Craniofacial Prostheses

PROSTHETICS CONCEPTS

PHYSICAL PROSTHETICS

CRANIOFACIAL PROSTHESES

PROSTHESES OF THE NECK

LOWER-LIMB PROSTHESIS

ASSEMBLY OF ENTIRE LIMP

REHABILITATION ROBOTICS

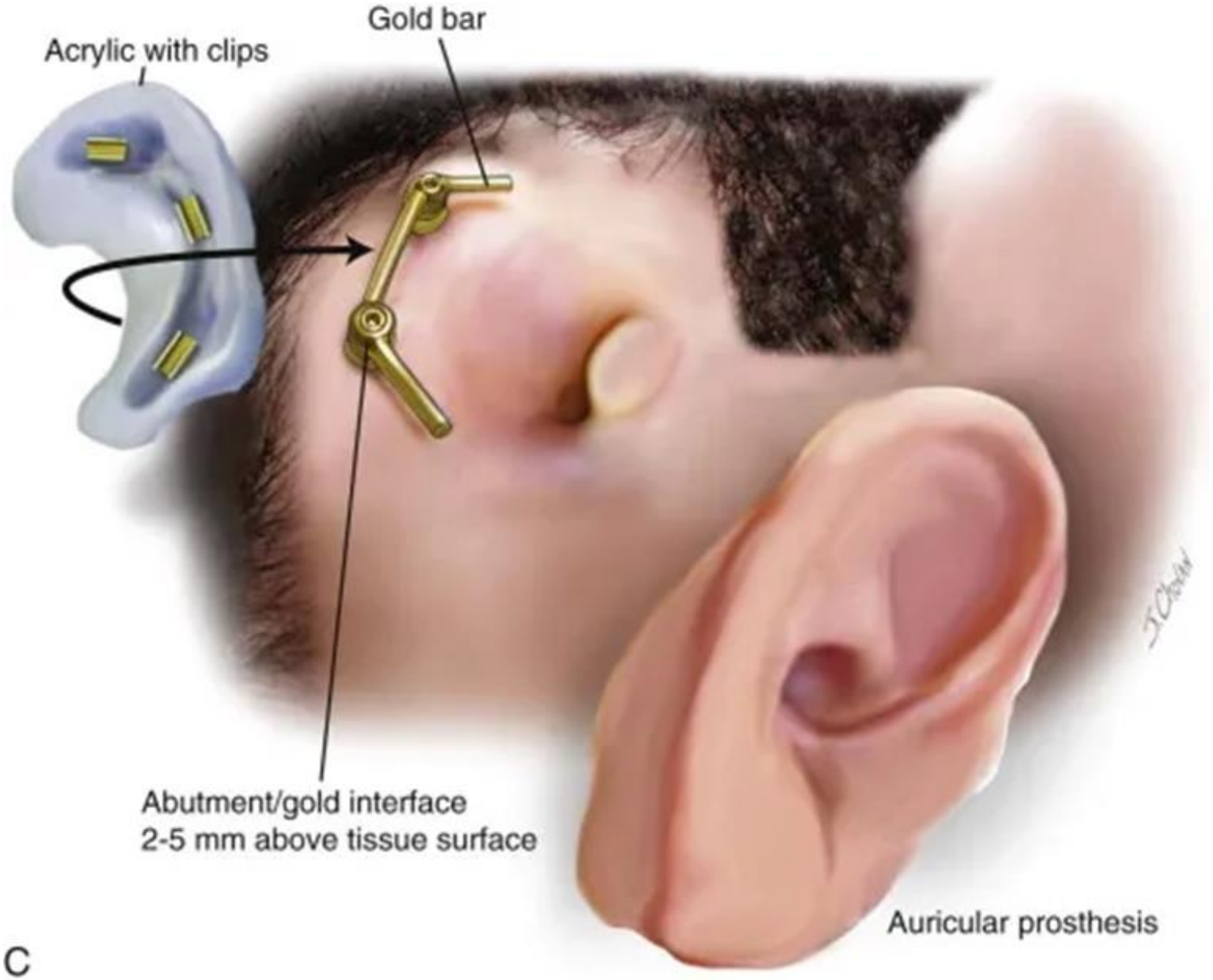
UPPER-LIMB PROSTHESIS

SENSORY PROSTHETICS

BREAST AND PENILE PROSTHESES

craniofacial prostheses for facial defects

Craniofacial prostheses, are artificial substitutes for facial defects. The breakthrough for rehabilitation of facial defects with implant-retained prostheses came with the development of the modern silicones and bone anchorage. Following the discovery of the osseointegration of titanium in the 1950s dental implants have been made of titanium in the 1960s. In 1977, the first extraoral titanium implant was inserted in a patient. Later, various solitary extraoral implant systems were developed. Grouped implant systems have also been developed which may be placed more reliably in areas with low bone presentation, as in the nasal and orbital region, or the ideally pneumatised mastoid process. Today, even large facial prostheses may be securely retained. The classical atraumatic surgical technique has remained an unchanged prerequisite for successful implantation of any system.


