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College of Dentistry

Subperiosteal Implants

"A Modern Approach for Patients with Severe Bone Loss."

A Project submitted to

College of Dentistry, University of Maysan, in Partial Fulfillment for the Degree of Bachelor of Dental Surgery (B.D.S.)

By

1- Hassan Abd Aladeem **2- Mohammed Rafid Mohammed**

3- Fatema Haider Abdul_jabbar **4-Fatima Yahya Sayed**

5- Zahraa Abdul Azim hoyer **6- Maryam Mahbas**

Supervised by
Prof. Dr.Yahya Abd_Ali

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"يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ ۚ وَاللَّهُ بِمَا تَعْمَلُونَ خَبِيرٌ"

(سورة المجادلة /الاية 11)

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First of all, I thank "Allah" almighty for granting me the will and strength to accomplish this research and I pray that his blessings upon me may continue l throughout my life

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Introduction :

Sub periosteal implant Introduction Dental implants are one of the main options for rehabilitating totally edentulous patients. However, in cases of severely atrophic maxillae or mandibles, the available bone might be insufficient for the placement of these medical devices. In these situations, bone grafting procedures might be indicated. Nevertheless, these techniques can be complex and usually require a longer treatment time . When upper arches are involved, zygomatic implants can be used since they have good clinical .outcomes and allow immediate loading. However, it is important to stress that zygomatic implants have also been associated with several complications, some of which can be quite difficult to manage. The development of new technologies has made it possible to manufacture customized implants to rehabilitate patients in whom standard implants cannot be placed because of trauma, oncological treatments, or malformations. These customized subperiosteal implants (CSIs) are designed for the patient's specific anatomy and enable the selection of the most suitable anchorage areas. Subperiosteal implants were first introduced in the early 1940s for the treatment of edentulous maxillary and mandibular arches with severe bone atrophy. After achieving widespread popularity in the 80s and 90s, this denture therapy was progressively abandoned due to significant technique limitations, including high rates of infection and the complications and difficulties with positioning implants and obtaining sufficiently extensive bone impressions. In the last two decades, digital technology has dramatically changed the world of implant dentistry. In particular, modern diagnostic imaging, digital technology, and direct metal laser sintering now allow for the projection of implants with the proper extension, leading to the fabrication of custommade titanium meshes that perfectly fit the specific anatomical requirements of patients. With modern production methods, subperiosteal implants have been digitally reinterpreted, and interest in them is being renewed for the treatment of edentulous patients with atrophic arches.

Anatomy:

• Periosteum: A dense, vascular connective tissue that covers the outer surface of bones. Subperiosteal implants are positioned underneath this layer.

• Mandible/Maxilla: These implants are typically used in patients with insufficient bone height or volume in the jaw, often in the posterior maxilla or mandible.

• Implant Framework: Custom-made, often from titanium or a cobalt-chromium alloy, to match the bony contours of the patient's jaw.

Components:

• Framework: Lies on the bone, under the periosteum.

• Posts: Extend through the mucosa to anchor prosthetic teeth.

• Screws or Wings (in some designs): May aid in stabilization, but many are held in place simply by the shape and fibrous tissue encapsulation.

Biomechanics:

• Load Distribution: Forces from mastication are transmitted through the implant framework to the underlying bone. The periosteum helps in distributing this load over a larger surface area.

• Stability: Achieved through precise adaptation of the implant to the bone surface and the fibrous integration that occurs over time.

• Stress Factors: Since subperiosteal implants do not integrate with bone like endosseous implants, they are more susceptible to micromovements and stress-related complications.

Soft Tissue Considerations in Dental Implant Placement

Soft tissues play a crucial role in the long-term success of implants by ensuring protection, esthetics, and function. Here's a breakdown of key factors:

1- Gingival Tissue Types

• Keratinized Mucosa (Attached Gingiva)

• Firm and resilient tissue around natural teeth.

• Important for implant health — helps resist mechanical stress and plaque accumulation.

• Non-keratinized Mucosa (Movable Mucosa)

• Less stable and more prone to inflammation or discomfort under functional loads.

Ideal scenario: At least 2 mm of keratinized mucosa around the implant for better hygiene and tissue stability.

2- Soft Tissue Thickness

• Thicker soft tissue (biotype) contributes to:

• Better esthetic outcomes (less metal show-through).

• Reduced risk of recession.

• Improved sealing around the implant.

• Thin biotypes may require soft tissue grafting or modified implant placement techniques.

3- Mucosal Seal (Biologic Width)

• The zone of soft tissue that adheres to the implant surface and acts as a biological barrier.

• Includes:

• Epithelial attachment (junctional epithelium)

• Connective tissue attachment

• Crucial to prevent bacterial invasion and peri-implantitis.

4- Soft Tissue Management During Surgery

• Flap Design: Should preserve blood supply and allow tension-free closure.

• Minimally Invasive Techniques: Help preserve soft tissue contours and esthetics.

• Sutures: Must support healing without causing trauma or tissue necrosis.

5- Soft Tissue Around Subperiosteal Implants

• Since the implant framework sits under the periosteum, special care is needed to ensure:

• Mucosal coverage of the exposed posts.

• Adequate healing and tissue adaptation around transgingival components.

• Prevention of soft tissue dehiscence or exposure, which can lead to infection.

6- Esthetic Considerations

• Papilla formation around implants in the anterior region depends on the height of the interproximal bone and soft tissue volume.

• Soft tissue grafts (e.g., connective tissue grafts) may be used to augment volume and improve esthetics.

1- Load Distribution

a. Goal:

Distribute occlusal (biting) forces efficiently to avoid overloading the bone and implant components.

b. Factors Influencing Load Distribution:

• Implant Design & Surface:

Threaded implants help dissipate stress evenly into the surrounding bone.

• Implant Diameter & Length:

• Wider and longer implants increase surface area, improving load distribution.

• Short implants concentrate stress more at the crestal bone.

• Bone Quality:

• Type I & II bone provide better load handling.

• Type IV bone may concentrate stress and lead to implant failure.

• Prosthetic Design:

• Splinting multiple implants can distribute forces more evenly.

• Cantilevers increase leverage and stress at the distal end.

• Angulation:

• Implants should ideally be placed axially to the occlusal load to minimize lateral forces.

• Off-axis loading can lead to bone loss or mechanical failure.

2- Implant Stability

Stability is essential for osseointegration and long-term function. It is evaluated in two stages:

a. Primary Stability (Mechanical):

• Immediate stability after implant placement.

• Dependent on:

• Bone density

• Surgical technique (e.g., under-preparing the osteotomy)

• Implant geometry (e.g., tapered shape increases press-fit)

• Critical for immediate loading protocols.

b. Secondary Stability (Biological)

• Develops over time through bone remodeling and osseointegration.

• Influenced by:

• Bone healing capacity

• Implant surface treatment (e.g., SLA, plasma-sprayed)

• Absence of micromotion (< 150 microns tolerated)

3- Subperiosteal Implants – Special Notes:

• Do not osseointegrate like endosteal implants.

• Stability is primarily from:

• Precise adaptation to the bony surface.

• Fibrous encapsulation.

• Tissue tension and anatomical fit.

• Load distribution relies on broad surface contact and passive fit of the custom frame.

. INDICATION AND CONTRAINDICATION OF SUBPERIOSTEAL IMPLANTS :

The most frequent indication for using subperiosteal implants was the rehabilitation of full mandibular and/or maxillary edentulous patients. Other indications were also mentioned, like the treatment of severe defects after oncological surgical treatments and patients unwilling to undergo complex regenerative procedures. Aesthetic Consideration Achieving aesthetic goals depends on proper selection of candidates [indication] and avoiding those situation where complications or poor outcomes are likely [contraindication]. For example , implants that are not placed with sufficient precision or in a patient with insufficient soft tissue support may lead aesthetic concerns, such as implant exposure or misalignment with surrounding natural teeth. The indication and contraindication of subperiosteal implants directly influence their aesthetic outcomes, as they determine how well the implant integrates into the oral structures, impacts the surrounding soft tissue, and contributes to the overall appearance of the patient's smile.

when are subperiosteal implants recommended

1. sever bone resorption

patients who present insufficient bone to place standard dental implants. Subperiosteal implants are often indicated for patients with severe bone resorption where other implant options (such as endosseous implants] cannot be used due to insufficient bone height or width. ' by Carl E. Misch' also used for patients who have experienced significant resorption or thinning of the maxillary or mandibular bones as a result of injury, periodontal disease, aging, and other factors.

