



# The severely atrophic maxilla: Decision making with zygomatic and pterygoid dental implants

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## ABSTRACT

The severely atrophic maxilla can present with some challenges during treatment planning with communication between those performing the surgical and prosthetic aspects of the treatment as well as communication with the patient as to what is being suggested for treatment. This article simplifies the communication and understanding of treating the severely atrophic maxilla and based on the Bedrossian classification gives a guideline for the surgical approach to be adapted based on the patient residual anatomy.

## 1. Introduction

A frequent occurrence with patients who have been in a full arch removable maxillary prosthesis is significant alveolar resorption that hampers implant placement. Lack of stimulation within the bone by either teeth or implants results in negative volumetric changes that are complicated in the posterior maxilla by sinus enlargement. Following tooth extraction or periodontal bone loss, a cascade starts of inevitable bone remodeling of the alveolar ridge. This remodeling occurs in a three-dimensional manner with loss to both height and width of the residual ridge resulting in inadequate bone for implant placement without augmentation procedures. When an advanced level of bone resorption has occurred in the maxilla, only a limited number of surgical options are available. Those may include tilted implants to avoid the pneumatized sinuses with a resulting prosthesis with premolar occlusion or significant osseous grafting in those deficient areas to permit implant placement in those areas lacking sufficient bone to house implants. Augmentation procedures add to the treatment time and the cost of the total treatment to achieve implant placement and restoration to return the patient to function. Non-grafting solutions to these clinically challenging situations has been presented which include tilted implants, zygomatic implants and pterygoid implants to utilize what bone volume is present.<sup>1</sup> Zygomatic implants have been in successful use to allow osseous grafting of the maxillary sinus and deficient ridge to be avoided and still permit implant placement in distant available bone.<sup>2,3</sup> Although zygomatic implants are more complex to place and require a higher

surgical skill level, their survival rates are similar to those of standard endosteal implants.<sup>4</sup> Zygomatic implants are useful in treating and managing the severely atrophic maxilla.<sup>5</sup>

Clinical evaluation utilizing panoramic and/or CBCT radiographs of the patient is performed to determine what the volume of bone is present in the areas of missing teeth to allow treatment planning options to treat the patient with an implant based approach. The evaluation needs to include determining the appropriate incisal edge position, need for lip support and the appropriate vertical dimension of occlusion.

Physiological bone remodeling can be associated with genetically low maxillary bone density and is observed at a faster more profound rate than in the mandible. This may be accelerated by traumatic induced resorption (ex: long term denture wear) leading to the bone available in the anterior and posterior areas without augmentation to allow placement of implants. Potential available bone sites are identified using the Bedrossian classification of the maxilla to identify zones that implants may be placed into.<sup>6,7</sup> (Fig. 1) The Bedrossian classification gives a guideline for the surgical approach to be adapted. This is done by reviewing the patient's panoramic radiograph. The maxilla is divided into different zones; Zone I - Between canine to canine, Zone II - bicuspids, Zone III- molars and Zone IV - zygoma. The presence or absence of bone in these zones determines the surgical approach to be adapted.

One of the methods for decision making in the atrophic maxilla is to follow the Bedrossian classification, a radiographic classification based on the systematic assessment of the available bone. This takes into

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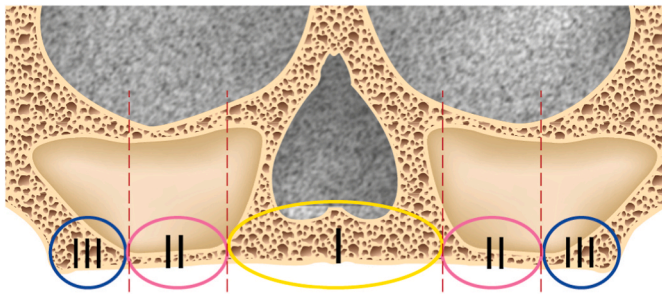
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**Fig. 1.** The Bedrossian zone classification of the maxilla. (Zone I = premaxilla, Zone II = premolars, Zone III = molars and Zone IV = zygomatic process).