Acrylic with clips
Gold bar
Abutment/gold interface
2-5 mm above tissue surface
Auricular prosthesis
C

Craniofacial prosthetic rehabilitation

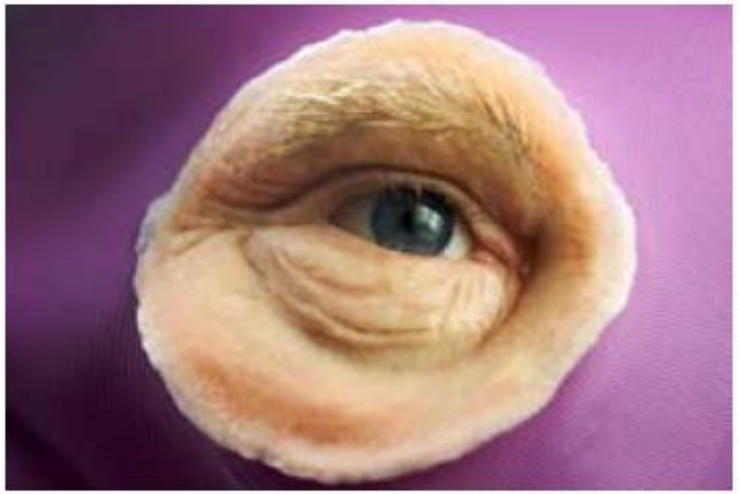
Defects or deformities in the head and facial area almost always lead to a severe emotional burden requiring rehabilitation. Here the complex aesthetic units of ear, nose and orbital cavity are predominant. In principle, two paths can be followed, those of either plastic surgery or prosthetic rehabilitation. The procedures involved in plastic surgery are extremely suitable for the correction of less complex aesthetic units or partial defects of the ear, nose and orbital cavity. Particularly mobile areas such as the lips are difficult to be adequately treated with prostheses and should definitely be surgically reconstructed, even if the remaining defect is treated with a prosthesis. This may be accompanied by possible visible traces of flap raising in an adjacent aesthetic unit

Materials for craniofacial prostheses

Following the large number of materials that have been tried out in the long history of anaplastology , as for example porcelain, natural rubber, gelatine and latex, two have established themselves: methacrylates and silicones. Methacrylates have the advantage of being more durable, they are, however, relatively hard. Silicones, on the other hand, are both soft and flexible and keep

body temperature. Hair and skin features such as pigmentations can be easily introduced (Figure). The edges can

be stretched so thinly as to become transparent. This enhances camouflage of the prosthesis as the intersection between the surrounding skin and the prosthesis is fluid. With modern silicones it is possible to produce prostheses of outstanding cosmetic quality



Orbital prosthesis made from silicon. Note the thin, transparent edges

Methods of retention of craniofacial prostheses

The anchorage of prostheses can be achieved in four ways :

1- anatomical anchorage (to already existing anatomical structures such as undercut areas in the cavities of an orbital defect)

2- mechanical anchorage (for example to spectacle frames)

3-chemical anchorage (using adhesives)

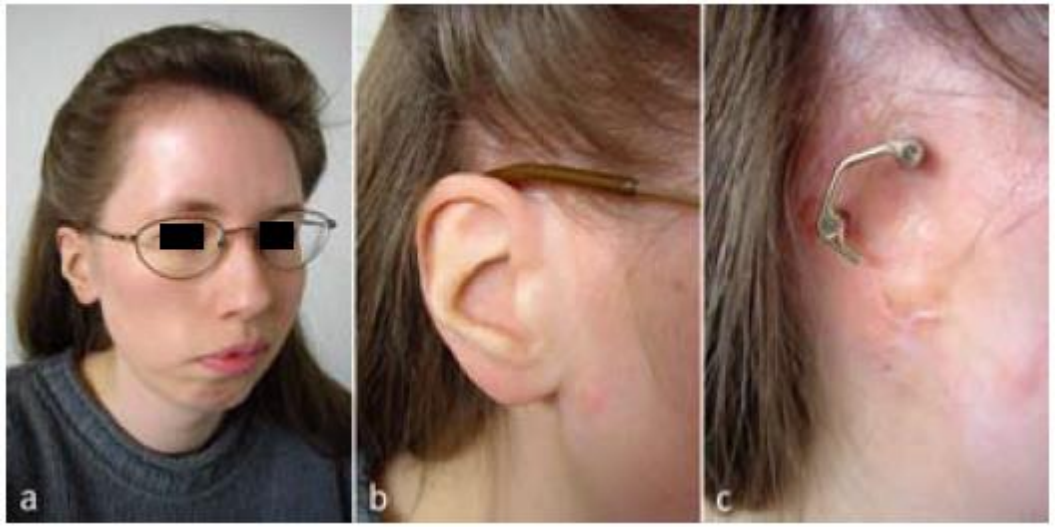
4-surgical anchorage (e.g. using surgically created retention elements)

