Implant Treatment for All: Full-Arch PFMs for an Edentulous Patient with Advanced Bone Resorption

In the decades since his pivotal discovery of osseointegration, practitioners of implant therapy have strived to fulfill Dr. Per-Ingvar Brånemark’s lofty goal of restoring the teeth and, by extension, the quality of life of every single patient suffering from edentulism. Amid technological advancements and the rise of prosthetically driven treatment planning, the population of patients who can be treated with this life-changing mode of therapy expands ever further. Innovations in prosthetic materials, digital treatment planning, dental lab technology, and clinical protocols allow for the highly predictable replacement of missing teeth, from the relatively healthy patient with a missing lower first molar to the completely edentulous patient with severe bone resorption.

In the absence of teeth, the rate of bone resorption substantially exceeds that of new bone formation, causing the ridge of the edentulous arch to recede. The impact of this phenomenon on personal well-being is substantial. As bone resorption worsens, traditional dentures become less stable, which increasingly hampers speech and masticatory capabilities over time. Further, the combination of bone loss and gingival recession deprives the mouth of structural support, which can compromise facial esthetics and provoke negative emotional and social consequences. For these reasons, implants should be placed as soon as possible following tooth loss or extraction in order to mitigate the regression of the hard and soft tissues.¹

Once osseointegration is complete, edentulous patients can be made whole again with a removable or fixed implant restoration, the latter of which optimizes prosthetic stability by attaching to the implants. Fixed options range from full-arch PFMs, to acrylic hybrid dentures, to the BruxZir® Solid Zirconia Full-Arch Implant Prosthesis, which provides the maximum amount of durability, but cannot be milled in a small number of instances due to anatomical considerations such as limited inter-arch space and advanced bone loss. Whichever restoration is indicated, the improved dental function, comfort and esthetics provided by implant-retained prostheses can utterly transform the life of the edentulous patient.² Even before the final restoration has been delivered, many patients can be provided with a provisional implant restoration, offering immediate relief in the presence of sufficient primary implant stability.

For a variety of reasons ranging from financial limitations to a lack of awareness concerning the consequences of
edentulism, many patients are not able to receive implant therapy in a timely manner and thus present for treatment with severe bone resorption. Historically, this has limited the treatment options available to such patients or required a substantial bone augmentation. However, implantology has become more adaptable over time. By combining modern diagnostic tools with a prosthetically driven approach, we can now place implants in the precise position required to facilitate a functional, esthetic outcome for virtually any patient, utilizing a minimally invasive surgical protocol.

The following case report demonstrates the versatility of contemporary implant therapy. A patient who had been suffering from edentulism and unstable dentures for many years is provided with fixed implant-supported restorations, despite the advanced state of bone resorption with which he presented for treatment. In addition to optimizing prosthetic stability and dental function for the patient, this treatment would significantly improve facial esthetics, spotlighting the life-changing capacity of implant therapy.

Case Report
A 52-year-old male presented to the office with completely edentulous arches and a Class III discrepancy positioning his mandible to the anterior of his maxilla (Figs. 1a, 1b). Since losing his teeth in his early 30s due to dental neglect, the patient had worn complete dentures that were, although well-fitting, extremely unstable due to the severity of his prognathic occlusal relationship (Figs. 2a, 2b). The combination of the patient’s malocclusion and the severe bone resorption that occurred following the loss of his teeth eventually made it so difficult to function that he was no longer wearing his dentures at the time he presented for treatment.

The patient had been saving up money for implant therapy, desiring a fixed solution that would simulate natural teeth to the maximum degree possible. Because his dentures were well-fitting, they would serve as the basis for the definitive design of implant-supported restorations. Although BruxZir Solid Zirconia restorations would have been preferable in order to maximize durability, the prostheses needed to be fabricated by fusing porcelain to metal due to the location of the patient’s ridges, which precluded the prosthetic design needed to mill a monolithic implant restoration.

Due to the highly resorbed state of his ridges, implant treatment would not have been possible without a prosthetically driven treatment plan and the advent of cone-beam computed...
tomography (CBCT) scanning. Treatment planning centered around determining the implant positioning needed to accommodate the prosthetic design of his existing dentures.