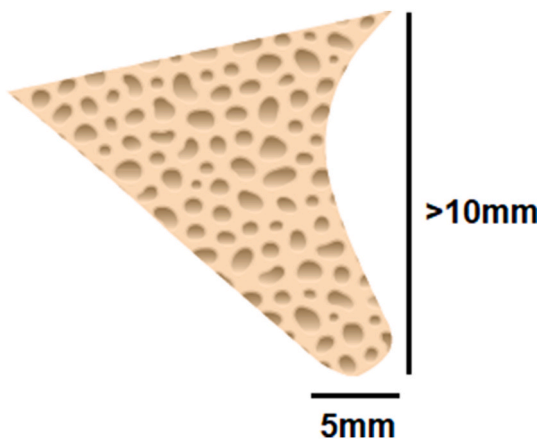
consideration the relationship between the alveolus, nasal floor and the position and size of maxillary sinus. With the Bedrossian zone classification when adequate bone is present that can accommodate implant placement without augmentation, treatment would follow these guidelines. Adequate volume of bone in zones I, II and III would be treated with 4–8 implants placed in an axial (non-angled) direction. When inadequate bone is present in zone III, but is sufficient volume in zones I and II then the ALL-on-X approach would be followed with 4–6 implants placed axially or angled (tilted) achieve the widest arch spread for better A-P ratio. A maxilla that has adequate bone only in zones I and IV with insufficient volume in zones II and III treatment would allow placement of 2–4 implants in zone one and a zygomatic implant bilaterally in zone IV.<sup>8</sup> When bone is also present in zone III, as well as zones I and IV, pteryoid implants can be placed into zone III to augment the implants in zones I and IV.<sup>9</sup> Inadequate bone in zones I and II, without bone augmentation may be treated with dual bilateral (quad) zygomatic implants. When spread of the zygomatic implants in each quadrant has the implant platforms with inadequate spread and sufficient bone is present in zone III, pteryoid implants may be added to increase the A-P spread to allow restoration of the arch.

**2. Zone based treatment planning**

Based on bone availability the severely atrophied maxilla is divided into three types, 1, 2A and 2B.

**2.1. Type 1**

A type 1 maxillary arch presents with a premaxilla (zone II) with a height of 10 mm or greater and a width of 5 mm or greater (Fig. 2). This will allow placement of 2–4 regular platforms axial or tilted (depending on anterior sinus wall proximity) dental implants in the zone I with no



**Fig. 2.** Cross-section of the premolar area of the maxilla (zone II) that presents with 10 mm + height and 5 mm + width for implant placement.

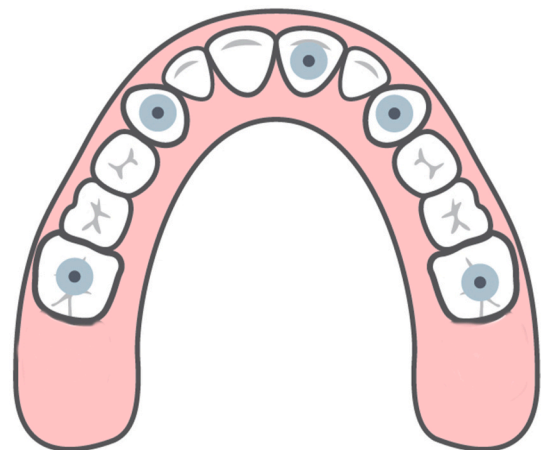
grafting needed as implant can be placed into native bone and no biological complication are expected (no fenestration, dehiscence) requiring grafting. Posteriorly, a single zygomatic implant is placed bilaterally with its platform at the 1st molar position providing a good A-P spread and no distal cantilever prosthetically.<sup>10</sup> (Fig. 3) Those patients with a mandibular 2nd molar or larger arch length, may require a cantilever distal to the zygomatic implant (Fig. 4). When a cantilever is not required, cleansability is greater for the patient than those cases with a cantilever present. The disadvantages to this type approach are the zygoma position at the 1st molar places it in a more vertical orientation with the apical portion of the implant closer to the orbit and blocking the placement of an anterior zygomatic implant if required in the future (Fig. 5). The result provides adequate A-P spread to restore a type 1 resorbed maxillary arch (Fig. 6).