Today, surgical anchorage is carried out using skin penetrating osseointegrated titanium implants (Figure) on the bone . It has superseded surgical procedures such as various flaps for the creation of skin pockets for securing prostheses. Due to the secure retention, bone anchorage has contributed to a breakthrough in prosthetic rehabilitation . The first use of titanium fixtures outside the oral cavity was by the Oto-Rhino-Laryngologist Anders Tjellstöm in 1977 for a bone-anchored hearing aid , and in 1979 for a bone-anchored prosthesis.

Figure 2: Implant systems for bone-anchored craniofacial prostheses. Left: Epitec system, back left: Brånemark system, back right: ITI system, front: universal plate of the Epiplating system, right: titanium bone screws with lengths of 4, 5.5 and 7 mm.

Bone anchorage has the following advantages :

- enhanced and reliable retention
- retention is not affected by environmental factors (e.g. sweating)
- facilitated insertion of the prosthesis into the proper position by the patient himself
- the convenience of wearing is improved by not using adhesives and fewer skin occlusions
- the abovementioned thin, transparent edges of silicone prostheses can be maintained longer than with adhesive prostheses.



Extraoral implant systems

For many producers, extra-oral application plays a subordinate role to that of dental application. The classic Brånemark system (Figure 2) as a solitary screw implant, as well the large number of analogous systems from the field of dentistry are collectively referred to here under the term “solitary implants”.

Brånemark system:

The Brånemark system (Figure 3) was the first implant system to be used extraorally. The longest and most extensive experience has been gathered with this system. For the extraoral area, titanium screws of a length of 3 and 4 mm (and 5.5 mm) are available. The flange was originally designed to avoid an intracranial dislocation of the implant due to trauma. The flange is now available in closed form At present flangeless screws are also obtainable. Abutments can be held by a special clamp. It must be understood, however, that the clamp only reduces the torque by 10 Ncm so that care must be taken not to inadvertently overwind the implant. Currently the Brånemark system is being marketed by the Cochlear Company under the brand name Vistafix.

ITI systems

With ITI implants (International Team for Implantology) marketed by the Straumann company, a sand-blasted, large grit, acid-etched surface was introduced, the so called SLA surface. The resulting roughness is two-staged: the greater roughness of ca. 20 µm is overlaid by a finer roughness of 2 µm intervals [48]. For the extraoral region self-tapping titanium screws with a diameter of 3.3 mm and a countersunk depth of 3.5 or 5 mm with a coned seat, as well as with a diameter of 2.5 or 4 mm with flange (Figure 2). The longer screws which were designed for the extraoral region are also available with the hydrophilic SLActive surface.

Other systems with solitary implants

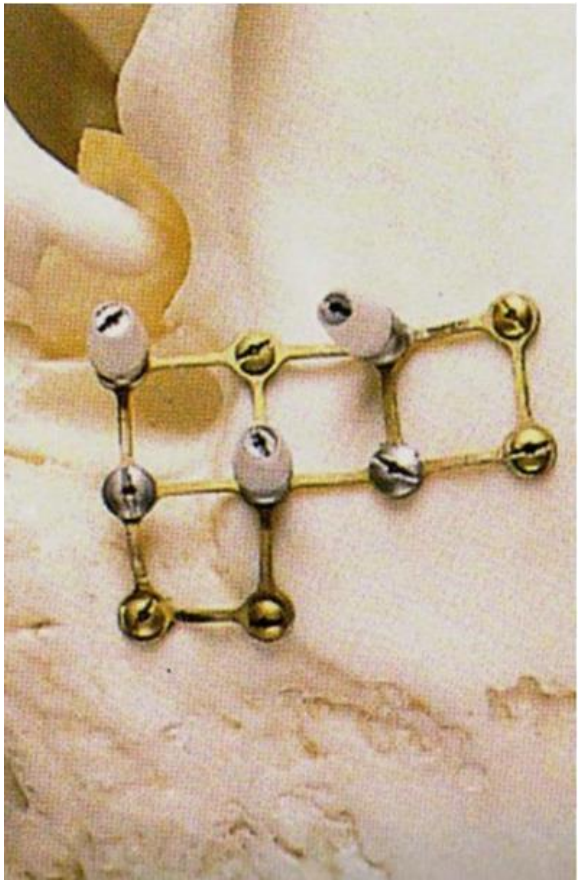
Some systems which were designed for the extraoral region, as for example the IMZ system marketed by Friatec (Friadent), or the epiplant system marketed by Mathys, are no longer on the market. Dentsply Friadent is currently marketing the Ankylos system. Yet another company, Southern Implants, is marketing extraoral screws of grade 4 titanium, as well as dental implants.

