



Patient-Specific Subperiosteal Implants in the Rehabilitation of the Severely Atrophic Maxilla: A Clinical Series



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Introduction

Alveolar bone morphology plays a key role in the rehabilitation of the edentulous patient. In the presence of teeth, mechanical compression and muscle function help maintain bone. In edentulism, maxillary resorption follows a centripetal trajectory, leading to a narrower maxilla and a prosthetically-unfavorable pseudo-class III ridge relationship. Longer durations of edentulism, especially in the context of poorly fitting dentures, can yield severely atrophic maxillae. Rehabilitation of atrophic maxillae remains a challenge, as standard endosseous implants usually require extensive grafting. One may consider supplementing intraosseous implants with two zygomatic implants bilaterally, but this requires high surgical skill and carries risk of sinus complications. Additively-manufactured subperiosteal implants offer an immediate fixed solution for patients exhibiting Cawood and Howell class V-VI bone atrophy, for whom conventional solutions have failed or are contraindicated. We present two patients who have received patient-specific, prosthetically-driven subperiosteal implants with immediate provisionalization (IPS Preprosthetic, KLS Martin). Cone-beam computed tomography (CBCT) and computer-aided design (CAD) are used to redefine a controversial 70-year-old concept, using prosthodontic reverse-engineering to offer added stability, reduced morbidity, improved patient satisfaction, and minimized sinus complications.



