiographs were taken to document implant placement in relation to the anatomy and the grafted sinus (Fig. 12). It is noted that the trans-sinus implant engages the three-cortex providing immediate stability for provisional restoration placement while splinted to the other implants across the arch. A panoramic radiograph following full arch implant placement with pterygoid implants (bilateral), a trans-sinus on the right, anterior implants

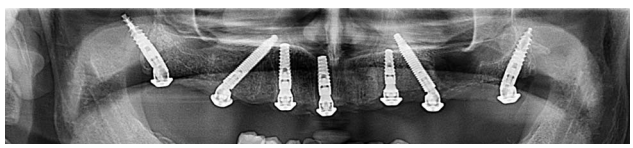

Figure 13. Radiograph following full arch implants with pterygoid implants (bilateral), a trans-sinus on the right, anterior implants in the premaxilla, and a tilted implant on the left to bypass the sinus.

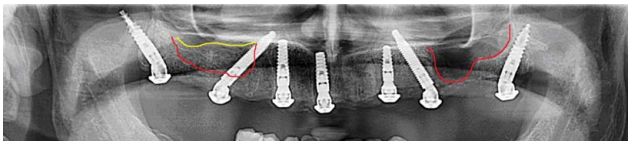

Figure 14. Panoramic radiograph following implant placement demonstrating the implants in the posteriors bilaterally in relation to the sinus floor prior to surgery (red) and level of graft placement (yellow).

in the premaxilla, and a tilted implant on the left to bypass the sinus (Fig. 13). The sinus floor and medial wall can be noted in the radiograph bilaterally (red line) as well as the new sinus floor on the right following placement of the sinus augmentation (yellow line) (Fig. 14). A polymethyl methacrylate provisional hybrid prosthesis was fabricated (Fig. 15) and seated intraorally on the MUA's that had been placed on the implants. A panoramic radiograph was taken to verify seating of the provisional prosthesis (Fig. 16).

Discussion

Utilization with zygomatic dental implants are a resourceful tool to use in the treatment of Bedrossian zone I and II combined edentulism. They provide primary stability, good anterior posterior spread, with a graftless technique reducing treatment time and overall cost are positive attributes to consider when treatment planning cases of severe bone loss in the maxilla. But zygomatic implants also represent a terminal treatment modality for the patient as they block the possibility of revision or change in treatment for the patient should conditions change down the road. For that reason, the trans-sinus technique when indicated represents a valuable alternative as it keeps the door open for the patient for further treatment option in the future should conditions of the implants placed require revision.

Utilization of extended-length angulated trans-sinus implants provides surgical and prosthetic advantages for immediate fixed rehabilitation of the severely atrophic maxilla[11]. The literature

Figure 15. A polymethyl methacrylate hybrid was fabricated as a provisional restoration.

Figure 16. Panoramic radiograph following insertion of the polymethyl methacrylate hybrid provisional to verify seating on the multiunit abutments.

has discussed the need of grafting or not to support trans-sinus implant usage. Jensen has recommended to graft if the residual crestal bone is less than 4 mm[12]. Other studies reported that there was a lower implant survival and poorer clinical results when grafting was not utilized in implants placed in the sinus area[13,14]. Although several studies have reported no difference in survival of trans-sinus implant with or without simultaneous sinus augmentation, planning should consider future potential for revision[15,16]. The authors therefore recommend in the trans-sinus approach discussed with the two cases presented to graft the sinus cavity not only to encase and support the trans-sinus implant but also to develop the site for any potential future revision that may be required. As patient treatment needs evolve as they age, the placement of additional implants in the future should implant failure occur or revision becomes necessary may occur, so the area is ready for those potential occurrences. The grafting also limits further pneumatization of the maxillary sinus providing a better anatomical situation for future implant placement, be it zygomatic or traditional implants.

Additionally, comparing trans-sinus placement to a crestal approach with sinus augmentation where both have 3–5 mm of crestal bone engagement, the trans-sinus implant having its apical terminus in bone at placement permits immediate loading. Whereas, implant placement with a crestal sinus augmentation with similar crestal engagement typically has insufficient stability to permit immediate loading. This approach can be combined with zygomatic or traditional implant placement in the anterior increasing treatment options for immediate loading of the maxillary arch on those cases where significant ridge height has been lost either due to bone resorption, sinus pneumatization or a combination of those.

When deciding treatment options there are some things to consider. Trans-sinus surgery is less traumatic for the patient then placement of zygomatic implants and does not require the high level of surgical skill required for zygomatic implant placement. Surgical placement of the trans-sinus implant is similar to a lateral sinus approach and visualization allows the practitioner to see where the drill is contacting the piriform rim of the lateral nasal wall bone. Potential complications include misjudgment of the depth of the drill when creating the osteotomy in the piriform rim of the lateral nasal wall bone with the resulting perforation into the nasal fossa. To avoid this, use of a panoramic radiograph or cone beam computed tomography is required to be able to measure how thick the lateral nasal wall is when planning the osteotomy. Morbidity is lower than with zygomatic implant placement and comparable to lateral sinus augmentation surgery or a crestal approach.