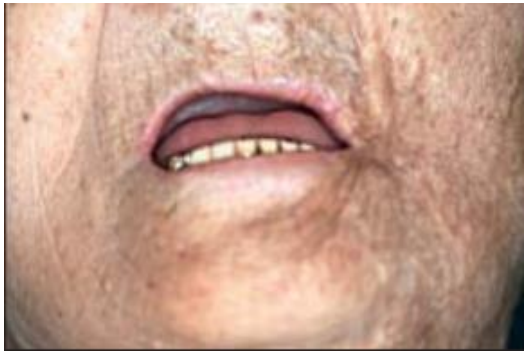
Extraoral systems with grouped implants

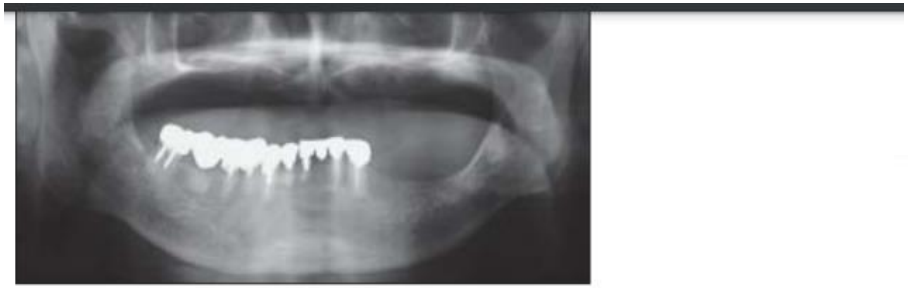
In contrast to the solitary implants, the forces are distributed across the plate over several titanium bone screws. An already thinned out area can be used again following the loss of another (solitary) implant. In this way a secure fixing in anatomically difficult regions with limited bone area is possible.

Epitec system

The Epitec system, credited with being developed in 1991 by Mostafa Farmand [52] and the company Leibinger, represents a great advancement. The system consists of a mouldable quadratic titanium grid with 16 thread holes, the so-called 3D carrier plate, and self-tapping 2 mm titanium screws which are available in lengths of 4.5 and 6 mm. The 3D carrier plate has to be cut to the required shape. For reasons of stability, as many connecting bridges between the single screw holes as possible must be maintained. Single extensions are not stable. Plate retention results primarily from the use of these monocortical bone screws. Secondary to this, the 1 mm thick connecting bridges of the 3D carrier plate will be covered over by bone. A thinning of the skin is usually not recommended. Due to the easy pliancy, constructions extending into the defect are currently no longer recommended. In order to screw on the mountings, only a thread height of 1 mm with 2 screw leads is available.







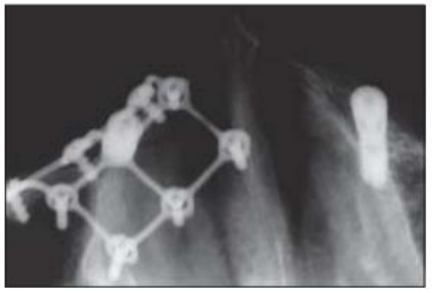
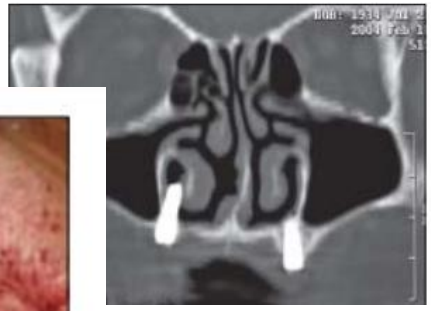
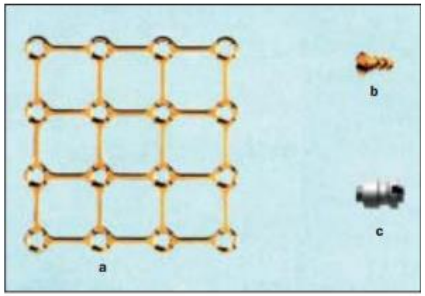
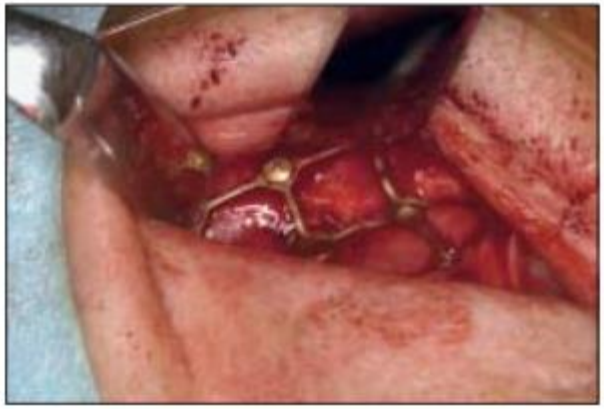
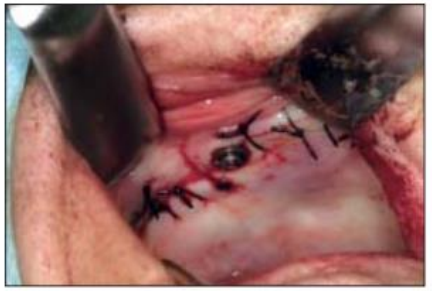


