Principles of Cortically Fixed At Once (CF@O)

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1. Introduction

Whenever the use of implants is being considered or has been decided upon, the perennial issue of possible bone insufficiency will have to be addressed. Any type of bone insufficiency - quantitative or qualitative, localized or more general - is a major obstacle to the use of implants, and so to prosthetic restoration.

Practitioners use various methods to resolve this problem, either by increasing bone volume (bone grafts, sinus lift, etc.) or adapting to the patient's bone volume by changing the size or shape of implants, implant sites and operative protocols.

We will describe the Principles of the Cortically Fixed at Once, which is a useful alternative to conventional implant placement in cases where there is substantial bone resorption (atrophic maxillae, resorption caused by trauma, substantial pneumatisation of the sinuses, etc.)

However, it is important to emphasize that this technique needs special training, complete mastery of the surgery involved and a very good knowledge of craniofacial anatomy. It is therefore intended for use by an experienced implantologist, or even a very highly experienced implant specialist, rather than a beginner.

2. Background

There were a number of different stages in the journey towards cortical implant placement and the foundations of CF@O; amongst other names, the discipline was called *basal implantology* in France, and indeed that name is still used today.

The term *basal implantology* was first used in 1972 by Jean-Marc Juliet. He described the advantages of using two cortical anchorages and developed an implant (T3D) consisting of a perforated rectangular titanium plate with a vertical pillar soldered onto it (Fig. 2.1).

In 1975, another French practitioner, Dr Clunet-Coste applied for a patent for an implant that was similar, but with a more rounded plate design with larger holes. He also proposed a system in which the pillar was screwed onto the implant (1).

Fig. 2.1 Implant designed by Dr Jean-Marc Juliet

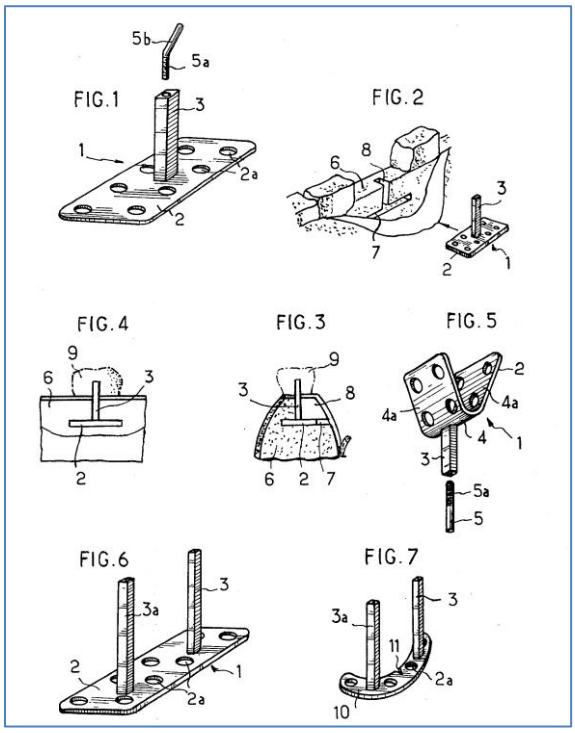


Fig. 2.3 Self-tapping disc implant.