**2.2. Type 2**

The type 2 resorbed maxillary arch is divided into subcategory A and B depending on the degree of resorption. Long-term survival of the anterior implants may be questionable due to the native anatomical limitations related to the bone quantity and quality availability and thus the possibility of surgical modification in case of failure should be predicted.

**2.3. Type 2 A**

This type and subcategory present with an atrophic premaxilla (zone I) with a height of 10 mm and width between 3 and 5 mm (Fig. 7). This allows the placement of 2 narrow diameter axial positioned implants, Vomer or nasalus implants. Bone grafting can be expected at the time of the implant surgery due to possible fenestration and dehiscence. Posteriorly, a single zygomatic implant is placed with its platform positioned in the 2nd premolar position. Pteryoid implants are placed to allow support in the molar area without the need for sinus augmentation in the molar area and improve AP spread while voiding a posterior cantilever (Fig. 8). Should in the future the anterior axial implants fail, a second zygomatic implant may be placed (Fig. 9). The disadvantage to this approach is patient hygiene is more difficult to reach around the restored pteryoid implants as their position is at or distal to the natural 2nd molar position. Impression capture during the restorative phase may also present with some challenges due to the pteryoid implants position. Position of the pteryoid implants provides maximized A-P spread and occlusion with whatever teeth or implants are present in the mandibular arch (Fig. 10).



**Fig. 3.** A-P spread with placement of a zygomatic implant bilaterally at the 1st molar position and standard implants in zones I and II.

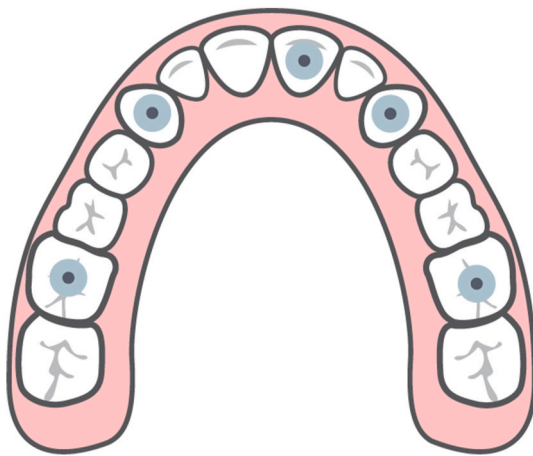


Fig. 4. A type I maxillary treatment with a cantilever distal to the 1st molar position of the zygomatic implant.

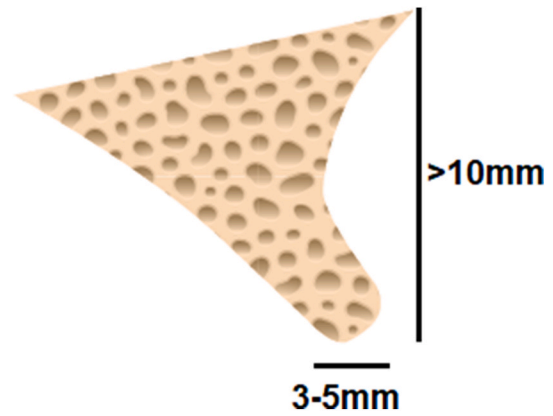


Fig. 7. Cross-section of the anterior area of the maxilla (zone I) that presents with 10 mm height and 3–5 mm width for implant placement.