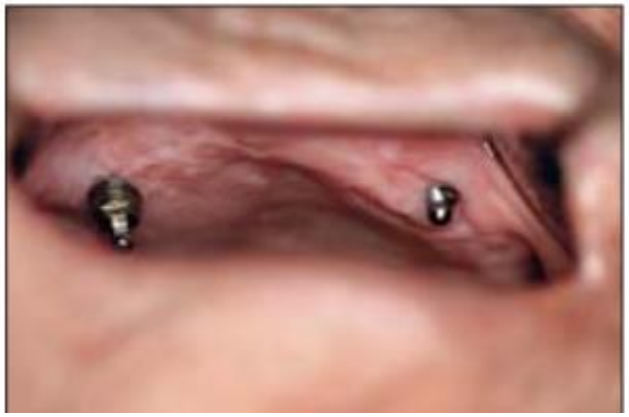
Fig 5b Occlusal radiograph showing a carrier plate fixed at the right canine region with 8 bone screws.

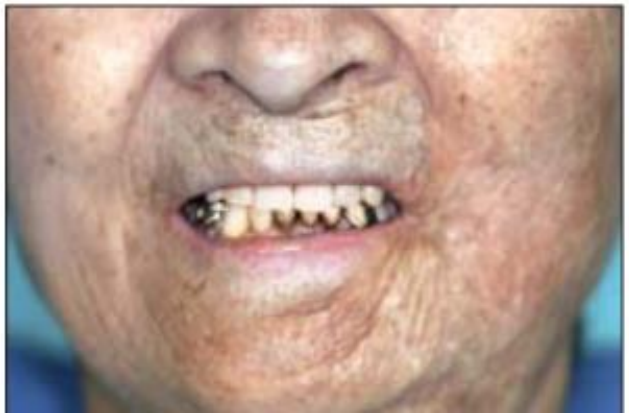












Epiplating system

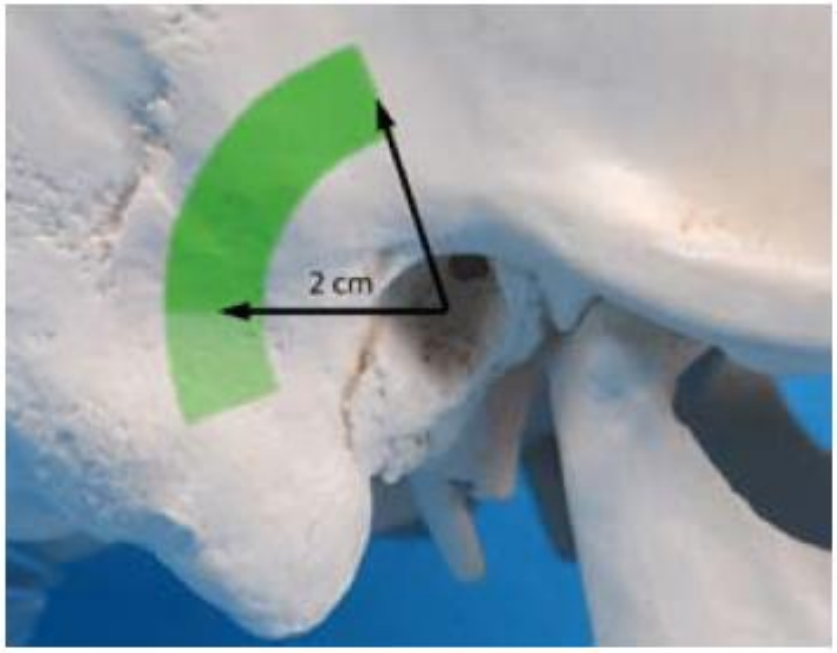
The Epiplating system (Figure 4) was developed in 2000 by the Medicon company in collaboration with P. Federspil, Ph.A. Federspil and M. Schneider . It is the adaptation of the 2.0 titanium mini-plate system produced by Medicon and used in traumatology to the requirements of anaplastology. Specially adapted implants are available for the auricular, orbital and nasal regions, as well as a universal plate. The titanium plates of the Epiplating system are 1 mm thick, but 2 mm in width and are thus stronger than the Epitec grid system. In the area of the tapped holes provided for the mountings, the thickness of the plate is 2 mm, appropriate for 4 thread turns, which counterbalances any tendency of loosening of the percutaneous base posts or magnets. To anchor the plates, titanium screws of 2 mm in breadth are used which are supplied as standard in the following lengths: 4, 5.5 and 7 mm. Thus the high stability known from plate osteosynthesis can be achieved. At the same time, the plates are more resistant against rotational forces which occur when screwing down and unscrewing the mountings. A counter instrument such as this as is usual in solitary implants does therefore not have to be used. Magnets can either be screwed directly into the plate or onto a base posts, as the height of the mounting requires. In addition, the Epiplating system can be combined with the hearing device abutment of the BAHA system .