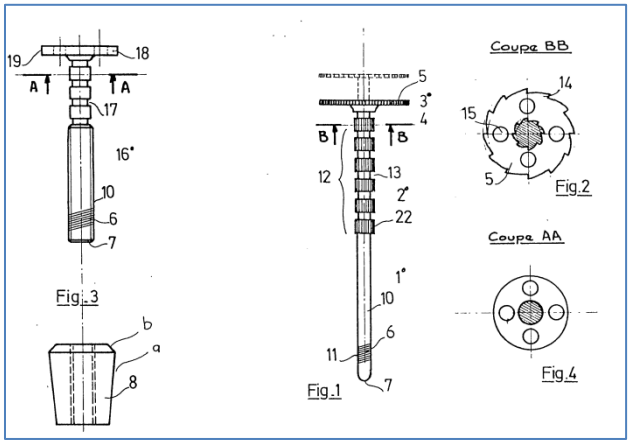
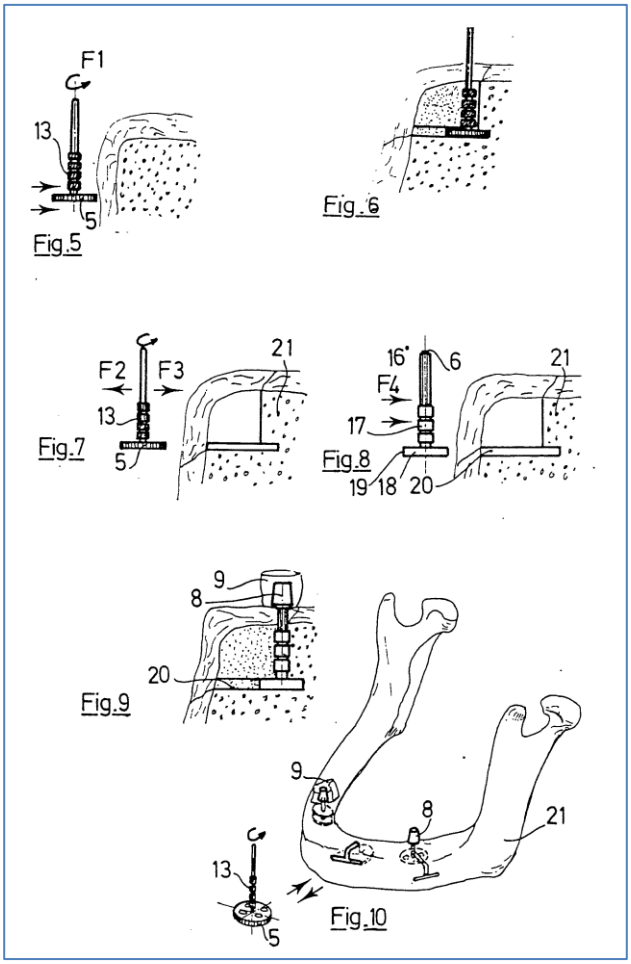


Fig. 2.2 Lateral insertion of the implant designed by Dr G.Scortecci



However, basal implantology really began to develop with Dr.Gerard Scortecci; in the early 1980s he proposed the Diskimplant®, disc implant system that was inserted laterally (Fig. 2.2), and which he refined over the next few years.

In 1985, self-tapping disk- implants (Fig. 2.3) were a very attractive idea, but they were not widely used because the pillar diameter had to be the same as the diameter of the drill bit on the handpiece, or 1.6 mm, which often led to implant fractures at this point.

The shape, size and holes of disc implants were modified many times by their inventor to improve implant osseointegration and to offer a more satisfactory response to the constraints of the prosthesis.

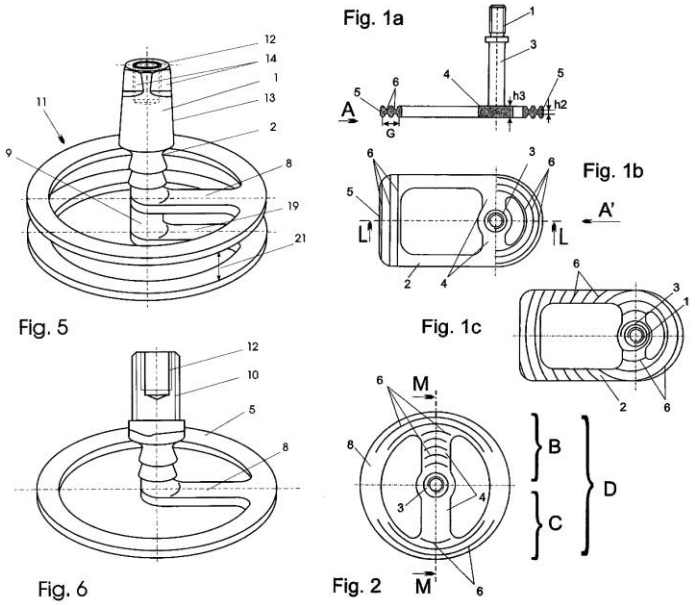
In 1982, a Belgian dentist called Robert Streel patented an implant which was similar, but with variable geometry (it was pliable) to improve primary stability.