For the patient’s maxilla, the treatment plan called for a restorative design that positions the prosthetic teeth labial to the implants that would be placed in the patient’s receded arch. The proposed PFM restoration would be screw-retained and extend back from the apical portion of the prosthetic teeth toward the lingual in order to attach to the implants. This would position the prosthesis in the location needed to adjust for the patient’s bite while avoiding having screw access holes that extend through the facial aspect of the prosthesis and the negative effect this would have on final esthetics.

A cement-retained restoration was proposed for the patient’s mandible that would sit directly over the lower arch. This would help account for the patient’s Class III discrepancy and facilitate dental function. Further, cementing the prosthesis over titanium custom abutments would avoid having screw access holes coming through the facial of the prosthetic teeth, which would have been necessary to accommodate implant angulation had a screw-retained restoration been selected. For both restorations, layering porcelain over a metal framework would allow for the prosthetic design needed to adjust for the receded arches and malocclusion.

Upon patient acceptance of the proposed treatment plan, CBCT scanning was performed so the optimal number and placement of implants could be determined for the edentulous arches via digital treatment planning software. Radiopaque gutta-percha markers were placed on the patient’s existing dentures, allowing the laboratory to merge the data collected from the patient’s edentulous ridges with that of his dentures to create a digital wax-up for the proposed restorations. A dual-scan protocol was utilized in which the upper and lower dentures were scanned both while seated in the mouth and in vitro.

Using this information, the lab was able to toggle back and forth between the digital representation of the patient’s ridges and the proposed prosthetic designs. In this virtual environment, the planned implant locations were verified to be certain that they emerged from the bone and soft tissue in the position needed to accommodate the implant-supported prostheses (Figs. 3a–3d). This also helped to ensure there was sufficient restorative space for the lab to create the metal work and porcelain needed to connect the restorations to the implants.
By utilizing the three-dimensional diagnostic data collected in the CBCT scans, the placement of the implants was predetermined with their prosthetic platforms in the precise position needed to connect to the fixed implant restorations. This approach would help to provide the patient with natural-looking restorations and allowed for the selection of maximum implant length and diameter while avoiding the mandibular foramen, maxillary sinus and other critical anatomical structures.

Because the patient’s edentulous ridges were already in a healed state and there was sufficient inter-arch clearance...
for the proposed restorations, two tissue-supported surgical guides were produced to control the placement of the implants at their predetermined positions (Figs. 4a, 4b). The tissue-supported guides were fabricated from the CBCT data and would avoid the need to reflect a flap at the implant sites, thus minimizing surgical trauma, promoting faster healing, and preserving the blood supply to the bone.

Six implants were selected for each jaw in order to minimize cantilever forces on the prostheses and distribute the occlusal loads applied to the fixed implant restorations evenly across the arches. With only minimal horizontal bone volume in both arches, 3.4 mm implants were selected for the anterior, while the bone thickness in the posterior was sufficient for 4.6 mm implants.

The surgical guides, which were designed to accommodate a series of metal sleeves that control the depth and orientation of drilling, were tried in and fit the patient well (Figs. 5a, 5b). Fixation pins were used to ensure the guide remained firmly seated throughout surgery. The surgical process began with tissue punches, facilitating the flapless protocol that would be followed for both arches. The implant osteotomies were created through the surgical guide with a pilot drill and followed by subsequently larger drills until the sites were ready for implantation (Fig. 6). Parallel pins were used to verify the angulation of the osteotomies prior to implant placement (Fig. 7). A total of 12 Axiom® REG implants (Anthogyr Inc.; Sallanches, France) were placed in the precise positions called for by the treatment plan (Figs. 8a, 8b).

With surgical placement complete, healing abutments were delivered to provide for tissue contouring at the implant sites during the healing period (Figs. 9a, 9b). The width of the healing abutments was selected in accordance with the diameter of each implant, with a height sufficient to protrude above the surface of the soft tissue and create an esthetic transmucosal passage. The patient's existing dentures were modified and soft-lined to fit over the healing abutments, and provided adequate function and esthetics during the healing phase.

The patient returned after three months of healing, so final
impressions could be taken for the implant-supported prostheses (Figs. 10a, 10b). Upon removal of the healing abutments, each implant site exhibited excellent tissue health and emergence profiles (Figs. 11a–11c). Multi-unit abutments were placed in the maxilla to establish a uniform restorative platform for the screw-retained prosthesis (Figs. 12a, 12b).