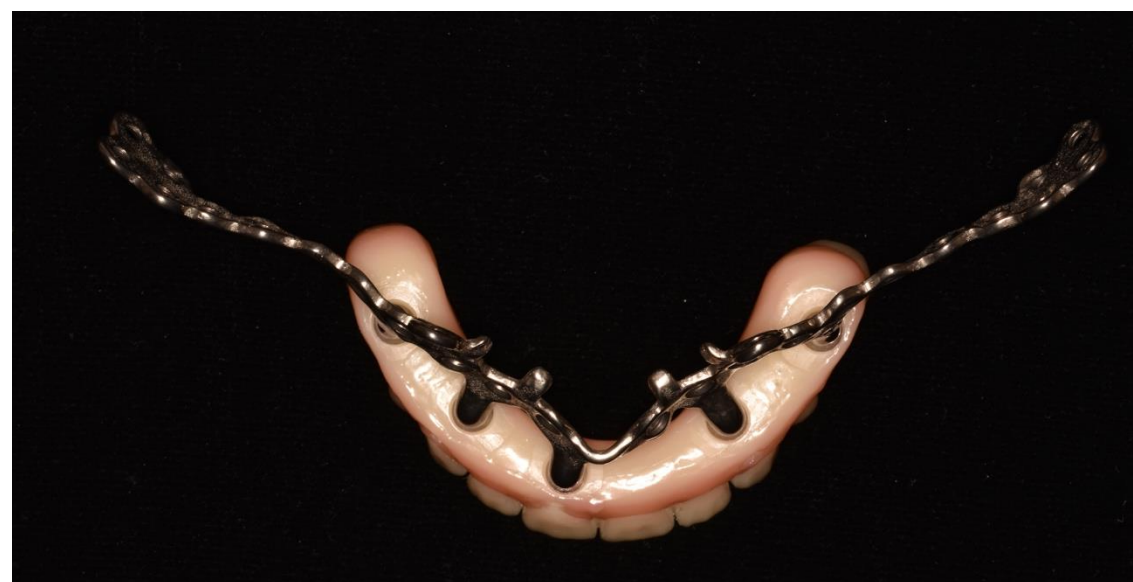
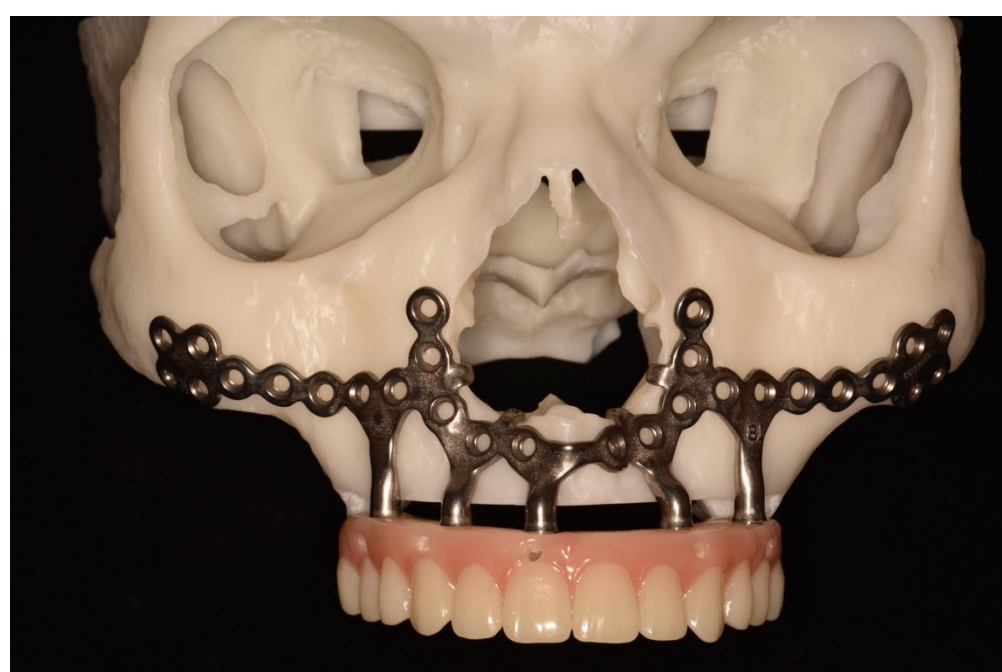
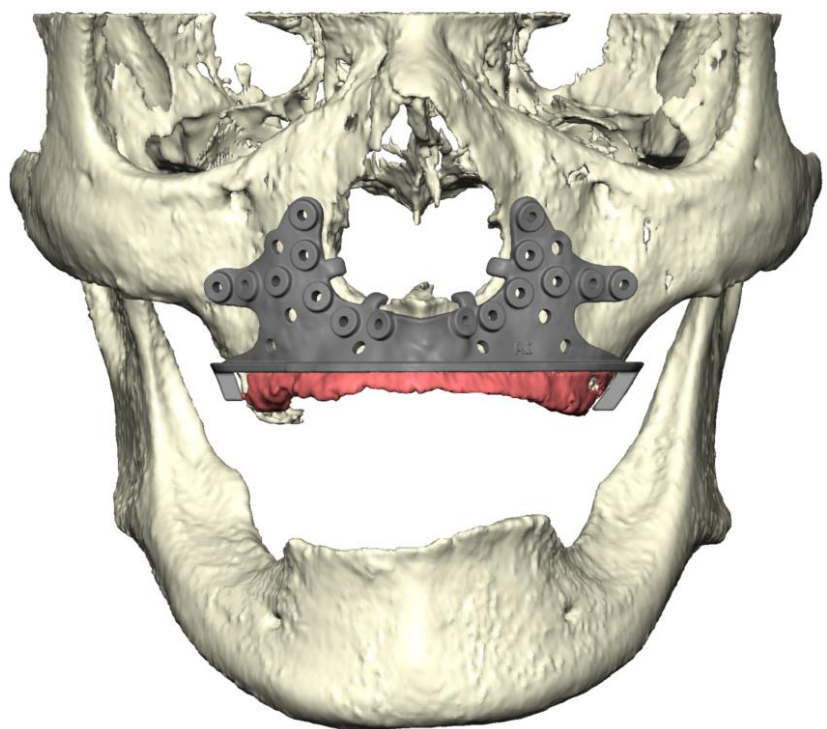
Patient #1 – Initial, Occlusal View