A number of basal implants were developed during the 1980s, some of which (such as the implant designed by A. Kurtis) made use of innovative geometric properties to divert or redistribute the various forces, and to give the implant a certain elasticity, while others (such as Kawahara's implant designed in 1989) had irregular perforations over the surface to improve the blood supply around the implant.

The 1990s and 2000s brought many improvements and variants, too numerous to describe here; however, as an example we would mention two- or three-plate disk- implants (Scortecci), asymmetrical disc- implants (Spahn, Ihde) and dis- implants using osteosynthesis plates (Fig. 2.6) (1).

Fig. 2.6

Disc-implants by Dr. Stefan Ihde



Two plate disc-implants (Spahn)

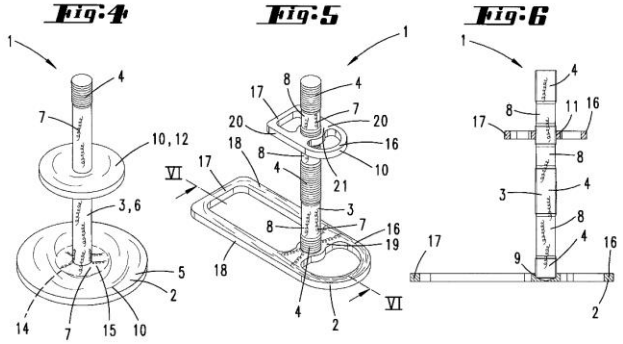
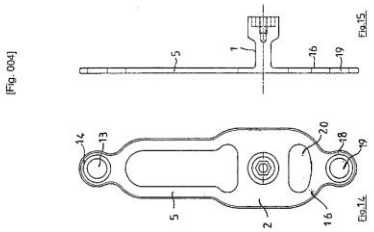


Plate implant with osteosynthesis screws (Scortecci)



3. Anatomical and physiological considerations

3.1 Characteristics and dynamics of bone tissue in the various areas used for implants

3.1.1 Dynamics of facial bone tissues

As far back as 1771, Hunter stated that the alveolar processes were part of the teeth rather than the maxilla; they were born with the teeth, accompanied them when they erupted and when they moved within the arch throughout the individual's life, and they disappeared when they did.

Over time, and as teeth are lost, the alveolar bone is remodelled, gradually reducing in volume and density.

As shown by Lindhe's studies, resorption of alveolar bone is a normal consequence of tooth loss, taking place centripetally in the maxilla and centrifugally in the mandible. These bone losses affect an average 40–60% of the original height and thickness, with maximum loss during the first year (2).

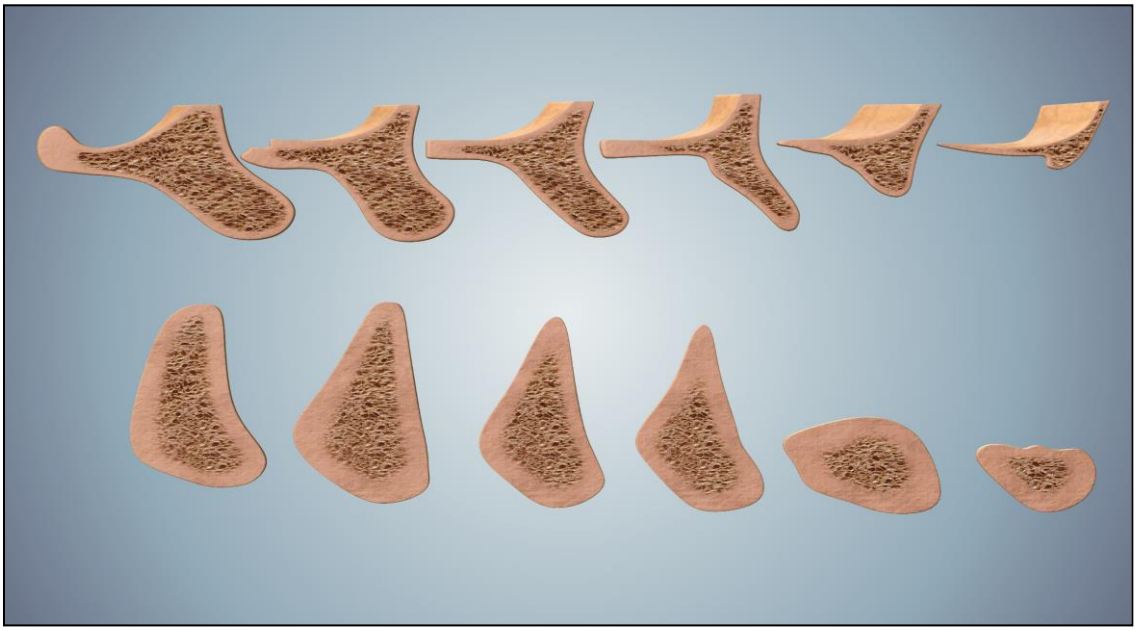
The speed of this bone softening also varies according to a number of parameters such as age, quality of healing, degree of edentulousness and the presence of bone stimulation (non-iatrogenic effects) or conversely, with the application of excessive forces that accelerate osteolysis.