Examples for the attachment of implants of the Epiplating system in the auricular, nasal and orbital regions.The trimmed universal plate in the glabella is only expedient in the case of resected nasal bones.

Planning implant position and regionally specific characteristics

1- Ear:

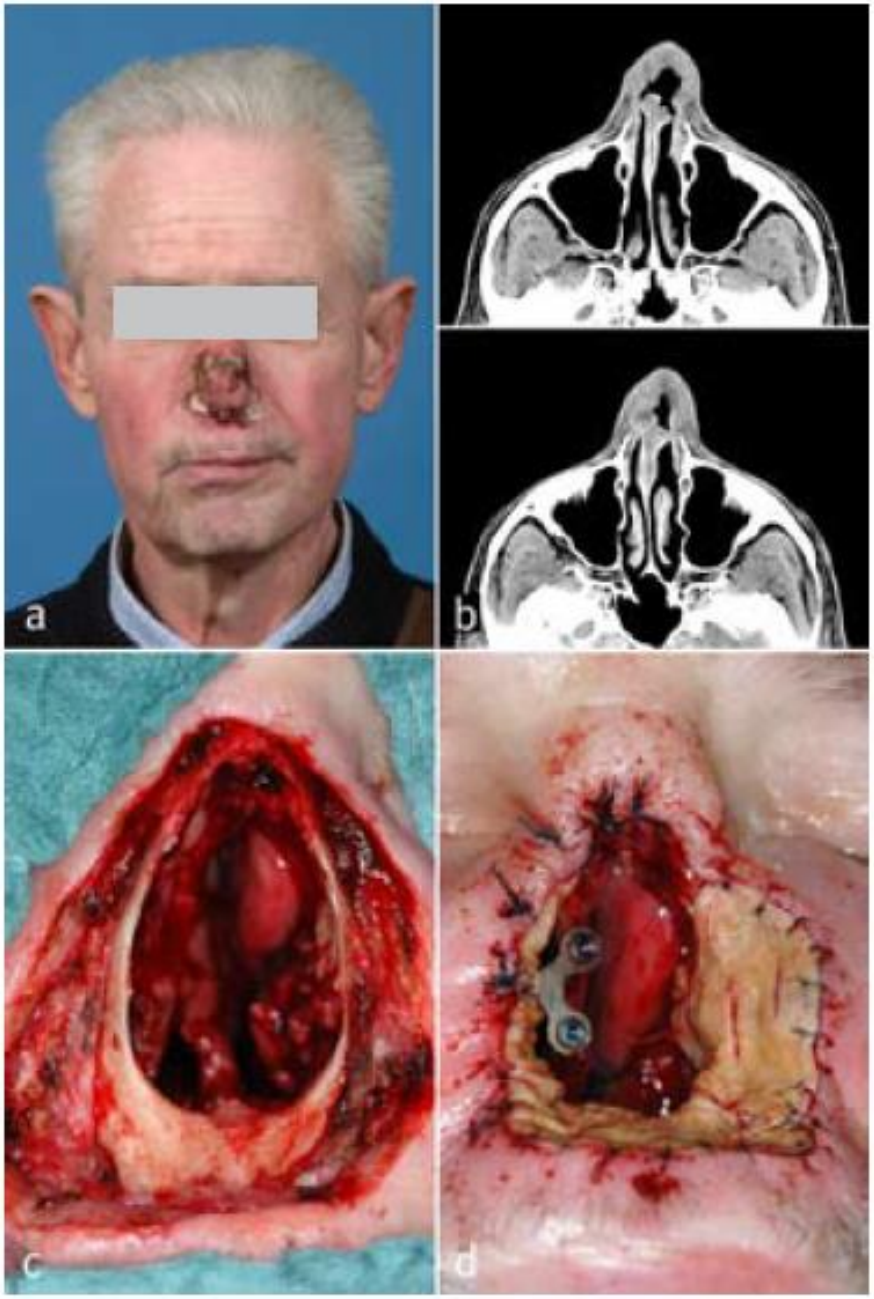
If the dial of a watch was to be projected onto the right ear, the classic regions for implantation would be eight o'clock or, even better, 9 o'clock, as well as between 10 and 11 o'clock at a distance of 2 cm from the external ear canal (Figure). This localization corresponds roughly with the anthelix and thus allows a sufficiently high space for the abutment of the auricular prosthesis. Two abutments are sufficient for a bar construction. When using magnets, a third magnet can improve retention. This is then usually placed caudally from seven to eight o'clock. If 3 magnets are used, they should preferably not be in a straight line. Any remnants of the auricle still present should, as a rule, be removed. In an ideal pneumatisation the cortical bone in adults is partially only 1–2 mm thick. In this case grouped implant systems have particular advantages. As well as the classic auricular plate with 2 tapped holes with the Epiplating system, a new plate with 3 tapped holes is also available. The optimum distance of 1.5 cm between the magnets is, in the case of the Epiplating auricular plate, already taken into account.