Patient #2 – Initial, Frontal and Occlusal Views

Diagnosis and Treatment Planning

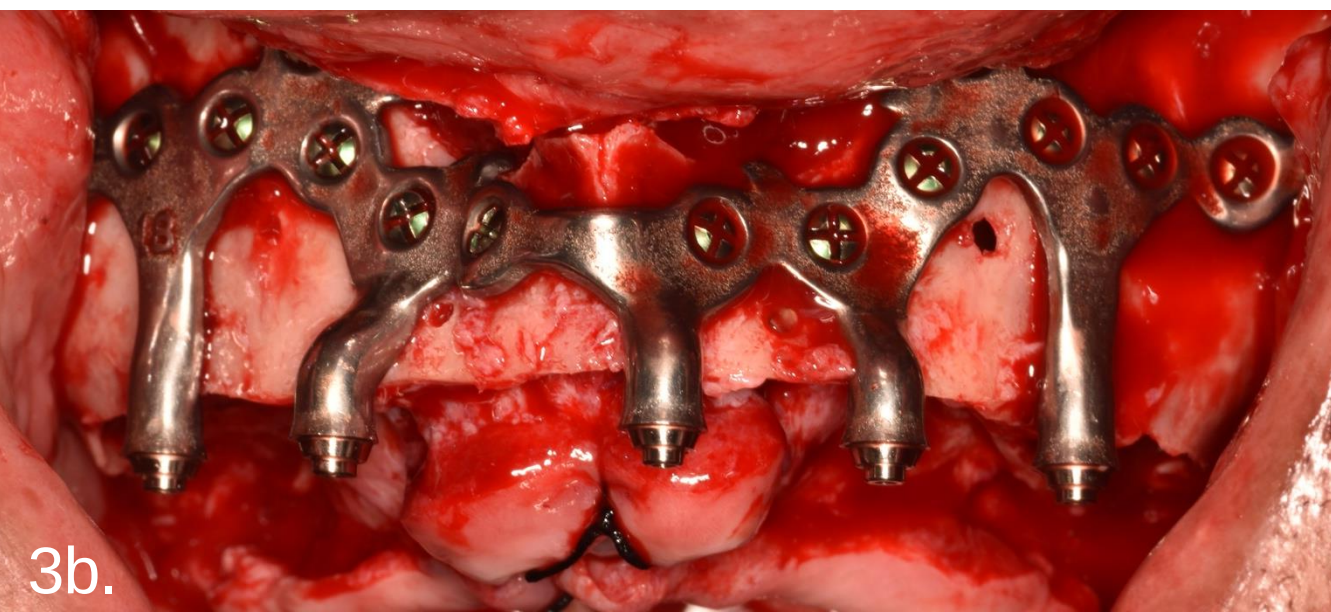
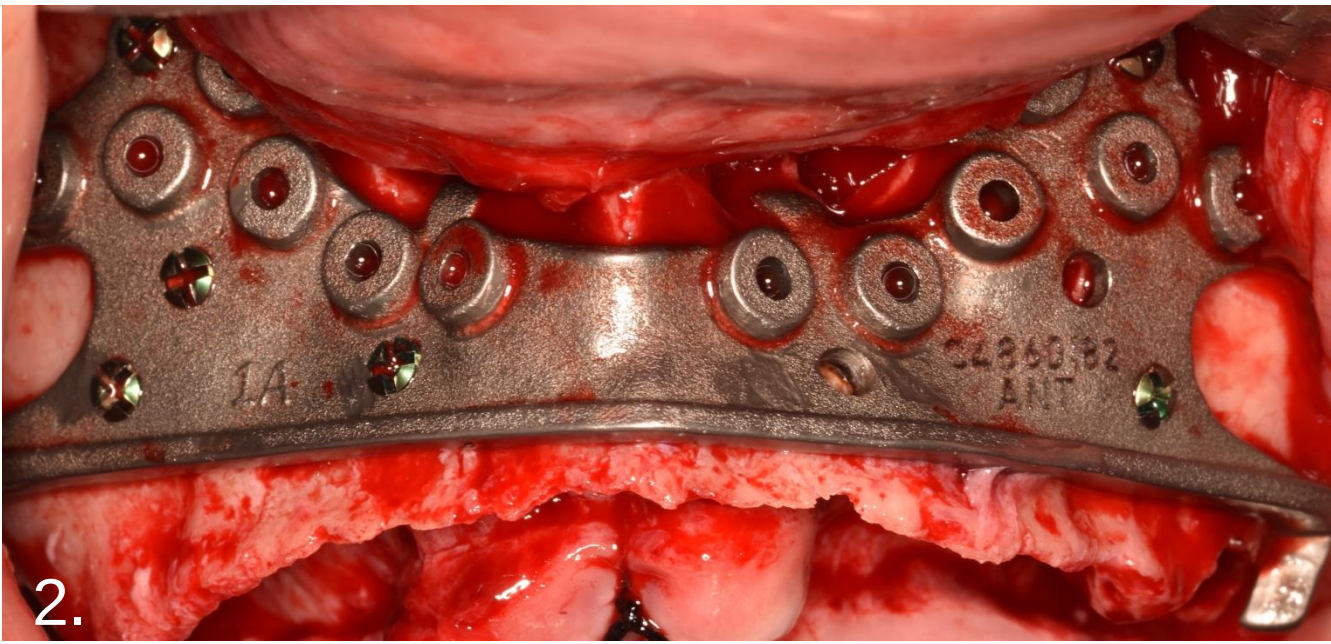
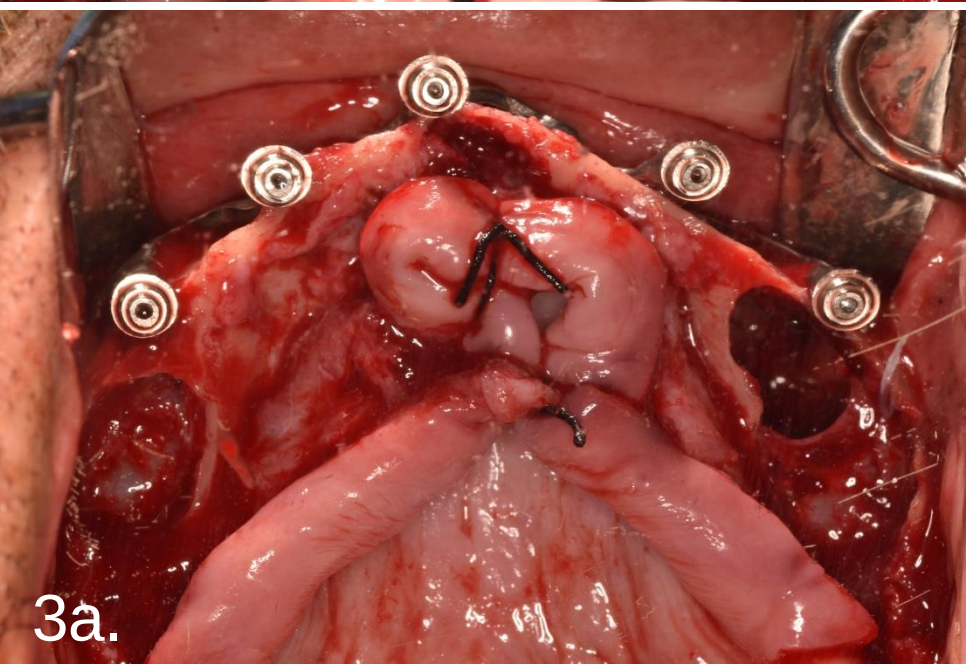
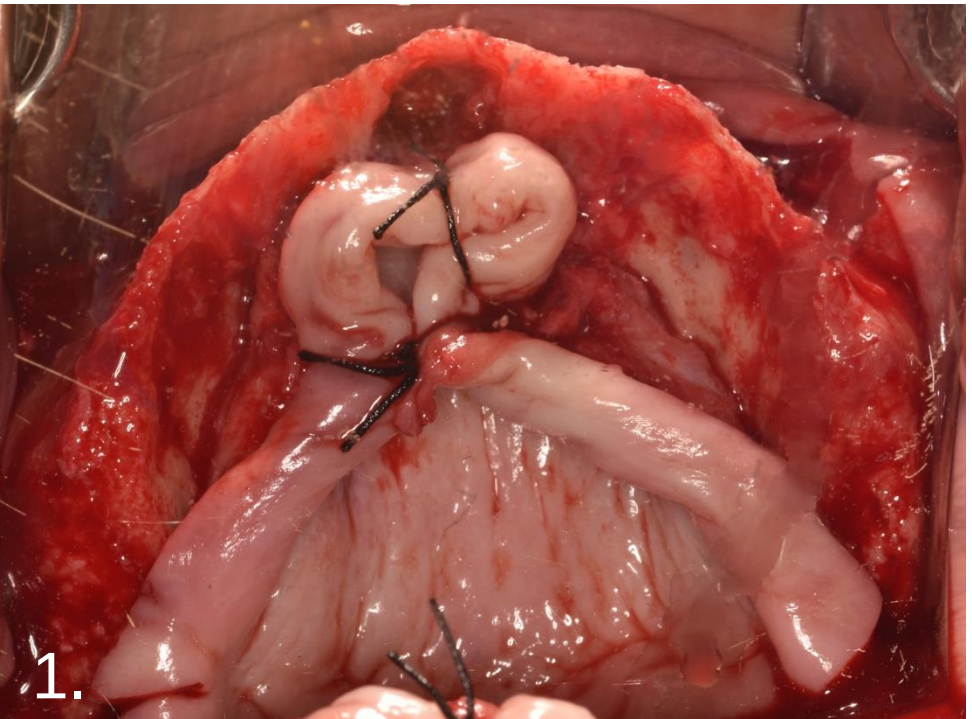
Each patient was screened clinically and radiographically to evaluate severity of maxillary atrophy. Clinical evaluation focused on the assessment of available inter-arch distance, residual ridge architecture, and identification of any tissue deformities and/or pathologies. Much like conventional full-arch implant protocol with immediate loading, the patient must either already have or receive well-functioning complete dentures with acceptable esthetics, phonetics, and occlusion. The prosthesis is used as a radiographic guide via the dual-scan CBCT technique and is digitized using a desktop scanner. The two files are merged into a 3D rendering, which serves as a blueprint for the design of the patient-specific subperiosteal implant. A web-based treatment planning session provides a platform for multidisciplinary care between the surgeon, prosthodontic resident, and KLS Martin designers.