Subsequently, implantologists have to use different ways of reconstituting the bone (onlay grafts, Summers' osteotome technique, sinus lift, etc.) to restore good conditions for axial implant placement.

However, these methods still require sufficient residual bone.

When bone continues to soften, the alveolar bone disappears almost completely, leaving only the basal bone (Fig. 3.1) that makes up the facial skeleton, and which retains its density and its volume because it is stimulated by muscle insertions ("Function creates the organ" - Lamarck).

Fig. 3.1 Bone resorption cycle in the maxilla and the mandible (3)



The facial pillars consist of this basal or cortical bone; they are areas of thickened bone and multiple muscle insertions that are the first choice sites for cortical implant placement: The various regions are (Fig. 3.2):

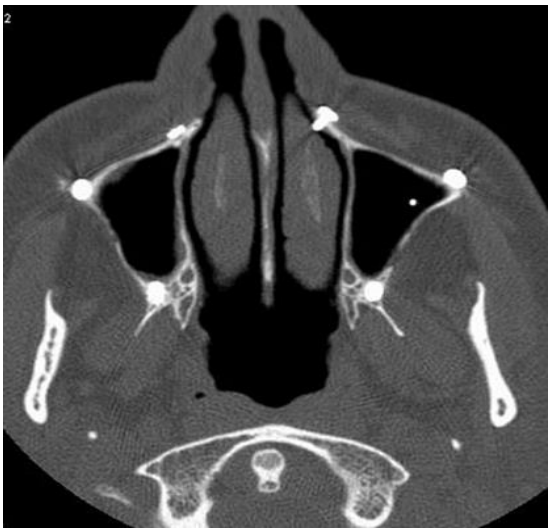
In the maxilla:

- The pterygoid pillars
- The zygomatic pillars
- The canine pillars and the nasal spine

In the mandible:

- The retromolar areas
- The area of the mandibular symphysis

Fig. 3.2 The pterygoid, zygomatic and canine pillars identified by implants on a CT scan (3)



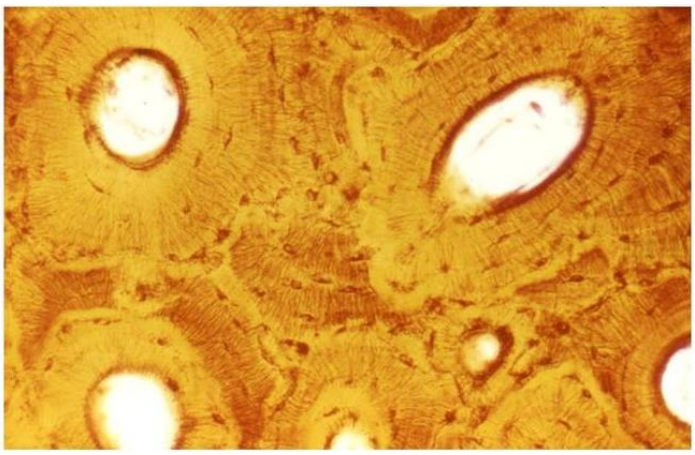
3.1.2 Physiological characteristics of basal bone

3.1.2.1 General summary

Basal bone is compact bone, i.e. Haversian bone, consisting of osteons surrounding the Haversian canals.