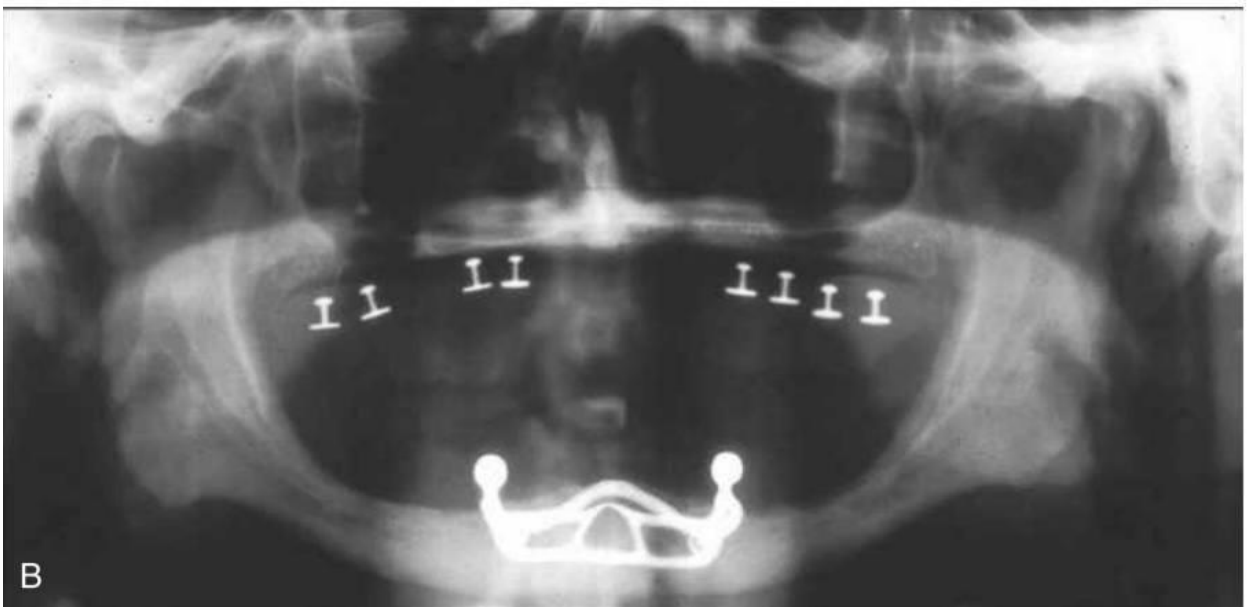


FIGURE 3-1 , : B, Radiograph of a sub-periosteal implant in the anterior mandible.

2. complex regenerative techniques are contraindicate

-when complex regenerative techniques cannot be performed or are not accepted by the patients because of the associated morbidity. Such as bone grafting, Patients with systemic health conditions that prevent bone grafting or bone regeneration may be candidates for subperiosteal implants. ' by K. G. Froum'

3.patients who do not tolerate removable prostheses or when these cannot be made.

4.subperiosteal implants might be considered as an alternative to zygomatic implants when a fixed prosthesis is required.

5. Edendulous mandible and maxilla

-Patients who are edentulous with insufficient bone but need replacement of multiple missing teeth can benefit from subperiosteal implants ' by Raymond J. Fonseca'

6.functional and aesthetic reconstruction .

-Subperiosteal implants can help in both the functional restoration of chewing ability and the aesthetic reconstruction of facial structures. ' by Michael G. S. Baldi' .

7. irreversible anatomic defects

-Dental rehabilitation is a major challenge for patients with severe jaw atrophy since the latter hinders the use of conventional dental implants. Virtual planning and CAD/CAM technologies have contributed to developing customized subperiosteal

implants, which can be a safe and predictable treatment alternative in these cases. We present maxillary dental rehabilitation using custom subperiosteal implants in a 29-year-old patient with bilateral complete cleft lip and palate along with severe hard and soft tissue atrophy in the premaxilla bone following primary surgery. Customized subperiosteal implants are an alternative treatment option in cases where conventional dental implants are not possible or where bone augmentation procedures have failed or are not feasible. therefore use of these implants in patients with cleft lip and palate with complex bone defects is preferable. by 'S. Gennai, R. Izzetti, M.C. Pioli, L. Music, F.Graziani Impact of rehabilitation versus edentulism on systemic health and quality of life in patients affected by periodontitis: a systematic review and meta-analysis'.

3.2- contraindication for subperiosteal implant

1. **sever systemic disease**

- patients with systemic pathologies and Severe uncontrolled systemic diseases (e.g., poorly controlled diabetes, immunocompromised states, bleeding disorders, osteoporosis] that contraindicate the surgical procedure because that may interfere with wound healing or implant integration that can reduce the success of subperiosteal implants. by ' Stephen T. Sonis'. insufficient bone volume

-Past beliefs regarding subperiosteal implants indicated their use on atrophied bone over any other type of implant support, and the less bone available, the more ideal the indication for a subperiosteal implant. On the contrary, adequate bone should also be present for this implant modality. Though subperiosteal implants are often used when there is insufficient bone, extremely inadequate bone or other anatomical issues (e.g., excessive bone resorption, insufficient soft tissue coverage] can still contraindication. by 'Harald W. Watzek and Carl E. Misch'.

2. **inadequate soft tissue quality**

-poor soft tissue quality, such as sever periodontal disease or insufficient gingival coverage, can compromise the success of subperiosteal implants. by 'Nairn Wilson'.

active infection in the area

-Active infections in the mouth or the potential for infection due to periodontal disease are contraindications for subperiosteal implant placement. furthermore acute infections and active inflammatory condition lead to danger of implant failure and complications. by ' Nils Claes Persson'.

3. **young age [incomplete skeletal development]**

-Subperiosteal implants are generally not recommended for younger patients whose skeletal development is not yet complete, as bone growth could affect implant stability. by 'T. M. Graber'.

4. **lack of patients compliance and poor oral hygiene**

-non-compliance patient with postoperative instructions can lead to implants failure. patient's inability to maintain proper oral hygiene can lead to peri-implant infection and serious complications. by ' Edward S. Cohen and Jan Lindhe'.

5. **sever mental and emotional disorders**

-Patients with severe mental health conditions or who are unable to follow the necessary treatment plan may not be good candidates for subperiosteal implants. this condition falls in the name psychiatric or psychological issues, also patient who has unrealistic expectations about the treatment outcomes may not be suitable candidates. by ' Henrik A. L. Ohlsson and Mohammad Ali M. Khursheed'.

6. **smoking**

-Smoking increases the risk of implant failure due to its negative effects on osseointegration and tissue healing. by ' Charles A. Babbush'.

local anatomic issues

- Specific anatomic challenges, such as proximity to critical structures

(e.g., nerves, sinuses], may contraindicate the use of subperiosteal implants. By 'Raymond J. Fonseca'.

-The present study is limited by the small number of patients included and the absence of consensus on the design of PSIs, their indications based on bone quality. and the optimal positioning and number of screws required to achieve both primary and longterm stability. Despite promising advancements in subperiosteal implant technology have shown promising results, the limited clinical data available highlight the need for further research. Future studies should focus on increasing the sample size and extending follow-up periods to fully assess the viability of these advanced implant solutions.

patients selection criteria

age over 65 years good systemic and oral health acceptable oral hygiene

-partially edentulous mandible, with two or more teeth missing in the posterior sectors and marked atrophy that disallowed insertion of standard size implants (length ≥ 10 mm)

