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Medical University of Lodz

**Jan Łoginoff, MD, supervisor:Prof. dr hab. n. med. Agata Majos,
assistant supervisor: Dr n. tech. Marcin Elgalal**

Preoperative planning and manufacturing of custom dental implants using multi-planar or volumetric diagnostic imaging techniques and modern production methods.

Affiliation: II Department of Radiology and Diagnostic Imaging, Medical University of Lodz

The aim of this study is to evaluate the effectiveness and safety of custom subperiosteal implants as an alternative to traditional implantation methods for patients presenting with advanced atrophy of the alveolar ridge in the maxilla or mandible.

Intruduction:

In cases where individuals present with bone resorption categorized as Class IV, V, or VI according to the Cawood and Howell classification system, the presence of a flat morphology of the alveolar ridge and extensive bone loss present significant challenges for successful prosthetic and implant therapies utilizing conventional endosteal implants without prior surgical procedures such as autogenous bone grafting, distraction osteogenesis or reconstruction of bone substrate using alloplastic materials, and in the case of maxillary deficiencies, sinus floor elevation. These procedures carry a significant risk of inflammatory complications, graft resorption and require at least two surgical interventions. Subperiosteal implants (SPI) allow us to limit surgical interventions to a single procedurę. Initially introduced in the 1940s, SPIs presented an alternative to endosteal implants by being positioned on the surface of the maxilla or mandible beneath the periosteum. Despite their initial popularity, challenges related to impression techniques, infection rates, and implant placement led to a decline in their usage, in favor of endosteal implants. However, recent advancements in manufacturing methods, particularly the emergence of 3D printing, and diagnostic imaging techniques like Computed Tomography (CT), have reignited enthusiasm for SPIs. These advancements have facilitated the development of precise implant configurations, enhanced suitability, and prolonged durability, resulting in superior clinical outcomes.