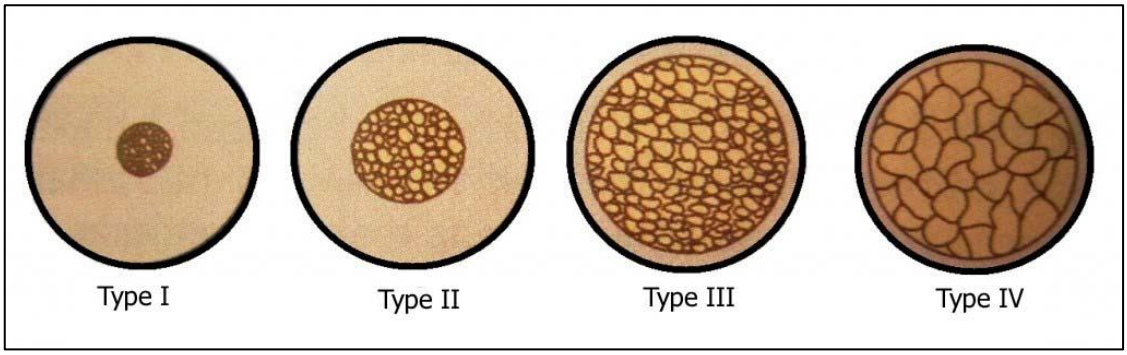
Osteoblasts are located on the periphery of the osteon, producing bone by gradually becoming enclosed in a bone matrix; they then become osteocytes, which communicate between themselves via canaliculi. They form concentric layers around the central canal. They live for ten years and regulate the activity of osteoblasts and osteoclasts (Fig. 3.3).

Fig. 3.3 Haversian bone (2)



Bone density is measured using the Lekholm and Zarb classification (Fig. 3.4) (2).

Fig. 3.4 Lekholm and Zarb classification of bone quality (1985)



- Type I: Consists almost entirely of homogeneous compact bone
- Type II: A thick layer of compact bone surrounds a core of dense trabecular bone
- Type III: A thin layer of cortical bone surrounds a core of dense trabecular bone
- Type IV: A thin layer of cortical bone surrounds a core of low density trabecular bone

3.1.2.2 Characteristics of basal bone

Basal bone may be one of two types of bone, i.e. very dense type I bone that can fracture easily, or conversely, low-density type IV bone with yellow bone marrow filled with fat cells.

Cortical basal bone has a very high mineral content (99% hydroxyapatite and type I collagen), they have few cells and a sparse vascular network (vascular supply is mainly via the periosteum).

Although basal bone generally has good mechanical properties, it is very thin (1–8 mm high and 1–5 mm wide), and its reduced blood supply means there is a higher risk of infection (osteitis) and slower healing. So basal implantology procedures must be carried out in rigorously aseptic conditions, identical to those used in orthopaedic surgery, and the periosteum must remain intact.

3.1.2.3 Anatomical sites where the CF@O protocol is applied

3.1.3 Pterygoid-maxillary region

The pterygoid region is a very useful site. It offers sufficient bone volume for solid posterior anchorage, while avoiding the need for cantilevers in prosthetic structures.

The area is defined anteriorly by the posterior wall of the maxillary sinus, by the posterior or pterygopalatine surface of the maxilla in contact with the pterygoid process of the sphenoid bone and the pyramidal process of the palatine bone posteriorly, and the perpendicular plate of the palatine bone medially (4).

The maxillary tuberosity consists of areas of thin cortical bone onto which the anterior fibres of the medial and lateral pterygoid muscles insert, on its lateral surface. The presence of these powerful muscle insertions often makes it bulky.

The maxillary bone has a flat suture with the pterygoid process of the sphenoid bone and the pyramidal process of the palatine bone; this suture forms a very resistant buttress. A knowledge and understanding of this architecture are needed for safe insertion of implants.