-willingness not to undergo regenerative bone surgery

-willingness to attend the follow-up control visits

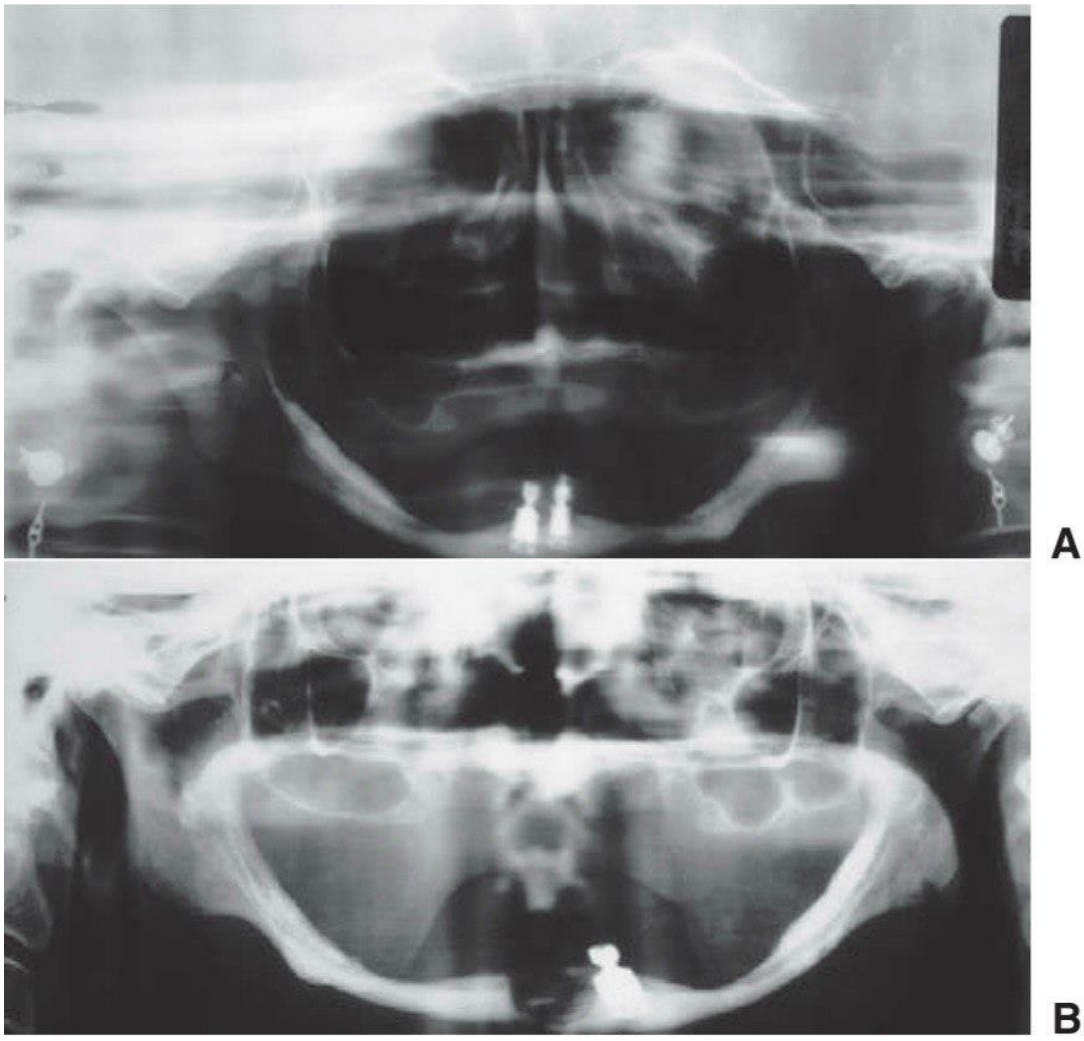


Figure 3-3: A, Advanced atrophy of the jaws provides reduced implant surface area, large crown heights, and poor soft tissue support. B, Implant failure in patients with advanced atrophy may lead to fracture of the mandible or oral antral and nasal fi stulae in the maxilla.

Materials &design

Implant materials : A synthetic material used to make devices to replace part of a living system or to function in intimate contact with living tissue

Classification of implant materials:-

1- According to biocompatibility of the material in the bone Strunt's classification.
2- According to type of material. metallic or non-metallic (Combe's classification).

Strunt's classification according to biocompatibility:

Depending on their reaction with surrounding bone and on the ability of implant material to stimulate bone formation (behaviour of the material in bone)

a) **Distant osteogenesis: (biotolerated material)** In this type, there will be a gap between implant & bone which is filled with connective tissue. There will be a connective tissue capsule (fibrous scar). Possible osteoid or chondroid contact can be seen. The type of the materials include, Stainless steel, Co-Cr-alloy, gold alloy, poly methyl methacrylate .
b) **Contact osteogenesis: (Bio inert material)** In this type, there is contact between implant & bone like: Titanium. Tantalum, Aluminium oxide & ceramic (non-reactive type) . Ceramics are 2 type: Reactive: induce bone formation

C) True bond osteogenesis: (Bioactive material) : In this type, there is a chemical bond between the implant and bone, materials like ceramics bioglass , calcium phosphate apatite.

D)Bond osteogenesis: (Bio inert & structure osteotropic material) : In this type there is physical & chemical bonding of implant to bone, materials: Titanium with rough surface (to increase the surface area) & very thin thickness of coating layer

Combe's classification:-

1- Metallic material.
2- Non-metallic material.

Non-metallic material:

a. **Bio inert (non-reactive):** mean minimal interaction between implant material & the tissue like: Polymers, Viterous carbon, nonreactive types of Ceramic e.g. (Aluminium oxide and Zirconium oxide).

Polymers: There are a large number of polymeric materials that have been used as implants or part of implant systems. The polymeric systems include acrylics, polyamides, polyesters, polyethylene, polysiloxanes, polyurethane, polytetra-fluoro-ethylene (PTFE), poly ether ether ketone (PEEK) and a number of reprocessed biological materials.

All polymers are radiolucent, they are used as coating or membrane but nowadays they used the PEEK as solid implant after modification of their mechanical properties by addition of different types of fillers.

Vitreous carbon :- Stable & well tolerated material, classified as ceramic because of inertness & biocompatibility. It has undesirable physical properties, Widely used in cardio vascular disease.

Disadvantages of carbon:

a) It has not performed well in clinical practice & high percentage of clinical failure & withdrawal of this device.
b) Radiolucent in x-ray.
c) Color of the material is black.
d) Brittle & lack of ductility.

Non-reactive ceramics:

- One type of non-reactive ceramics that has shown evidence of success in clinical studies is made from Aluminum oxide (Al2O3),either as a poly crystalline or as single crystal
- Although this ceramics is well tolerated by bone , it is not bioactive, because it does not promote the formation of bone
- It does possess high strength , stiffness and hardness
- These implants are designed with either screw or blade shape
- It appears to work optimally when they are used as abutment for prosthesis in partially edentulous patient.

Zirconia-based ceramics

- It is well tolerated in the tissue
- Possess mechanical stability during the experimental method of one year

- Attractive color Ease of preparation of abutment
- Radiographic opacity
- Surface structure is important to create enough unique fracture toughness * Because of their good combination of mechanical property and excellent biocompatibility, Zirconium's ceramics are recognized as one of the best biocompatibility for joint prosthesis.

b. Bio active (Hydroxy apatite, Bioglass):- those material used to enhanced the bond strength of implant to bone & accelerate the rate at which attachments occurs mainly used as coating applied to develop bounded interface with bone to promote bone formation.

Hydroxy apatite

HA ceramics has been shown to be biocompatible. non-toxic & capable of forming a biochemical bond with bone due to its chemical similarity to bone mineral. The use of HA as coating for titanium substructures addressed to mechanical deficiencies of the material while realizing the benefits of its bioactivity.

Bioglass:-

dense ceramic material made from CaO,Na2O,PO5,Si2O, this material bonds chemically to bone. The bond has been shown to be strong that when tested failure fracture occurs with bone or bioglass material leaving interface intact. Thus the brittle nature of bioglass become the limiting factor in its use as stress bearing dental implant.

Metallic materials:

The conventional metals and alloys used for medical devices belong to three main metallic systems: stainless steel, cobalt chrommium alloys and titanium alloys.These systems exhibit an excellent combination of high strength, relative workability and good resistance to corrosion. The improvements made mainly consist in variations in the chemical composition, heat treatments and processing technologies in order to improve aspects such as fatigue behaviour, wear, corrosion, ion release and stress transmission to the surrounding tissues.

Metal like Stainless steel &Co-Cr alloy because of their acceptable physical properties and relatively good corrosion resistance.

They are tolerated by bone to a certain extent but cannot integrate with it.

So currently titanium or titanium alloy implants are widely used for their superior properties of biocompatibility

Traditional Implant Materials

The initial subperiosteal implants described in the literature were constructed from various biomaterials. The materials used for subperiosteal implants were chromium, cobalt, and molybdenum alloys, with Vitallium being a well-known example, along with tantalum . The first subperiosteal implants by Goldberg and Gershkoff in 1948 and Weinberg in 1950 were made from Vitallium. These alloys were chosen for their reactive nature, strength, hardness, corrosion resistance, insolubility in bodily fluids, and biocompatibility. However, concerns about the side effects of these metals, resulting from them releasing ions into tissues, sparked the search for alternative solutions The field of subperiosteal implant research has made significant progress in recent decades, particularly in addressing the interaction between implants and human tissues. The release of metal ions into body tissues from implants is a key issue that has led researchers to explore various alternatives. At first, a carbon coating on implants was proposed, based on the supposed high biocompatibility of carbon . This approach aimed to minimize the formation of connective tissue capsule around the implant. However, its adoption was limited because of inconclusive evidence of its efficacy at the carbon–tissue interface and potential adverse histopathological effects, as documented in a study where two carbon-coated subperiosteal implants cases were reported Later, Kay et al. proposed another solution in the field of subperiosteal implants—the implementation of hydroxyapatite (HAP) coatings. These coatings were applied to the struts of subperiosteal implants.Hydroxyapatite (HA)coated subperiosteal implants show a more attenuated response of the surrounding soft tissues than uncoated implants. When HA-coated implants are exposed due to a minor dehiscence of the wound, the affected area usually heals uneventfully This healing includes the initial development of granulation tissue, followed by the appearance of normal mucosal tissue, without the persistent inflammation often seen with non-HA-coated implants In addition, HA-coated implants are associated with a faster healing process around the implant struts. The conducted study expected that these coatings would improve bone–implant integration using the biocompatibility of ceramics and the mechanical characteristics of metallic components. HAP is a ceramic material that is known for its composition that closely resembles bone tissue and for its bioactive and osteoconductive properties Several studies have shown results conducted on HA-coated subperiosteal

implants. For instance, research on 241 HA-coated mandibular subperiosteal implants revealed a survival rate of 98% over 7 years