This would keep the prosthetic connection above the tissue level and thus preserve the seal at the implant-abutment interface. Open-tray impression copings were then attached to the multi-unit abutments and luted together to prevent movement of the transfer posts during the final impression (Figs. 13a, 13b).
An open-tray method was selected to maximize the accuracy of the impression and eliminate any guesswork for the lab in determining the final position and angulation of the implants. After being filled with vinyl polysiloxane (VPS) impression material, the custom tray was seated over the impression copings. Once the material set, the custom tray was removed, picking up the splinted transfer posts (Figs. 14a, 14b). Implant analogs were then attached to the impression copings, and healing caps were placed over the multi-unit abutments to prevent any disturbance of the transmucosal passage while the final restoration was fabricated (Fig. 15). For the patient’s mandibular arch, the

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final impression for the cementable restoration was taken using the same open-tray technique, but with implant-level impression copings in place (Figs. 16a–16c).

At this point, the lab provided wax rims so jaw relation records could be taken using conventional denture techniques (Figs. 17a, 17b). The lab produced maxillary and mandibular wax setups, each of which included two screw access holes so they could be attached to implants during try-in (Figs. 18a–18c). After seating the wax setups and tightening the temporary cylinder screws, the centric relation, vertical dimension of occlusion (VDO), phonetics, midline, bite and esthetics were evaluated (Fig. 19).
Upon verification of the wax setup’s esthetics, bite and function, the lab produced a provisional implant prosthesis for each arch from poly(methyl methacrylate) (PMMA) (Figs. 20a–20d). These temporary appliances were a crucial element of the restorative process and provided the patient with an opportunity to verify the definitive prosthetic designs before the final PFM restorations were produced.

The maxillary provisional implant prosthesis was tried in, and the esthetics were found to be optimal, including the lip transition line (Figs. 21a, 21b). The mandibular custom abutments were transferred from the study cast to the patient’s mouth using the acrylic positioning jigs provided by the lab, exhibiting favorable soft-tissue margins (Figs. 22a–22c). The lower provisional appliance was then tried.

Figures 20a–20d: Provisional implant prostheses were fabricated for patient verification of the definitive design prior to fabrication of the final PFM restorations. Note how the screw access holes position the prosthetic teeth to the anterior of the maxillary arch, while the lower prosthesis seats directly over custom abutments.

Figures 21a, 21b: The transition line provided by the upper provisional was evaluated as the patient moved from normal smile to high smile, verifying the esthetics of the final prosthetic design.
in so the fit and esthetics could be verified (Fig. 23). The mandibular provisional restoration was then removed, and the proposed metal framework was tried in to confirm a passive fit (Fig. 24).

Neither of the provisional implant prostheses required adjustment, which was to be expected given that the PMMA appliance was an exact duplicate of the doctor-approved setup. The patient provided approval of the definitive prosthetic designs, and the case was returned to the laboratory so the final restorations could be fabricated.

The patient returned for delivery of the final upper and lower restorations, which were fabricated by the lab by
Figures 26a, 26b: The final PFM implant prostheses (bottom) are essentially duplicates of the patient-verified provisionals (top), ensuring proper fit, esthetics and function for the final restoration.

Figures 27a–27c: The final implant-supported PFM prostheses were delivered, restoring the patient’s edentulous arches.

layering porcelain over cast metal in accordance with the approved prosthetic design (Figs. 25a, 25b). The final restorations were essentially PFM versions of the approved provisional implant prostheses, thus preserving the doctor-approved setup throughout the restorative process (Figs. 26a, 26b). The final prostheses fit perfectly, completing the full-mouth rehabilitation (Figs. 27a–27c). With the secure, stable prostheses in place, the patient could function effectively for the first time in two decades and exhibited dramatically improved facial esthetics (Figs. 28a, 28b).
Conclusion

With the clinical flexibility afforded by modern diagnostic tools and a restorative-minded approach to treatment, we can provide patients with implant restorations that offer the form and function of natural teeth, even in cases of advanced bone loss. With continued technological advancements and practitioner innovations, our capacity to improve the lives of our patients can only improve further, with the completely edentulous patient benefiting most.

REFERENCES


Figures 28a, 28b: After suffering from edentulism and prosthetic instability for many years, the patient could function effectively with the final restorations in place. Further, the structural support provided by the final restorations significantly enhanced his facial esthetics.