Clockwise from top left (Patient #2): bone reduction guide design; patient-specific subperiosteal implant and immediate prosthesis (frontal); implant and prosthesis (coronal); prosthesis on patient model (transverse)

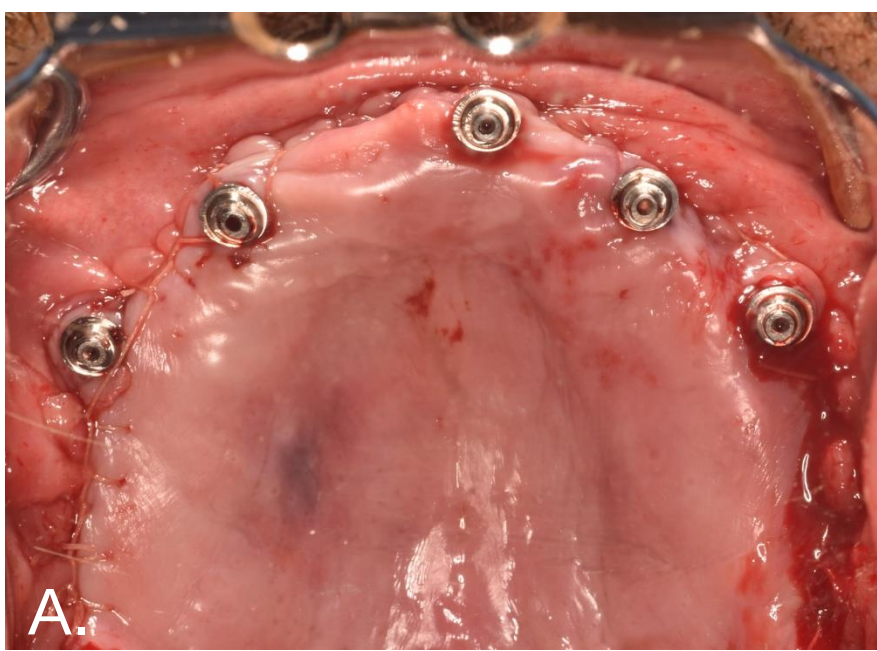
Clinical Procedure

I. Surgery: Patient #2



1. Mid-crestal incision, full-thickness flap extending to infraorbital rim. 2. Bone reduction carried out with patient-specific surgical guide. 3a and 3b. Subperiosteal plate seated by engaging the piriform aperture. Implant held with positioning pins, and osteosynthesis pins drilled into the maxillary, zygomatic and nasal bones through pre-designed holes. Immediate prosthesis inserted with bite registration to verify occlusion. 4. Primary closure achieved around prosthetic pillars and prosthesis delivered.