The anatomical hazards of this region may involve bleeding because of (4, 5):

- The descending palatine artery, whose path goes through its canal on the posterior border of the maxilla. It travels downwards and enters the palatine canal (or posterior palate) with the greater and lesser palatine nerves (the sensory branch originating in the pterygopalatine ganglion of V2; it innervates the gums, the mucosa and the glands of most of the hard palate). It then divides into the greater and lesser palatine arteries, which irrigate the mucosa and the glands of the palate. The position of the canal must be correctly identified as it governs the incision, dissection and, of course, the axis of the implant (Fig. 3.6).
- The internal maxillary artery is situated externally and very high in the pterygoid (it extends from the neck of the condyle to the top of the zygomatic or infratemporal fossa).

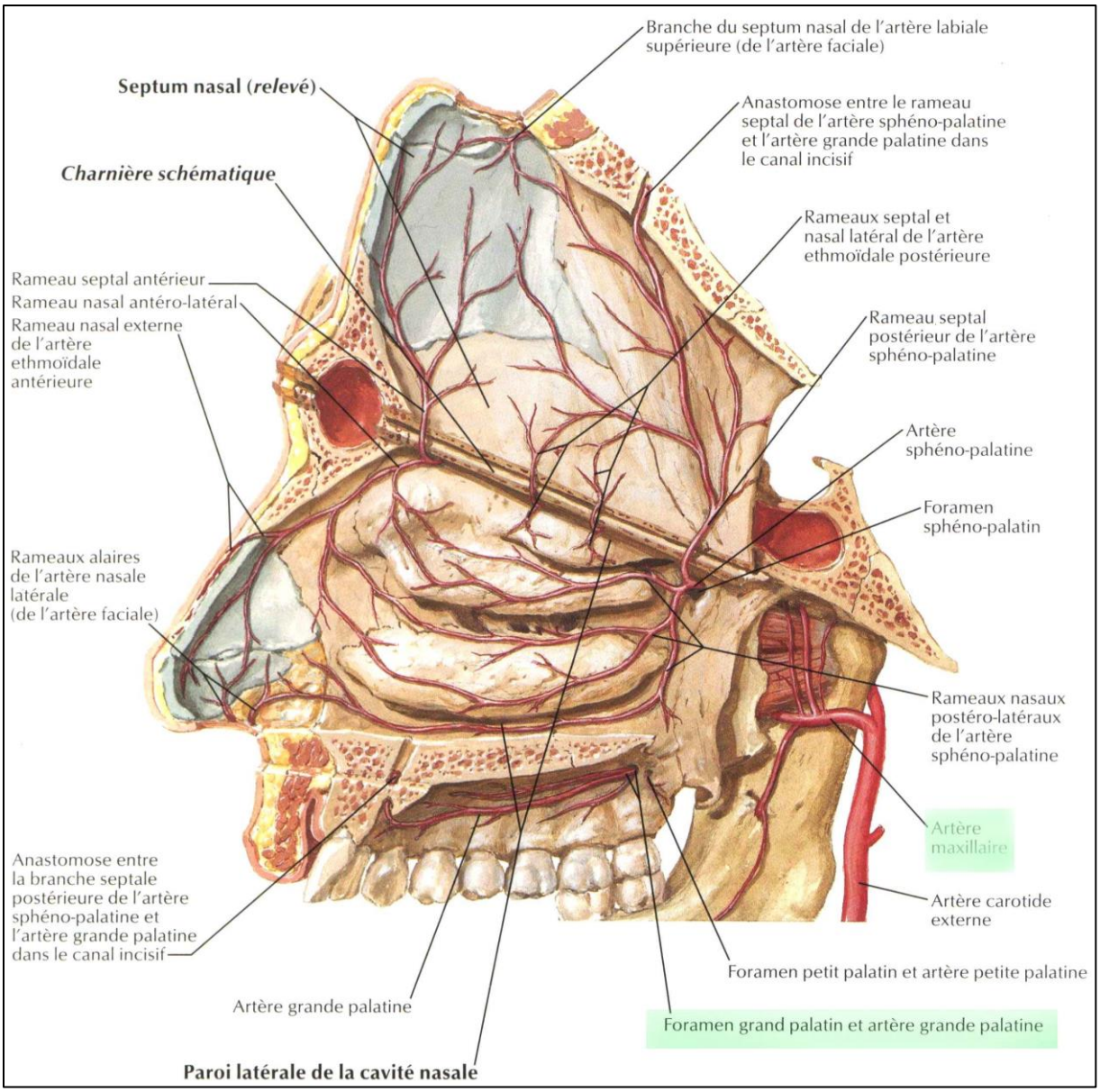


Fig. 3.6 Maxillary and palatine artery.