Implant Design

Early designs of the maxillary subperiosteal implant relied on the hard palate for structural support, utilizing crossover struts. However, it soon became apparent that palatal soft tissues were unsuitable for resting on anything other than the palatal bone , which then led to the rapid abandonment of this initial design. Following versions of the maxillary subperiosteal implant encountered problems due to expansion into the maxillary sinus, with implant struts eventually settling and perforating the porous alveolar bone located beneath or next to the sinuses Removing struts and understanding that dense, stable bone should support the implant represented a significant leap forward in its development. Areas of dense, stable bone in the maxilla include the anterior nasal spine, canine fossas, and the palatal surface of the alveolar ridge. Nevertheless, these anatomical locations do not provide distal support. Therefore, in 1970, Linkow modified the design to include the pterygomaxillary suture. Expanding on this idea in 1985, Cranin et al. introduced the maxillary pterygohamular subperiosteal implant by utilizing pterygoid plates as buttresses

Modern Implant Materials

Titanium : Titanium is highly valued for its biocompatibility, strength, and corrosion resistance. It forms a stable bond with bone, a process known as osseointegration, which is essential for the long-term stability of implants. Its properties facilitate a bond with the bone while reducing the footprint of the implant's baseplate, resulting in reduced invasiveness, improved outcomes, and quicker recovery. Recent advancements have been made possible by using different materials and safer fabrication techniques. Titanium implants often develop a titanium oxide layer on their surface, which aids in healing by promoting protein adsorption, stabilizing blood clots, and ultimately integrating with bone tissue. These subperiosteal implants are primarily made from pure titanium or titanium alloys Polyether ether ketone (PEEK): Polyether ether ketone (PEEK) is a high-performance polymer known for its excellent mechanical properties and biocompatibility. It has a modulus of elasticity similar to that of bone, which helps in reducing stress shielding and promotes better load distribution. PEEK is also inert, reducing the risk of adverse reactions, and it

does not interfere with imaging techniques, such as MRI or CT scans PEEK is used in cases where metal implants might not be suitable, such as in patients with metal allergies. It can be used alone or combined with other materials to optimize the mechanical stability and biocompatibility. Surface modifications, such as coating with bioactive materials or increasing surface roughness, have been developed to enhance its osseointegration capabilities. These modifications help PEEK implants achieve better integration with bone tissues, making them a viable alternative to titanium in certain clinical situations The integration of these advanced materials and design technologies has significantly improved the outcomes of subperiostealimplants. By utilizing the unique properties of titanium and PEEK, modern subperiosteal implants offer enhanced biocompatibility, reduced invasiveness, and improved long-term stability Implant Design Over the past twenty years, advancements in diagnostic imaging technology, in particular computed tomography, have ushered in a new digital age for dentistry. This era is marked by progress in 3D visualization with the use of volumetric imaging in assessing maxilla-facial tissues, in particular, bone tissue These modern imaging methods provide much more detailed, multiplanar imaging data of patient anatomy, which can be used to create detailed virtual models of the facial skeleton. In turn, these 3D models can be suitably modified and later used in CAD software to plan complex surgeries and design patient-specific implants.

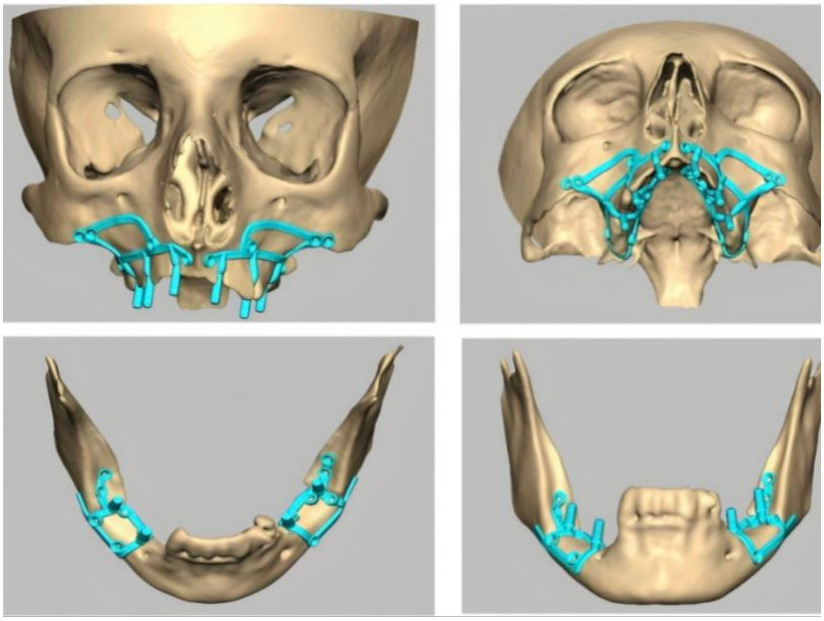
The process begins with acquiring detailed three-dimensional images of the patient's jaw using CT or CBCT imaging techniques. These images are converted into Digital Imaging and Communications in Medicine (DICOM) files and imported into specialized CAD software, such as Mimics (Materialise) and 3Matic (Materialise), to reconstruct the bone anatomy in 3D. The use of such software allows for the manipulation of the 3D bone model to design the implant, ensuring it conforms precisely to the bone contours, selecting optimal locations for fixation screws, and designing the prosthetic abutments Once the design is finalized, the CAD model is exported as an STL (stereolithography) file, which is used by additive manufacturing machines to create the physical implant. Technologies such as direct metal laser sintering (DMLS) are commonly employed to fabricate the implant from biocompatible materials, such as titanium. The precision of CAD/CAM ensures that the final product matches the digital model exactly, reducing the margin for error and improving the fit and function of the implant In recent years, there have been numerous developments in additive manufacturing technologies, i.e., 3D printing, in particular, powder bed fusion technologies, such as selective laser sintering (SLS), direct metal laser sintering (DMLS), and electron beam melting. These methods use either a laser or electron beam to melt and fuse layers of material powder together.

Using such technology, it is possible to create complex, custom-designed maxillo-facial prostheses from biocompatible metal alloys tailored to each patient's unique anatomical requirements This digital transformation has revitalized practices such as subperiosteal implants by integrating them with contemporary digital approaches, as follows:

First, assessment of patient anatomy using 3D imaging techniques and creating a detailed 3D model of the facial skeleton.

Second, implant design using computer software based on the unique patient anatomy and their specific treatment requirements.

Third, use of additive manufacturing technologies and biocompatible materials' metal alloys to ensure safety and compatibility with human tissues These new-generation subperiosteal implants represent an advancement over their predecessors, as they consist of custom-made meshes or lattice-like structures that are precisely adapted to fit each patient's bone geometry . This level of customization proves beneficial for treating edentulous alveolar arches by offering unprecedented precision and personalization compared to earlier implant technologies. As a result, these modern implants not only uphold the functionality of traditional implants but also enhance patient comfort and surgical outcomes



Surgical technique :