II. Immediate Prosthesis & Definitive Work-up: Patient #2

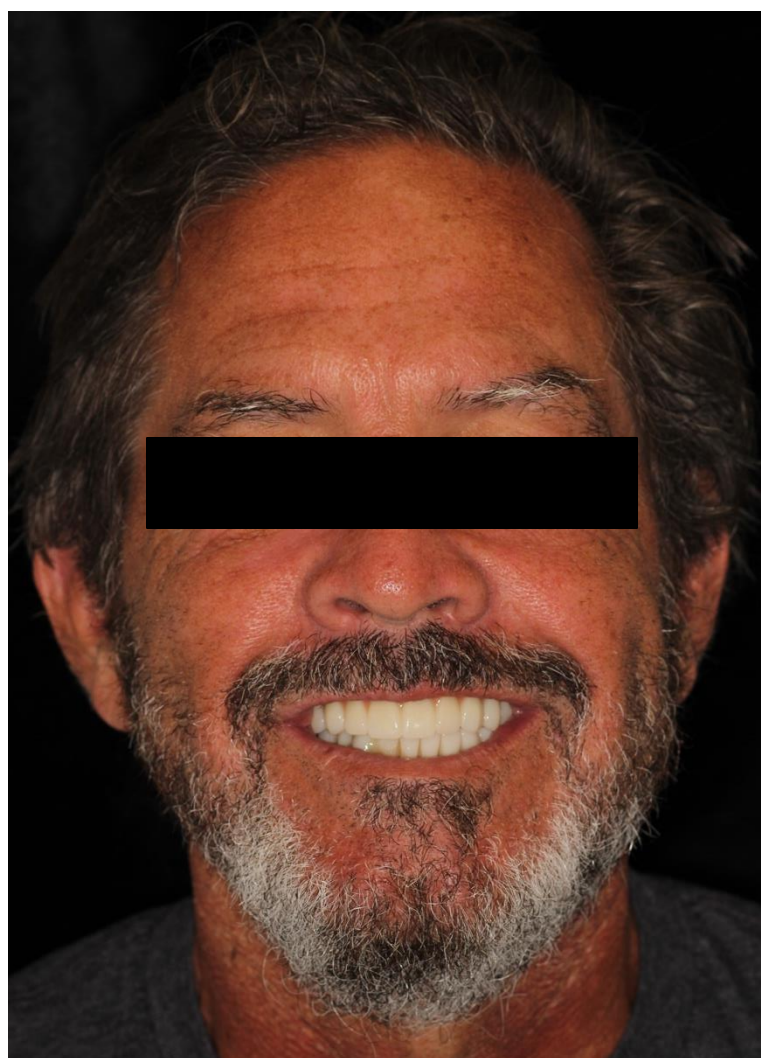


Post-operative:
A. Immediate
B. Immediate, with prosthesis
C. 1-week
D. 1-month
E. 4-months

III. Final Prosthesis: Patient #1



Final Monolithic Zirconia prosthesis with titanium bar substructure (NEXUS)



Discussion

In this novel approach, osteosynthesis pins anchor and immobilize the subperiosteal implant framework against the bone. Immobilization may encourage an osseointegrative environment, allowing bone ingrowth and mitigating risk of fibrous encapsulation. Patients were monitored following surgery and after placement of definitive restoration, which was fabricated using NEXUS scan gauges. In the first six months following surgery, the most commonly observed biological complication was biofilm accumulation around the prosthetic pillars. In the first case, we learned a key lesson while planning our bone reduction and subsequent implant and pillar position. Sufficient reduction raises the prosthetic platform and ensures pillar emergence that is harmonious with ridge form. Additionally, planning the pillar emergence over the ridge can facilitate keratinized tissue collar formation around pillars, often by harvesting from sites like the buccal fat pad. This tissue collar hides the unaesthetic pillars and is a critical barrier preventing spread of biofilm from superstructure to subperiosteal substructure. One technical complication encountered was the design of the multi-unit abutment replicas which emerge from the prosthetic pillars. We noticed discrepancies between the original and mimicked abutment; this can lead to issues with misfit, passivity, and potential microgap formation and biofilm colonization. Risks and complications of subperiosteal implants have yet to be fully appreciated due to short follow-up, but must be considered.



Patient #1 [left] exhibited persistent biofilm colonization at left posterior-most prosthetic pillar, despite patient home hygiene efforts.

Prosthetic platforms, observed in Patient #2 [right], do not exactly mimic morphology of Nobel multi-unit abutments and appear off-center.



Conclusions

Two patients received subperiosteal implants to rehabilitate severely atrophic maxillae. Both patients were monitored postoperatively with minimal complications; one received final restoration. Subperiosteal implants present a promising alternative to patients lacking the necessary bony architecture for conventional rehabilitative methods. During pre-surgical planning, it is prudent to ensure that prosthetic pillar emergence is harmonious with the patient's alveolar ridge; this often can be achieved through strategic bone reduction, while mindful of nearby sinus. More long-term data is necessary to better mitigate complications and confer more predictable outcomes.

Acknowledgements

We would like to thank the KLS Martin Team for their guidance preoperatively and intraoperatively, and for their continued support.

References