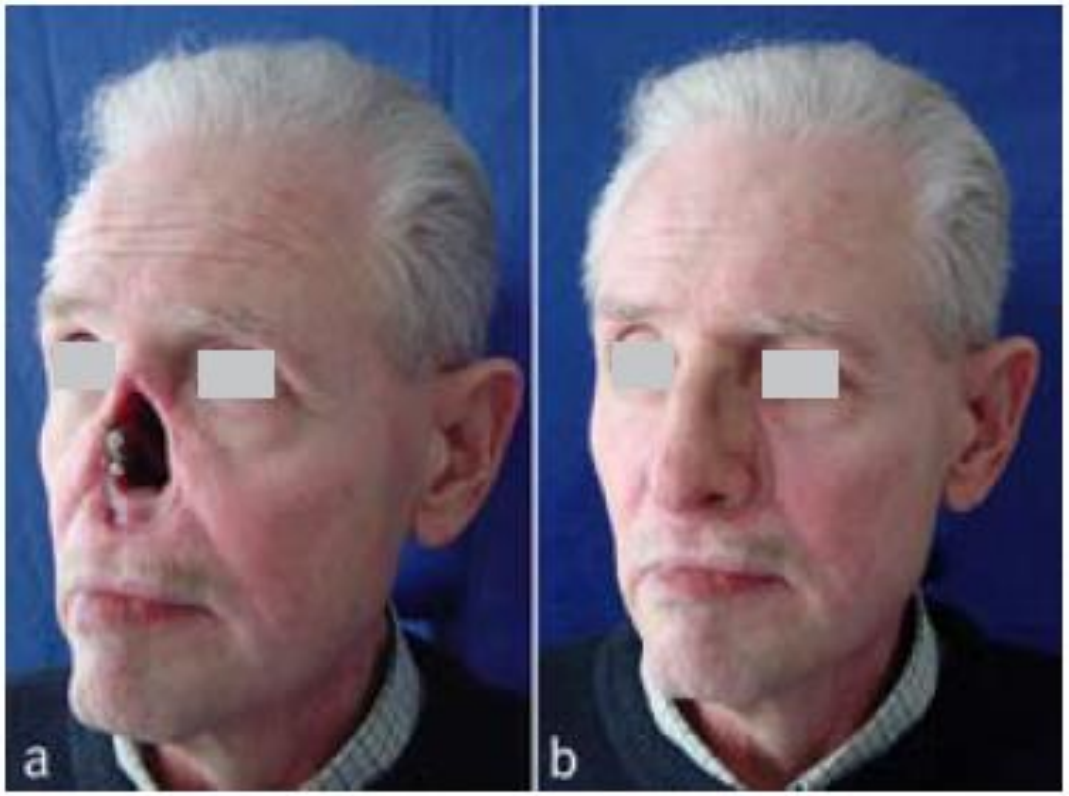
The ideal position for a structure for securing an auricular prosthesis on the right is marked in green. The distance to the center of the auditory canal is 2 cm.

2 -Nose

Due to the limited amount of bone available, the use of solitary implants in the nasal region is problematic. Provided that the nasal bone is completely removed, sufficient bone can be found around the glabella. Anchoring a nasal prosthesis to a solitary Brånemark implant in the glabella is possible. Otherwise solitary implants can be used solely at the nasal floor which, however, provides less a secure retention for the prosthesis. Good bone availability for the use of the Epiplating system can be found around the piriform aperture, and in particular at the frontal process of the maxilla. In addition, a universal plate of the Epiplating system can be implanted in the glabella (Figure Epiplating system).