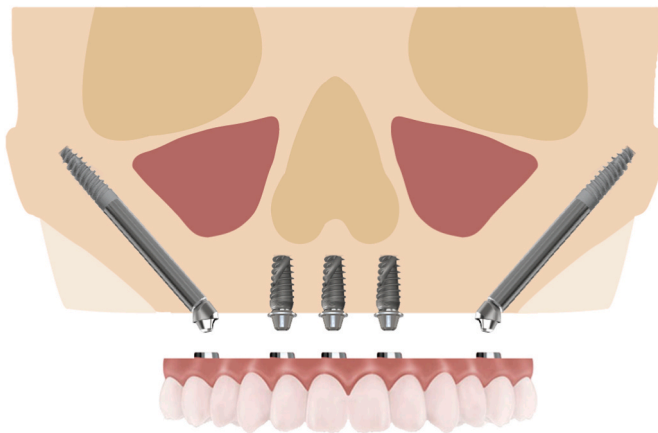


Fig. 5. Illustration of a type I implant treatment demonstrating the apical position of the zygomatic implant in relation to the orbit blocking potential for future placement of another zygomatic implant mesial to it should it be required later.

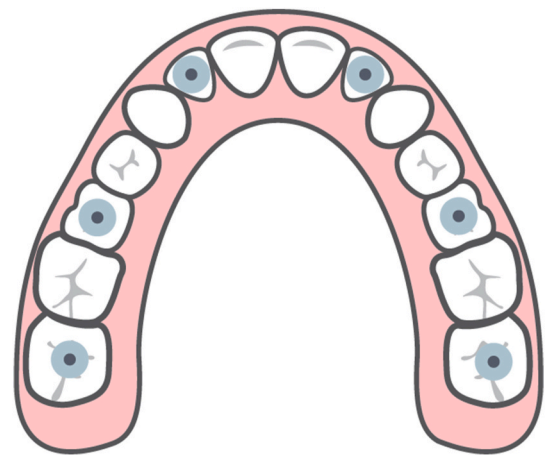


Fig. 8. Platform position in a type 2A implant treatment presents with good A-P spread and no distal cantilever on the prosthesis.

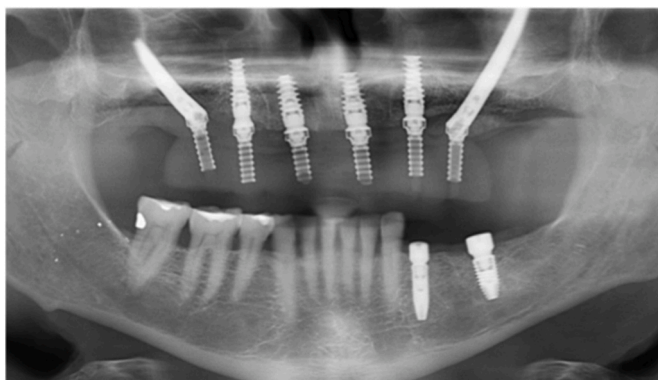


Fig. 6. Panoramic radiograph demonstrating zygomatic implant placement with traditional implants in the anterior and premolar areas in a type 1 configuration.

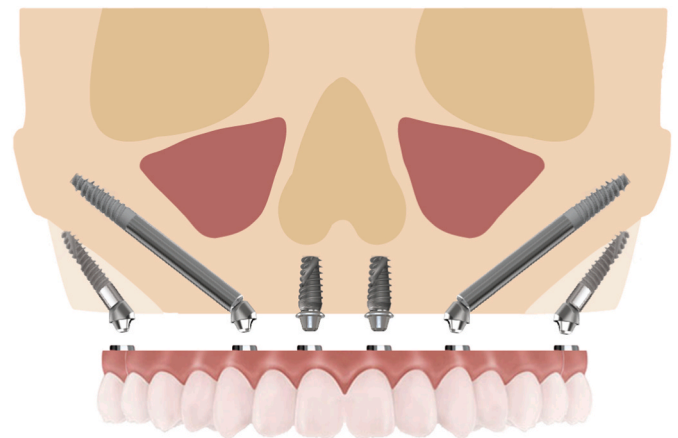


Fig. 9. Illustration of implant positions in a type 2A case with anterior implants, bilateral single zygomatic implants and pterygoid implants.