Conclusion

Trans-sinus implant placement should be considered as an alternative to zygomatic implants when the sinus anatomy permits its

use and 3–5 mm of crestal height remains. This will lower the cost of treatment and decrease potential complications reported with zygomatic implant placement while improving postoperative comfort for the patient during the early healing phase of treatment. The long trans-sinus implants with their engagement of the three cortices', allows when splinted across the arch utilization of immediate provisionalization during the healing phase of treatment. As the advanced surgical skills required for zygomatic implant placement are not required for trans-sinus implant placement, this treatment modality allows more practitioners to add this to their armamentarium. With the less traumatic surgery involved and lower morbidity trans-sinus implant placement will have an easier postoperative experience for the patient.

Ethical approval

All patients signed consent forms prior to any treatment.

Patient consent

Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the Editor-in-Chief of this journal on request.

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Author contributions

Dr A.A.A. treated and documented case 1. Dr A.K.-A. treated and documented case 1. Dr D.Z. treated and documented case 2. Dr S. O. reviewed and edited the draft. Dr D.H. reviewed and edited the draft. Dr G.M.K. wrote the draft and did the literature search.

Conflict of interest disclosure

The authors report no conflict of interests or commercial financial relationship.

Guarantor

Dr Kurtzman is corresponding author.

Provenance and peer review[17]

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References

[1] Bedrossian E. Systematic pretreatment evaluation of the edentulous maxilla. In: Bedrossian E, editor. Implant Treatment Planning For the Edentulous Patient: A Graftless Approach to Immediate Loading. Mosby Elsevier; 2011:pp. 37–40.
[2] Sadowsky SJ, Bedrossian E. Evidenced-based criteria for differential treatment planning of implant restorations for the partially edentulous patient. J Prosthodont 2013;22:319–29.
[3] D'Agostino A, Lombardo G, Favero V, *et al*. Complications related to zygomatic implants placement: A retrospective evaluation with 5 years follow-up. J Craniomaxillofac Surg 2021;49:620–7.
[4] Ramezanzade S, Yates J, Tuminelli FJ, *et al*. Zygomatic implants placed in atrophic maxilla: an overview of current systematic reviews and meta-analysis. Maxillofac Plast Reconstr Surg 2021;43:1.
[5] Krennmair S, Weinländer M, Forstner T, *et al*. The influence of different forms of sinus membrane perforation on the prevalence of postoperative complications in lateral window sinus floor elevation: a retrospective study. Clin Implant Dent Relat Res 2022;24:13–23.
[6] Iwanaga J, Wilson C, Lachkar S, *et al*. Clinical anatomy of the maxillary sinus: application to sinus floor augmentation. Anat Cell Biol 2019;52:17–24.
[7] Agliardi EL, Romeo D, Wenger A, *et al*. Immediate rehabilitation of the posterior maxilla with extensive sinus pneumatization with one axial and one trans-sinus tilted implant: a 3-year clinical report and a classification. J Prosthet Dent 2015;113:163–8.
[8] de Carvalho LP, de Carvalho AM, Francischone CE, *et al*. Biomechanical behavior of atrophic maxillary restorations using the all-on-four concept and long trans-sinus implants: a finite element analysis. J Dent Res Dent Clin Dent Prospects 2021;15:106–110.
[9] Vrielinck L, Moreno-Rabie C, Schepers S, *et al*. Peri-zygomatic infection associated with zygomatic implants: a retrospective longitudinal cohort study. Clin Oral Implants Res 2022;33:405–12.
[10] Sáez-Alcaide LM, Cortés-Bretón-Brinkmann J, Sánchez-Labrador L, *et al*. Patient-reported outcomes in patients with severe maxillary bone atrophy restored with zygomatic implant-supported complete dental prostheses: a systematic review. Acta Odontol Scand 2022;80: 363–73.
[11] Zaninovich M. Clinical guidelines for rehabilitation of the severely atrophic maxilla using extended-length subcrestal angulated implants and modified trans-sinus nasal protocol: a case report. Int J Oral Implantol (Berl) 2020;13:291–8.
[12] Jensen OT, Cottam J, Ringeman J, *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: 141–8.
[13] Lie SAN, Leung CAW, Claessen RMMA, *et al*. Implant survival after graftless sinus floor augmentation in highly atrophic maxillae: a randomized controlled trial in a split mouth study. Int J Implant Dent 2021;7: 107.
[14] Lie SAN, Claessen RMMA, Leung CAW, *et al*. Non-grafted versus grafted sinus lift procedures for implantation in the atrophic maxilla: a systematic review and meta-analysis of randomized controlled trials. Int J Oral Maxillofac Surg 2022;51:122–32.
[15] Maló P, Nobre Md, Lopes A. Immediate loading of 'All-on-4' maxillary prostheses using trans-sinus tilted implants without sinus bone grafting: a retrospective study reporting the 3-year outcome. Eur J Oral Implantol 2013;6:273–83.
[16] Grandi T, Faustini F, Casotto F, *et al*. Immediate fixed rehabilitation of severe maxillary atrophies using trans-sinus tilted implants with or without sinus bone grafting: One-year results from a randomised controlled trial. Int J Oral Implantol (Berl) 2019;12:141–52.
[17] Agha RA, Sohrabi C, Mathew G, *et al*. PROCESS Group. The PROCESS 2020 Guideline: Updating Consensus Preferred Reporting of CasESeries in Surgery (PROCESS) Guidelines. Int J Surg 2020;84:231–5.