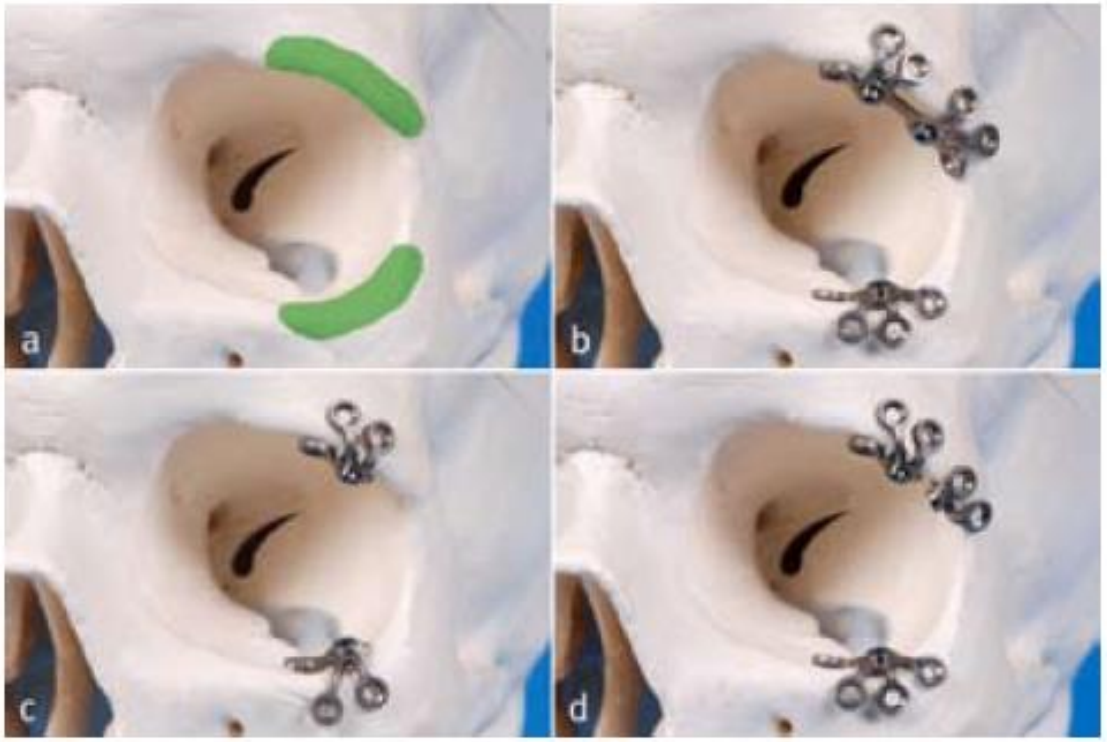
67 year-old patient with a squamous cell carcinoma of the inner nose. Recurrence after primary radiotherapy 1year earlier. b) The CT shows widespread infiltration. c) Intra-operative situation following tumour resection. d) An Epiplating nasal plate is inserted on the right. The tapped holes are secured with blue covering screws. Open wound areas are covered with split thickness skin transplants.



Patient from Fig. 9 two months after surgery. The implant is stable with no adverse skin reactions and is fitted with 2 magnet inserts (Steco). b) Patient with the bone-anchored nasal prosthesis

3-Orbital cavity

Classic implant regions are found in the laterocranial and laterocaudal orbital rim . The mediocranial area is too close to the frontal sinus and the bone in the mediocaudal area is usually too thin. No magnets should be placed laterally as here there is not enough height for the prosthesis. In the standard situation, an orbital plate of the Epiplating system can be implanted laterocranially for 2 magnets, and a universal plate laterocaudally for one further magnet. In the case of a small orbital cavity, 2 magnets distributed laterocranially and laterocaudally on one universal plate respectively are sufficient. Alternatively an orbital plate can also be divided and one half each distributed on the same positions. In the case of a flat orbital cavity, the Epitec or Epiplating system can be placed through the orbital cavity like a ladder in the sagittal plane. Alternatively, the flat orbital cavity must be secondarily deepened in order to achieve the necessary height for the prosthesis of around 1cm. The free transplantation of a non-vascularised bone from the iliac crest with the insertion of 2 solitary implants has also been reported. Alternatively, alongside the extraoral solitary implants, the longer dental implants may also be used. Thus Wächter et al.report on the use of 8, 10 and 12 mm long ITI titanium screws in the orbital region.



The ideal positions for implant placement for orbital prostheses are marked in green. b) Classic positioning of an orbital plate for 2 magnets (cranial) and 1 universal plate (caudal). The long eyelets of the orbital plate have been removed here. 4 arms were used form the universal plate. c) For smaller orbital defects, one magnet above and below is sufficient. Here an orbital plate was inserted in two halves. d) Other combinations are possible, here, for example, a halved orbital plate and a universal plate with 2 arms was inserted above. Below, a universal plate can be seen.

Advantages and disadvantages of implant-retained prostheses

Advantages	Disadvantages
Well suited for complex anatomic regions (ear, orbital cavity, nose)	Not well suited for the replacement of mobile parts of the face
Optimal camouflage	Must be removed at night
No donor site defects	+/- colour matching with changing complexion
Cosmetic results excellent and predictable	Discoloration due to cigarette smoke
Simple and quick methods	Costs
Early recognition of tumour recurrence	New prosthesis every 2 years
Secure retention	Maintenance for percutaneous parts
Edges of the prosthesis become transparent and allow smooth transition from the facial skin to the prosthesis	“foreign bodies”