The fact of not having the need to drill the bone is one of the advantages osubperiosteal implants. The authors believe that an optimal solution would be the onthat makes use of this concept, thus making the procedure less invasive. In this sense, the idea would be to customize the implant accordingly to the patient's cortical bone geometry at the time of implant design/implantation. This means that the implant would be designed to perfectly accommodate in the bone socket as it is, whether the tooth has been removed recently or months/years before. In the first situation, after tooth removal, the socket would just have to be properly cleaned and the implant would be designed accordingly to the postextraction socket geometry. In the second situation (when the tooth has been removed a long time before), since the socket would probably already be filled with new bone, the implant would be designed and manufactured accordingly to the cortical bone new geometry. In both situations the implant would be placed above the available cortical bone, thus improving the implant's stability. This optimal solution would comprise a small surgery area since a good fitting of the implant to the bone is achieved and a relatively small area is enough for good anchorage. Eventually, some micro-screws can be used to fix this new implant. In addition, both strategies have the advantage of preserving the natural cortical bone, and consequently, reduce the bone loss and inherent esthetical issues due to improved stress distribution in resistant bone (cortical). it is possible to observe a schematic representation of the two aforementioned approaches, as well as an endosseous and a traditional subperiosteal implant Another advantage of placing a dental implant over the cortical bone (subperiostealimplants and optimal/improved solution) is that it will allow its functional use much more quickly than the endosseous implant because the latter is anchored on the trabecular bone and needs time for osseointegration. When the implant is anchored in the cortical bone, it can be loaded .much more quickly since the implant's mechanical stability will already be ensured

preoperative planning and Digital imaging

The design of the subperiosteal implants must allow the transfer of load from the denture to the post, and from the post to the strut structure, with neglectable stress concentrations and static or cyclic fatigue mechanisms.The technique of designing this type of implant was first described by Kratochvil and Boyne. This technique used to start with a direct impression of the bone where the implant would lay, leading to the need of a two-stage surgery, as will later be explained, in the Methodsofimplantation section. In this method, a previously prepared plastic tray used to be fitted over the exposed bone and over the remaining anterior teeth, followed by some corrections to

ensure a good fit between the implant and bone.Then, the tray was filled with elastic materials, namely rubber adhesive. After approximately 10 min, the impressions were removed, and the occlusal registration was made. It is important to mention that some more recent studies performed this step without the need of using the prefabricated trays, by simply making bone impressions with materials such as polysulfides, silicones, and polyethers. During this procedure, the patient was occluded onto a prepared baseplate and occlusion rim, which was seated on the exposed mandible. The base of the occlusion rim was lined with soft wax to ensure that it would seat directly onto the bone. This record was later used to determine the interocclusal distance and to serve as a guide to the height of the implant posts.Following the impression step, a bone model was made in dental stone and mounted at the proper vertical dimension for the implant fabrication.This method was characterized for inducing a significant .postoperative discomfort to the patients due to the excessive bone exposure

In this sense, aiming to reduce the patient discomfort and avoid a two-stage surgery, in Truitt et al. developed a noninvasive technique for the design of mandibular 1985 subperiosteal implants, based on the computerized tomography (CT) scanning technique. The main advantage of this method is that the clinician can obtain the bone model by making use of a CT and a computer-generated model. The CT is performed before any surgical intervention, and only one surgery is needed to insert the implant, making the overall process much less invasive. Since the introduction of this new technique, some studies can be found in the literature with quite satisfactory results.Apart from its noninvasive nature, this technique also avoids the potentially toxic effects of foreign bodies of the impression material, and does not require the use of anesthesia. After CT acquisition, stereolithography has been used to fabricate very precise anatomical models of the patients' jaws anatomy. This highly accurate technology uses the data from the three-dimensional (3D) computer model to, layer by layer, fabricate a 3D model of the patient anatomy. The model is then delivered to a .dental laboratory to ultimately fabricate the cast framework Some surface treatments such as polishing, sandblasting, acid etching, HAP coating, and sterilization are also reported. Direct metal laser sintering (DMLS) is an additive manufacturing technique characterized by its ability to produce custom-made grids and implants, perfectly adaptable to specific anatomical requirements. In this sense, in the past few years, DMLS has emerged as a potential manufacturing technique for the production of subperiosteal implants. One study performed by Cerea and Dolcini evaluated the clinical performance of 70 custom-made DMLS titanium subperiosteal implants and a satisfactory survival rate of 95.8% was reported in a 2-years follow-up. Briefly, in this technique, the implant was fabricated on a moveable platform by applying layers of

grade 5 titanium micro-powders. For each layer, the machine lays down a thin film of the metallic powder with a specific thickness. The laser melts selected areas and the platform then moves down by the preestablished layer thickness, a fresh film of metal powder is poured and the next layer is melted via exposure to the laser source.This process is repeated, layer by layer, until de implant is complete. In this specific case, the implant was then polished by electroerosion and finally sterilized. Even more recently, Mangano et al.evaluated the clinical outcomes of ten subperiosteal implants fabricated by DMLS. Despite the fit of two of the implants not being satisfactory, at .the 1-year follow-up no implants were lost, leading to a 100% survival rate

This approach of fabricating subperiosteal implants by DMLS is a novel technique that still requires further clinical evidence to corroborate these positive preliminary .clinical outcomes

Clinical studies on a larger number of patients and a longer follow-up periods are need

- A thorough diagnosis is paramount for adequate treatment planning. High resolution computer tomography (CT) following the instructions provided by the CSI manufacturer is mandatory. Cone-beam computer tomography (CBCT) is not suitable for designing CSIs
- A proper diagnosis should include the occlusal position, a standard tessellation ;language (STL) file with the intraoral anatomy, and a CT scan
- Passive fit of the CSI to the surrounding bone is critical since this is a custom ;made device
- Since the most frequent complication is CSI exposure, a polished titanium surface is recommended
- It is essential to avoid abrupt transitions and sharp angles in the areas between the CSI frame and the prosthetic connections
- Fixation of the CSI is a key factor for achieving a successful treatment out come. The fixation elements should be placed in high anatomic buttress areas (nasal and zygomatic) and the palatal region. The use of self-drilling screws is recommend
- In cases with totally edentulous arches, clinicians should consider designingtwo independent fres to facilitate implant insertion during the ocedure , This issue is particularly important when high fixation zones are selected

- Specific surgical templates are recommended to guide the removal of the resid ual alveolar ridge , This improve the adaptation of CSI, fitate its, and reduce the risk of postoperative soft tissue dehis cence
- From a biomechanical perspective, there is no contraindication for conn previously placed conventional dental implantsI
- is advisable to print a 3D model of the patient before surgeryDesign and Production of Patient-Specific Subper
  Utilizing Exoplan 3.0 Galway software (Exocad GmbH, Darmstadt, Germany), thecollected Digital Imaging and Communications inMedicineformat(DICOM)data form the CBCT scans were processed to reconstruct the residual anatomical structure o patient's bone in three dimensions; we subsequently saved the model as a standard tessellation (STL) file. Appropriate threshold values were meticulously selected to accurately render the cortical boundaries of the remaining bone. This process also included the strategic placement of the osseous fixation screws. Subsequently, the STL file underwent refinement within Exocad Galway 3.0 software (Exocad GmbH, Darmstadt, Germany), where descattering, removal of irregularities, and rectification of mesh anomalies were performed, thereby J. Pers. Med. 2024, enhancing the visualization of the requisite prosthetic emergence profile and .facilitating superior implant design

Continuing within the same digital framework, the surgical cutting guide and the implant framework were constructed based on the STL files. Precise locations for the osteosynthesis screws were designated, and internal threading was incorporated to ac commodate the multi-unit abutments. The edges were refined, surfaces were smoothed, angles were rounded, and the congruency of the implant with the bone .surface was verified J. Pers. Med. 2024

render the cortical boundaries of the remaining bone. This process also included the stra tegic placement of the osseous fixation screws. Subsequently, the STL file underwent re finement within Exocad Galway 3.0 so

comprehensive final designs were prepared for the manufacturing phase and subsequently sent to be printed with a DMLS system (Mysint 100, Sisma S.p.A., Piovene Rocchette, Italy) and titanium alloy powder (PowderRange Ti64, Carpenter Technology Corporation, Philadelphia, PA, USA). In total, 61 hybrid prostheses were

fabricated and before packing and delivering, acid etching, plasma cleaning, and autoclave sterilization were perfor

Step by step surgical procedure

Number of surgeries and clinical procedure When placing a dental implant, the number of surgeries that are necessary to complete the process of implantation plays an important role. The patient will always prefer a treatment that is the less invasive possible and therefore, one surgery will be preferable when comparing to two surgeries. As before mentioned, the first generation of subperiosteal implants used to encompass two surgical procedures. With the constant technological developments, new strategies were implemented, and it became possible to perform this kind of subperiosteal dental restoration in one surgery only. To place an endosseous dental implant, one surgical intervention is usually enoughDespite being possible to place an endosseous implant in only one surgical intervention, very aggressive techniques are associated with this type of dental restoration. Before placing the implant, the dentist needs to prepare and drill the bone, making it an extremely invasive procedure, that causes a lot of discomfort to the patient. In addition, the trauma caused by this type of surgical intervention, together with other factors such as occlusal overload and the presence of micro-gaps may induce bone loss around the implant.In its turn, the loss of bone in the peri-implant zone is expected to lead to the implant's exposure and inherent aesthetical issues and ultimately, induce the implant's mobility and consequent failure. To place a subperiosteal implant there is no need to drill the bone but, given the dimensions and geometry of the implant, big incisions have to be performed in the gingiva and high quantity of bone needs to be exposed for the settling of the implant. Furthermore, the strategies used to reduce the fit mismatch between the implant and bone make this procedure even more invasive and literature reports high levels of discomfort to the patient. Surgical Procedures The surgical procedure for placing modern subperiosteal implants (SPIs) has undergone significant advancements, resulting in a more efficient, less invasive, and highly precise process compared to conventional methods. Below is a detailed description of the current .surgical protocol and its benefits