2.4. Type 2B

This type and subcategory present with a severely atrophic premaxillae (zone I) with insufficient height, width and angulation issues to permit implant placement (Fig. 11). The premaxillary resorption

extends to the nasal floor and thus dental implant without prior grafting are not indicated. The resorptive presentation due to angulation issues may not allow implant placement to permit restoration even following grafting. Bilateral double zygomatic implant placement (referred to as “quad” zygoma implants) is indicated with implant platform placement at the canine/lateral positions and 2nd Premolar positions allows





Fig. 10. Panoramic radiograph demonstrating zygomatic in a type 2A configuration.

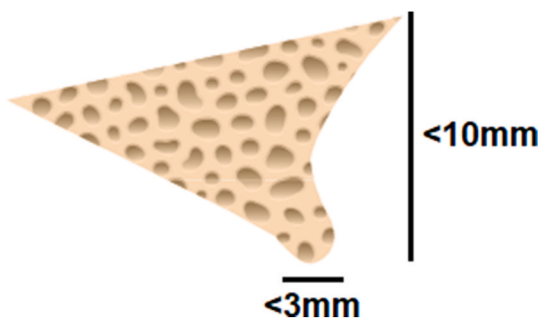


Fig. 11. Maxillary anterior area presenting with severe atrophy preventing implant placement in the anterior due to minimal height, width and angulation issues to the premaxilla.

stability of the planned prosthesis but termination of the prosthetics at the 1st molar with a resulting cantilever.<sup>11, 12</sup> (Figs. 12–14) Quad zygomas have been reported to have comparable success rates as bilateral single zygomatic implants but offer better implant platform spread in those cases that will not permit anterior implant placement.<sup>13, 14</sup> Pterygoid implants may be added to improve the AP spread and reduce the cantilever depending on the opposing dentition and occlusion (Figs. 15–17). As with type 2A, hygiene is more difficult for the patient due to the position of pterygoid implants if they are added and the cantilever if they are not added. Additionally, impression capture during the restorative phase may also present with some challenges due to the pterygoid implants position, as well as insertion of the prosthesis at placement.

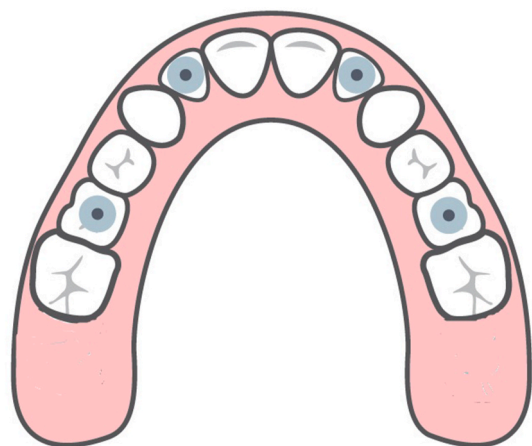


Fig. 12. Platform positions in a type 2B implant treatment presents with presence of distal cantilever on the prosthesis.

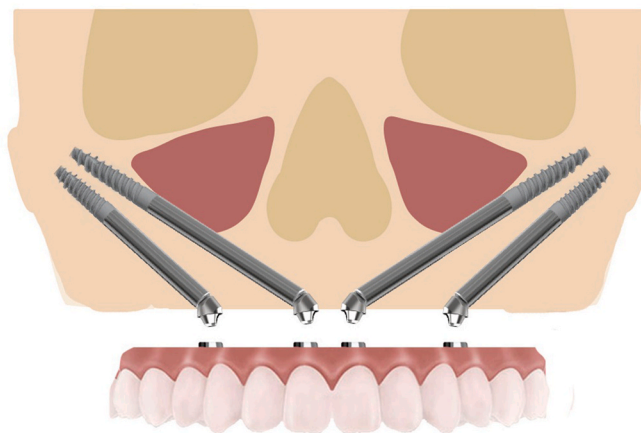


Fig. 13. Implant placement in a type 2B configuration with bilateral zygomatic implants with distal cantilevers prosthetically.