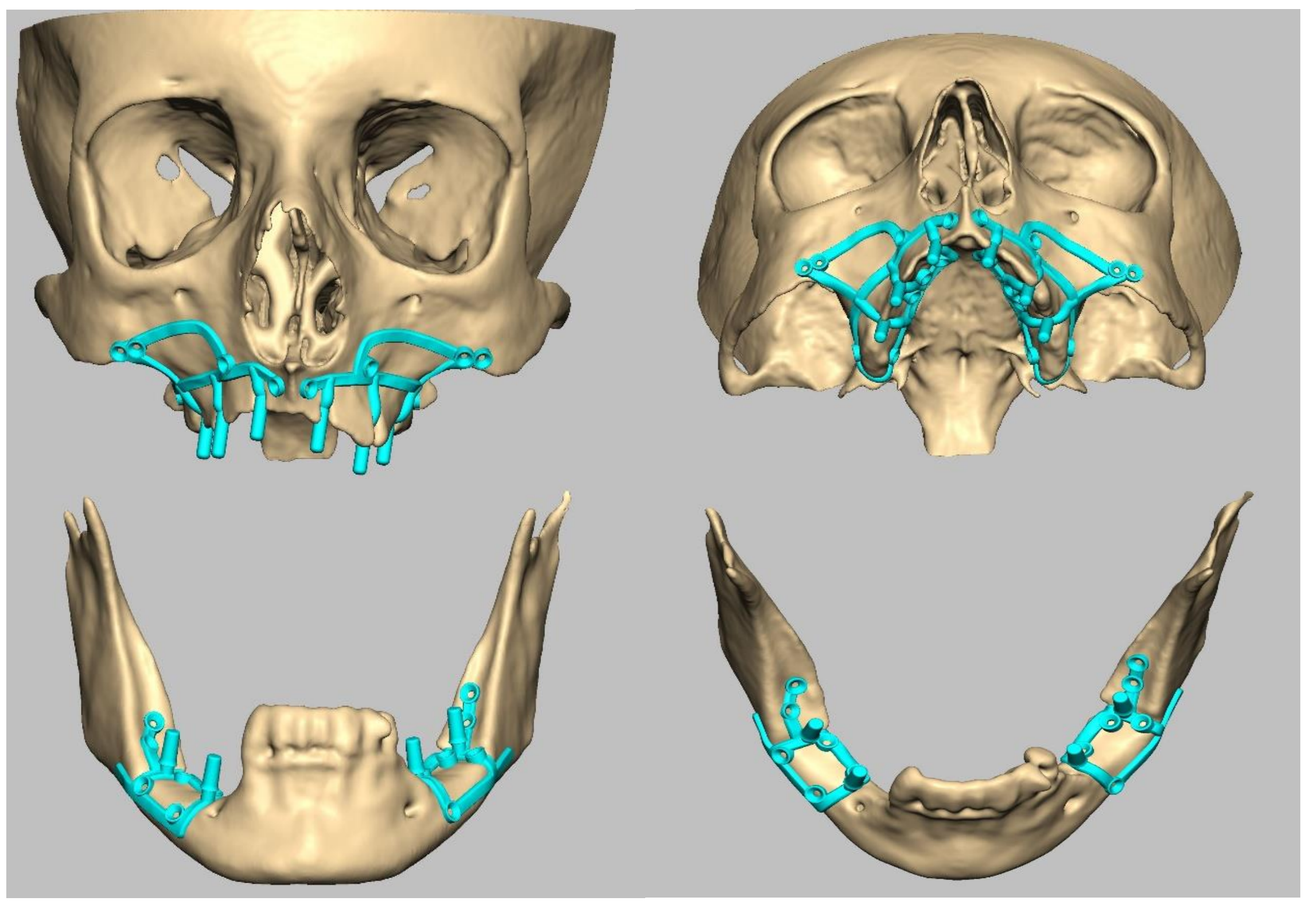


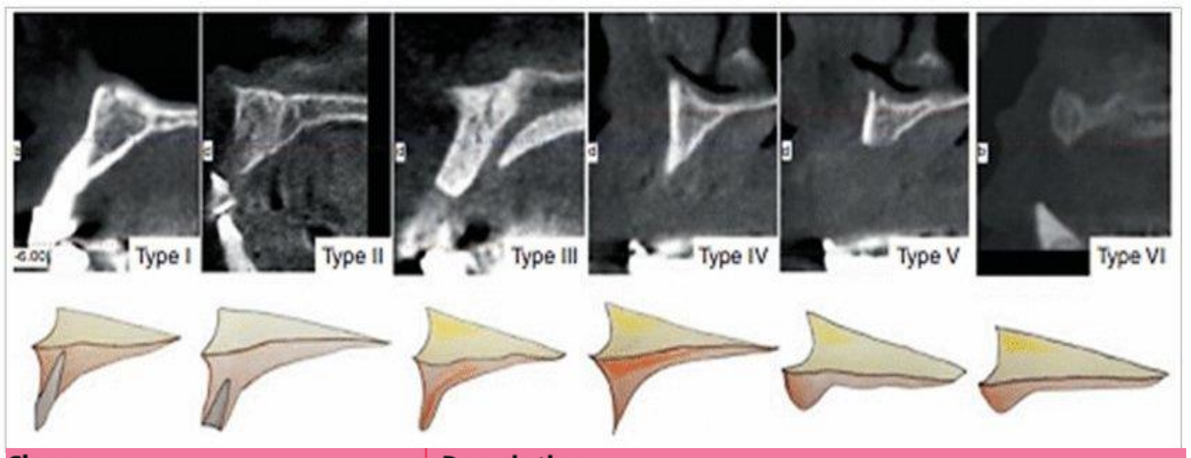
Fig 1. Examples of maxillary and mandibular subperiosteal implants

Aims of the study.

1. Radiological Assessment of Implant Stability:
Analysis of imaging data to assess the stability of subperiosteal implants within patient tissues. This includes examination of implant positioning, orientation, and structural integrity. Evaluation of changes in implant position over time to identify potential displacements or weakening of the maxilla and/or mandible structure.

2. Analysis of Bone Loss and Resorption Around Implants: Utilization of radiological imaging techniques for precise measurement of bone resorption degree around implants. This involves analyzing changes in bone density and volume at various time intervals post-surgery.

3. Assessment of Implant Integration with Bone Tissue: Investigation into the extent of implant integration with surrounding bone, utilizing CT/CBCT scans for osseointegration assessment. Evaluation of whether there are areas where the implant fails to integrate with bone, which may indicate potential issues.



Class	Description
Class I	Dentate
Class II	Immediately post extraction
Class III	Well rounded ridge form, adequate in height and width
Class IV	Knife-edged ridge form, adequate in height and inadequate in width
Class V	Flat ridge form, inadequate in height and width
Class VI	Depressed ridge form, with some basilar loss evident

Fig. 2 Cawood and Howell classification of edentulous maxilla.

Conclusions:

Modern custom subperiosteal implants present a promising alternative to traditional methods for patients with advanced alveolar ridge atrophy. Utilizing 3D printing, CT, and CBCT, these implants are precisely tailored to each patient's unique anatomy, enhancing treatment efficacy. CAD/CAM-designed implants, 3D printed with biocompatible materials like titanium, exhibit improved osseointegration, durability, and patient comfort. Studies demonstrate promising outcomes with high survival rates and improved patient satisfaction. For instance, a retrospective study revealed a 96% survival rate after a two-year follow-up period for subperiosteal implants. Similarly, another study utilizing CAD/CAM technologies and 3D metal printing reported a success rate of 85.7% over four years, with patients experiencing enhanced comfort, chewing ability, speech, and overall quality of life. Notably, implants manufactured using DMLS technology exhibited a 100% survival rate after one year. However, further research is needed to fully verify their effectiveness and safety on a broader scale. As technology advances and more clinical data accumulates, custom subperiosteal implants may become the standard in treating advanced bone atrophy, providing superior prosthetic solutions and improving patient quality of life.