Surgical Procedure Steps :

1.Anethesia

To ensure patient comfort throughout the procedure, local anesthesia is administered. Typically, 2% mepivacaine with 1:100,000 adrenaline is used for hemostasis. Each 1.8 mL cartridge contains 36 mg of mepivacaine hydrochloride and 18 mg of adrenaline, . providing effective anesthesia and minimizing intraoperative bleeding

2. Patient preparation :

The patient is prepared following standard surgical protocols, including scrubbing and draping with povidone-iodine surgical scrub. This preparation maintains a sterile . environment and minimizes the risk of infection

3. Incision and flap design :

A pyramidal flap is raised using three incision lines. The crestal incision is placed toward the palatal aspect of the crest of the ridge, made between the two teeth bounding the edentulous area. Two oblique releasing incisions are made at the distal ends of the crestal incision, allowing for adequate exposure of the bone

4. Bone exposure and implant placement :

After exposing the bone, the custom-made titanium subperiosteal implant is positioned on the bone surface. The implant is then secured using 2.0 mm grade-five titanium screws, ensuring a stable and precise fit, which enhances the implant's integration with the bone

5. Verification and adjustment :

Following the placement of the implant, the surgeon verifies its fit and stability. Any necessary adjustments are made to ensure the implant is correctly positioned and will .function effectively once the surgical site heals

6.Suturing :

The surgical site is closed using 3-0 Vicryl sutures. This promotes proper healing and protects the implant from exposure to the oral environment during the initial healing phase

Postoperative care and healing

Clinical Outcomes at Follow-UpIn the research conducted by Dimitroulis et al. postoperative monitoring was integral in ensuring the wellbeing of patients who received implants. Each patient underwent an evaluation using X-rays to detect any issues, such as broken screws or any compromise in the implant's structural stability.

Follow-up appointments involved the removal of prostheses to check for signs of infection discharge pockets around the posts or any indications of wound separation, which could expose the implant framework. Success in evaluating implants was based on factors such as the patient's comfortability to chew without pain, normal speech patterns, and satisfactory appearance. Criteria related to implants included ensuring no exposure of the metal baseplate, absence of movement, no clinical infections, and no X-ray evidence suggesting loosened screws or fractured prostheses. The presence of pink, keratinized gingiva surrounding each transmucosal post was also noted as a key indicator of success. The effectiveness of subperiosteal implants relies heavily on their ability to adhere functionally to bone. The process of osseointegration, where bone cells connect to the surface, is quite intricate and influenced by numerous factors These factors include the material and surface properties of the implant, the . congruence between the implant and bone, and the surgical techniques used. A lack of direct contact between the implant and bone often leads to fibrous integration instead of osseointegration

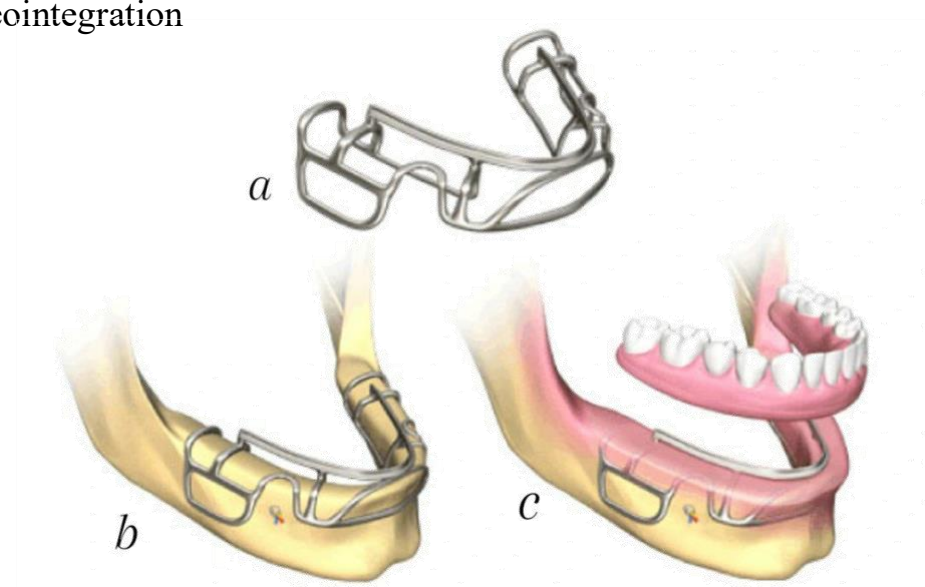


Figure 5-1 : a, Framework constructed. b, Framework confirmed. b, Framework inserted under gum onto jaw bone

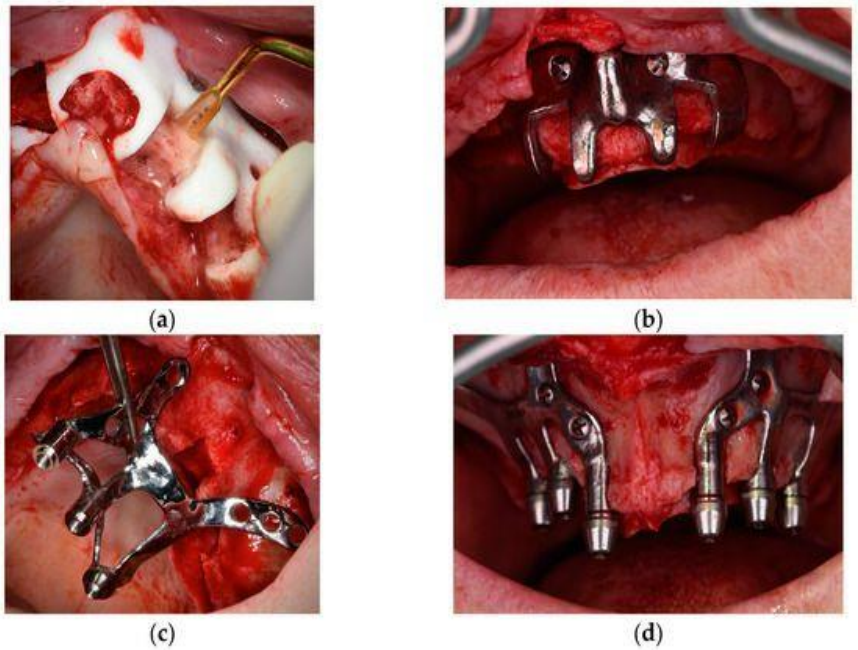


Figure 5-2 : Surgical template used to remove the residual alveolar ridge. a, Polyamide template. b, Titanium alloy template. c-d, CSI placement.

Complications Associated With Dental Implants

Implant-supported single crowns and multiple implant-supported bridges may suffer from various mechanical, biological, or technical complications [Table 1] Poor patient selection is one of the important factors that adversely contribute toward failures in implant dentistry.

Mechanical complications	Technical complications	Biologic complications
Screw loosening	Fracture of veneering porcelain	Adverse soft-tissue reactions
Screw fracture	Fracture of the framework in implant-supported fixed partial dentures	Sensory disturbances
Cement failure		Progressive marginal bone loss, loss of integration

Mechanical complications

Are usually a sequel to biomechanical overloading. Factors contributing to the biomechanical overloading are poor implant position/angulation (cuspal inclination, implant inclination, horizontal offset of the implant, and apical offset of the implant), insufficient posterior support (i.e., missing posterior teeth), and inadequate available bone or the presence of excessive forces due to the parafunctional habits, that is, bruxism.

Screw loosening

Overloading of the implants usually causes loosening or fracture of the implant component. stated that screw loosening or fracture prevailed more with the prosthetic screws as opposed to the abutment screws. Implants restored with single

crowns have shown more screw loosening as compared to multiple implants with multiple restored units, and mandibular molar implant restorations are more affected by screw loosening as compared to the maxillary ones. In another study, the incidences of loosening of the abutment screw or the abutment were found to be 59.6% in a follow-up of 15 years.

In a systemic review by Pjetursson *et al*. the yearly rate of abutment or screw loosening ranged from 0.62% to 2.29% that converts into a 5-year complication rate ranging from 3.1% to 10.8%. In another follow-up study of Branemark single-tooth implants, screw loosening was reported to be the most frequent complication.