Fig. 14. Panoramic radiograph demonstrating zygomatic in a type 2B configuration.

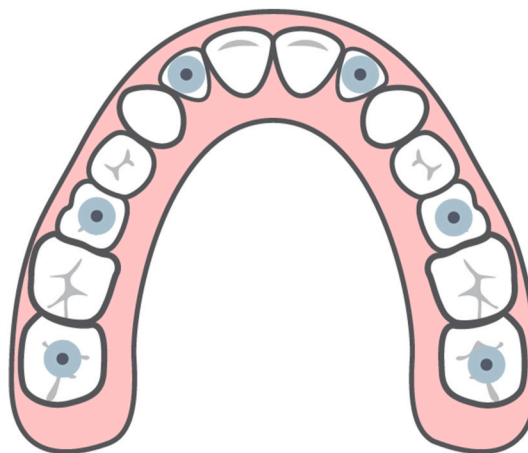
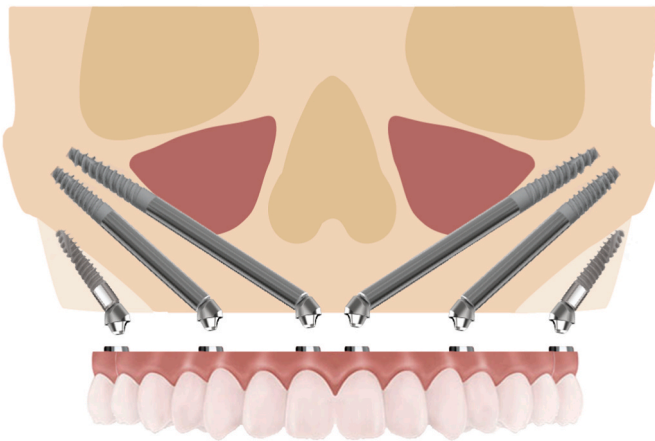


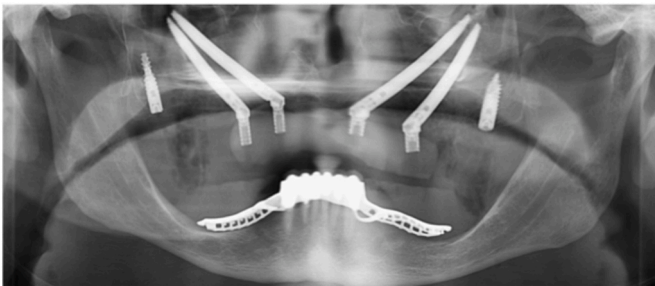
Fig. 15. Platform position in a type 2B implant treatment presents with good A-P spread and no distal cantilever on the prosthesis.

### 3. Conclusion

Patients may present either after long periods of maxillary denture wear or following loss of the dentition related to severe periodontal issues that result in severe atrophy of the maxilla that hamper implant placement to allow restoration of the arch. Extensive bone grafting may be performed but those procedures increase the treatment costs. Additionally, treatment time may be drastically increased precluding some patients from accepting treatment.



**Fig. 16.** Implant placement in a type 2B configuration with bilateral zygomatic implants and pterygoid implants.



**Fig. 17.** Panoramic radiograph demonstrating zygomatic in a type 2B configuration with addition of pterygoid implants.

The decision making presented herein is clinical based on the radiographic appearance of the patient acquired during treatment planning. This will help aid the practitioner in discussion with the patient as to what treatment options are available and also to those only performing the restorative aspects of treatment in discussion with the surgeon when formulating the joint treatment plan that will be then discussed with the patient.

#### Author contributions

\*Provided clinical information and technical details for the paper, reviewed article draft and provided editorial input.

\*\*Wrote the article draft and edited based on other author feedback.

\*\*\*Reviewed article draft and provided editorial input.

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#### Ethics approval and consent to participate

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#### Consent for publication

Not applicable.

#### Availability of data and material

Not applicable.

#### Declaration of competing interest

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

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