To ease the incidence of screw loosening, it is advised to maximize the joint clamping forces while curtailing joint separating forces. Joint separating forces include excursive contacts, cantilevered contacts, interproximal contacts, off-axis centric contacts, and nonpassive frameworks. In an article by SadidZadeh *et al*. , it was suggested to torque the abutment or the screw retained crown, with twice the force recommended by the manufacturer at an interval of 5 min between each rotation. Over the course of years, many manufacturers have revised the conventional implant components to reduce the incidents of screw loosening.

Screw/implant fracture

There are two major causes of implant fracture: biomechanical overloading and peri-implant vertical bone loss. The risk of implant fracture increases multifold when the vertical bone loss is severe enough to concur with the apical limit of the screw. Implant fractures are also attributable to flaws in the designs and manufacturing of implant itself. Unnoticed and recurrent screw loosening is a risk factor for dental implant fracture, which indicates change in the prosthesis design.

The most frequently encountered fracture is of the hexagonal head away from the main body of the screw. When a screw is loose, it is more disposed to excessive sideward load. Fracture of the implant abutment screw can be a grim setback as the

remaining fragment inside the implant jeopardizes the efficient functioning of the implant.

When patients wear an implant-supported prosthesis (fixed or removable), there is a decrease in the occlusal forces which ranges from 200 to 300 N. The failure of implant abutments occurs when the lateral forces exceed 370 N for the abutments having the joint depth of at least 2.1 mm and 530 N with a joint depth of at least 5.5 mm.

Implants with a smaller diameter of 4 and 3.75 mm are inclined to fractures more easily than those with the greater diameter.It has been reported that an implant having a diameter of 5 mm is three times stronger than the one with the diameter of 3.75 mm, while an implant of 6 mm diameter is 6 times stronger than a 3.75 mm implant.

The risk factors associated with implant components are categorized into three groups and are enumerated in Table 2.Abutment screw fracture and loosening can be reduced if certain strategies are followed. These include careful treatment planning, understanding of the occlusal scheme, tightening the implant to the recommended torque, and routine follow-up appointments.

Periodontal factors	Implant factors	Prosthetic factors
Pocket depth >5 mm	Diameter <4 mm	Loosening/torsion
Bone loss	Crown/implant >1	Prosthesis screw
Occlusal overload (bruxism)	Implants design	Cantilevers Ceramic fracture

Cement failure

Cement failure is another consequence of biomechanical overload, typically affects the prosthesis attachment and may be treated by recementation procedure. With the advancements in material science, particularly for luting agents, the incidence of decementation has reduced significantly. However, careful treatment planning and clinical criteria must be followed to avoid such incidences.

Technical complications

The frequency of occurrences of technical complications is greater in implant-supported FPDs as compared to the implant-supported removable prosthesis.

Fracture of the framework

Whenever there is a rigid connection between the osseointegrated implant and the fixed subsequent framework, the strains are inevitably induced in every component of the framework. The additional functional load produces supplementary strains, which affect the bone-implant-prosthesis assembly. Hence, the challenge remains for a prosthodontist to deliver a tolerable prosthesis that does not jeopardize the endurance of the treatment. Therefore, passive fit of the framework has been advocated as a requirement for successful long-term osseointegration of the implant with the surrounding bone.

The problem of fracture of framework is reportedly exaggerated in partially edentulous jaws, because the implant-abutment interface and abutment retention screw are exposed to higher lateral bending loads, tipping, and elongation as compared to bilaterally splinted implants in a completely edentulous jaw. The length of the cast bar or framework span is directly proportional to the construction-related distortion, which could get worsened by nonparallel placement of dental implants .

To correct the gross misfit of the abutment–superstructure relationship, cutting the framework or bar and then joining the sections by welding or soldering is recommended, but both techniques may further impair the original fit. Since the

corrective methods usually lead to a misfit, in order to avoid the need for such corrections, it is recommended that effort must be made to improve the original/initial fit of the cast frameworks. Factors that influence the accuracy of the initial fit of the framework include the impression material , impression technique,and positional stability of the transfer posts. Refined approaches and detailed and accurate prosthodontic procedures are still a requisite to achieve a passive fit with an implant-supported superstructure.

Peri-implantitis

Biological failures include bacterial infections, microbial plaque buildup, progressive bone loss, and sensory disruptions.Biological complications are subcategorized into early biological failures and late implant failures, where the early failures are attributed to the failure of placing the surgical implant under proper aseptic measures and the late complications are typically peri-implantitis and infections bred by bacterial plaque.

Peri-implant disease is defined as the inflammatory pathological change that takes place in the soft and hard tissues surrounding an osseointegrated implant.When an implant is successfully osseointegrated, the peri-implant disease that occurs is the consequence of disparity between the host defense and increasing bacterial load. It usually takes about 5 years for the peri-implant disease to progress and exhibit clinical signs and symptoms.

The incidence of peri-implantitis and implant loss could be greater if the studies with longer follow-up periods are evaluated.In a healthy environment around the implant, the tissues play a pivotal role in preventing the spread of agents that can be pathognomonic, and if the biological barrier is breached, it could lead to bacterial contamination around the bone resulting in hasty destruction of the tissues surrounding the implant. The peri-implant disease is also related to unequal occlusal load distribution, which may lead to loosening of the superstructure, infection of the surrounding area, eventually culminating into the inflammatory process.

Predisposing systemic conditions include uncontrolled diabetes mellitus, osteoporosis, smoking, long-standing treatment with steroids, uncontrolled periodontitis, radiation therapy, and chemotherapeutics. Table 3 enumerates clinical and radiographic symptoms that may be associated with peri-implant disease.

Probing depth <6 mm
Bleeding on probing/suppuration
Attachment loss/bone loss of 2.5 mm
Vertical destruction of crestal bone on radiographs
Possible swelling and hyperplasia of the peri-implant tissues
Pain (unusual) if present, depicts acute infection

The peri-implant disease treatment strategies have been explored and employed to prevent failure of the implant treatment. They include nonsurgical mechanical debridement, local antimicrobial delivery in periodontitis and peri-implantitis, and surgical debridement with bone grafting. Implant removal is warranted if there is more than 60% of bone loss following

peri-implantitis, and there is an evidence of mobility.

Figure.1 An open tray impression taken using addition cured silicone. Poor implant angulation can be judged which could lead to a mechanical failure

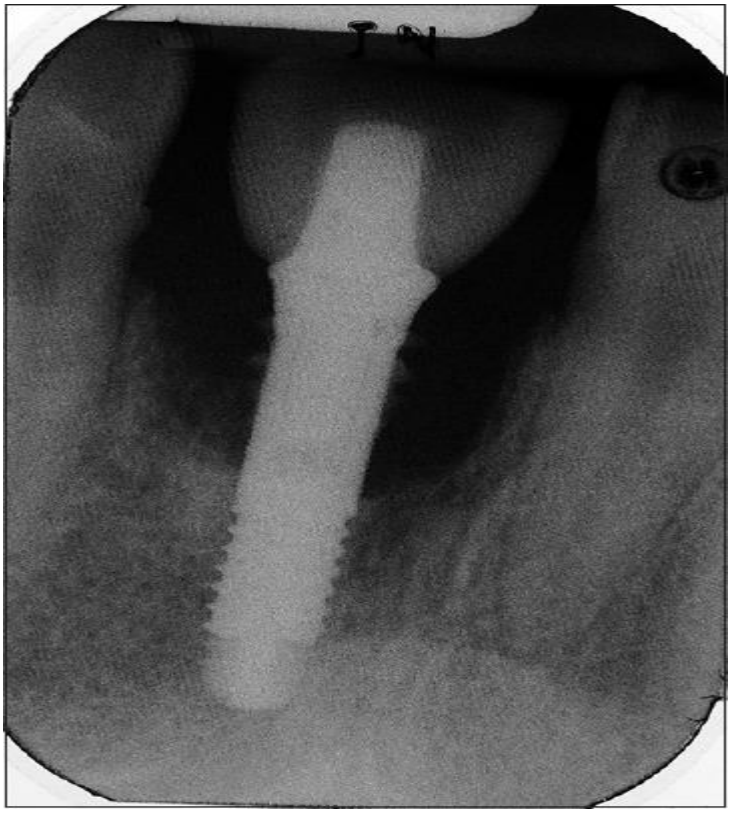


Figure. 2 Radiographic picture showing significant bone loss around the implant

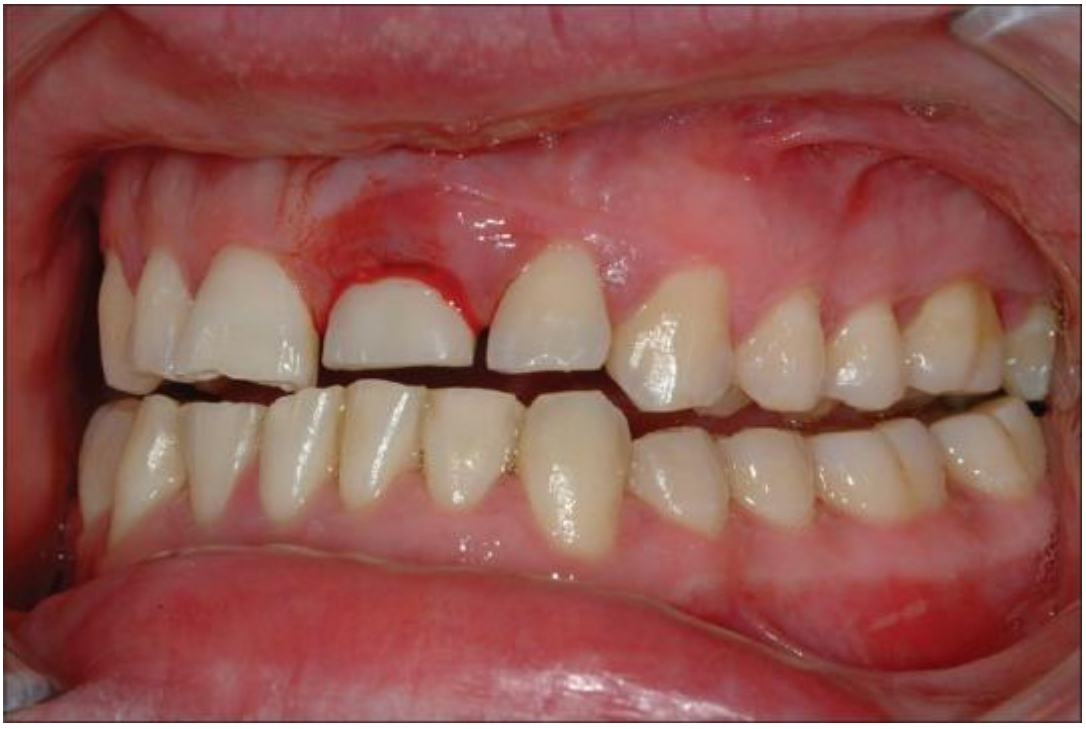


Figure.3 Soft-tissue inflammation caused due to peri-implantitis

Figure.4 Esthetic dental implant failure

Figure.5 Minor complication of dental implant during follow up

Aesthetic Considerations of Subperiosteal Implants

While subperiosteal implants are primarily used for functional rehabilitation in cases of severe jawbone resorption, aesthetic outcomes remain an essential part of treatment planning, especially in the anterior maxilla. Here's how aesthetics are considered and optimized with subperiosteal implants:

1- Soft Tissue Contours and Volume

a. Gingival Architecture

• Natural-looking soft tissue contours are important for a lifelike prosthetic appearance.

• Challenges:

• Lack of keratinized tissue.

• Irregular ridge form due to bone loss.

• Solutions:

• Soft tissue grafting (connective tissue or free gingival grafts) before or during implant placement.

• Customized healing abutments or provisional restorations to shape tissue.

b. Tissue Thickness

• Thicker soft tissue biotype:

• Reduces risk of mucosal recession.

• Masks implant posts (especially in thin biotypes or high smile lines).

• Soft tissue augmentation (e.g., dermal grafts) may be needed to achieve pleasing contours.

2- Implant Post Positioning

• Prosthetically driven planning ensures that posts emerge in ideal positions for crown or denture placement — critical for natural tooth appearance.

• Poorly positioned posts can:

• Cause bulky or unnatural prosthetic designs.

• Lead to visible metal or shadowing in thin tissue.

3- Smile Line and Lip Support

• In edentulous patients, subperiosteal implants must restore:

• Vertical dimension of occlusion (VDO)

• Lip support — especially in the upper anterior region.

• Proper prosthetic contouring can rejuvenate facial aesthetics and improve soft tissue drape.

4- Material Selection

• Subperiosteal frameworks are usually made from titanium, but:

• Zirconia-coated posts or custom abutments may be used to enhance esthetics in visible areas.

• Porcelain or high-quality acrylic used in prosthesis to match adjacent teeth or provide life-like translucency.

5- Ridge Deficiencies

• Subperiosteal implants often address severe atrophy, leading to flat or irregular ridge contours.

• Aesthetic prosthetic design must compensate for:

• Lost gingival volume.

• Lost papillae.

• Use of pink porcelain or acrylic simulates gingival tissues for a natural look.

6- Patient-Specific Esthetic Planning

• Digital smile design (DSD) can be used to:

• Simulate esthetic outcomes.

• Aid in communication with patients and lab technicians.

• Adjust post positioning and prosthetic contours virtually before surgery.

Aesthetic Considerations for Subperiosteal Implants

1- Gingival Contouring and Soft Tissue Management

Achieving natural, healthy-looking gingival architecture around subperiosteal implants requires careful surgical and prosthetic planning.

Key Points:

• Flap Design: Ensures optimal tissue adaptation around implant posts, preventing dehiscence or recession.

• Tissue Thickness: Thicker biotypes are more esthetic and stable; grafting may be needed for volume and keratinized tissue.

• Provisional Shaping: Temporary crowns or custom healing abutments are used to gradually sculpt the gingival margin and papilla.

• Tissue Grafting (if necessary): Connective tissue or free gingival grafts enhance volume and esthetic blending.

• Contour Trimming: May involve laser or electrosurgery to fine-tune tissue around emergence profiles.

Goal: Create a seamless, symmetrical, and natural soft tissue transition around prosthetic components.

2- Matching Implant Prosthetics with Natural Teeth

Prosthetics must mimic natural teeth in color, shape, size, and emergence profile.

Key Considerations:

• Prosthetic Planning: Done virtually using smile design tools and CBCT/intraoral scan integration.

• Emergence Profile: Posts must emerge in esthetic zones for lifelike prosthesis alignment.

• Material Selection:

• Zirconia or porcelain for crowns to match translucency and shade of natural enamel.

• Pink ceramics/acrylic to mimic missing soft tissue when bone loss is significant.

• Tooth Morphology: Customized crown shapes, lengths, and textures replicate adjacent teeth.

• Lip Line & Smile Design: Important in the maxillary anterior region; restoration must support lips and harmonize with facial features.

Goal: Create a prosthesis that is indistinguishable from the patient's natural dentition, especially in the smile zone.

3- Long-Term Aesthetic Outcomes

Long-term esthetic success depends on tissue stability, prosthetic durability, and maintenance.

Strategies for Success:

• Stable Soft Tissue: Ensure adequate keratinized mucosa and manage soft tissue with grafts and gentle flap techniques.

• Tissue Biotype Maintenance: Thicker tissues resist recession and bone remodeling over time.

• Avoiding Metal Exposure: Use zirconia posts or soft tissue thickening to prevent grayish hue in thin tissues.

• Prosthetic Durability: Use high-quality materials resistant to wear and staining.

• Maintenance Protocols:

• Patient education on hygiene around implants.

• Regular professional cleaning and monitoring.

• Adjustments as needed to compensate for soft tissue or prosthetic changes.

Goal: Maintain soft tissue harmony, prosthetic integrity, and patient satisfaction over many years.

Conclusion: Subperiosteal Implants with a Focus on Aesthetics

1. Summary of Key Points :

• Subperiosteal implants are a viable alternative for patients with severe alveolar ridge resorption who cannot undergo bone grafting or traditional endosseous implants.

• These implants are custom-designed to sit on top of the bone but beneath the periosteum, offering stability in patients with compromised bone conditions.

• From an aesthetic perspective, subperiosteal implants can offer excellent soft tissue support and facial contour restoration, especially in the posterior mandible and maxilla.

• The use of modern imaging (e.g., CBCT) and CAD/CAM technologies has significantly improved the precision and aesthetic outcomes of these implants.

2. Final Thoughts on Aesthetic Considerations Aesthetic outcomes in subperiosteal implants are heavily influenced by:

• The design accuracy of the framework,

• The soft tissue management during and after surgery,

• And the ability to restore the natural contours of the gingiva and facial profile.

While not the first-line choice for aesthetics, in complex cases, subperiosteal implants can yield surprisingly favorable results when carefully planned.

Recommendations for Practitioners

• Case selection is crucial: Reserve subperiosteal implants for patients who are not candidates for bone grafting or endosseous implants.

• Utilize advanced imaging and digital planning to ensure a precise fit and optimal soft tissue support.

• Collaborate closely with prosthodontists and lab technicians to optimize esthetic parameters such as emergence profile and crown morphology.

• Focus on patient education, setting realistic expectations for both functional and aesthetic outcomes.

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