left

Nasal septum (raised)

Diagrammatic hinge

Anterior septal branch

Anterior lateral nasal branch

Lateral nasal branch of anterior ethmoidal artery

Alar branches of the lateral nasal artery (lateral nasal branch of the facial artery)

Anastomosis between the posterior septal branch of the sphenopalatine artery and the greater palatine artery in the incisive canal

Greater palatine artery

Lateral wall of the nasal cavity

right

Branch of the nasal septum of the superior labial artery (superior labial branch of the facial artery)

Anastomosis between the septal branch of the sphenopalatine artery and the greater palatine artery in the incisive canal

Septal and lateral nasal branches of the posterior ethmoidal artery

Posterior septal branch of the sphenopalatine artery

Sphenopalatine artery

Sphenopalatine foramen

Posterior lateral branches of the maxillary artery

Maxillary artery

External carotid artery

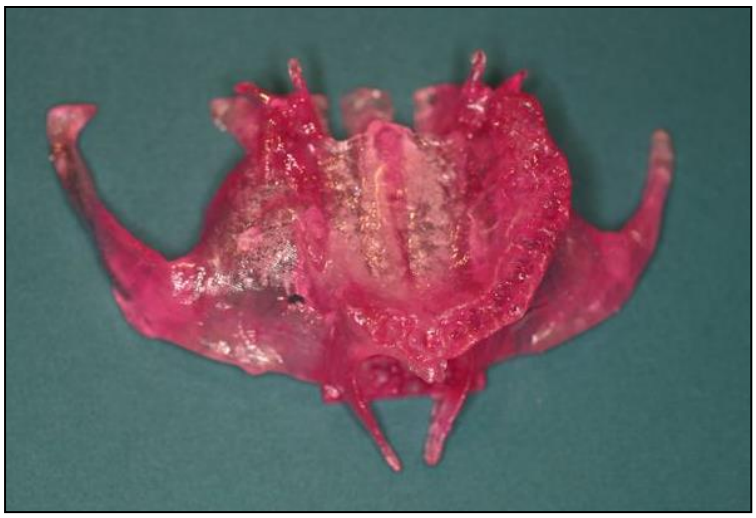
Lesser palatine foramen and lesser palatine artery

Greater palatine foramen and greater palatine artery

Bone quality in the area of the tuberosity is usually poor (Lekholm and Zarb classification Type IV), unlike that of the pterygoid-palatine buttress (dense type I bone). Bone density can be measured radiologically.

It is possible to analyze this complex region preoperatively using modern imaging methods (cone beam or CT scan) and by constructing a stereolithographic model (three-dimensional reconstruction of the bone Fig. 3.7).

Fig. 3.7 Stereolithographic model produced from a scan



3.1.4 2 Zygomatic process of the zygomatic bone

The body of the zygomatic bone (also called the malar bone or the zygoma) corresponds to the palpable raised area of the cheekbone (Fig. 3.8). This body is connected to the other facial bones by four extensions known as processes (4):

- A medial extension towards the lower orbital margin
- A superior extension towards the lateral orbital margin, joining the frontal bone
- An inferior extension towards the maxillary bone; this process can be felt in the mouth

Right zygomatic bone

- A posterior extension connecting it with the narrow extension of the temporal bone

Fig. 3.8 Zygomatic bone

left

articulates with the frontal bone

Frontal process

Zygomaticofacial foramen

articulates with the temporal bone

Greater zygomatic muscle

Lesser zygomatic muscle

right

articulates with the sphenoid

Orbital margin

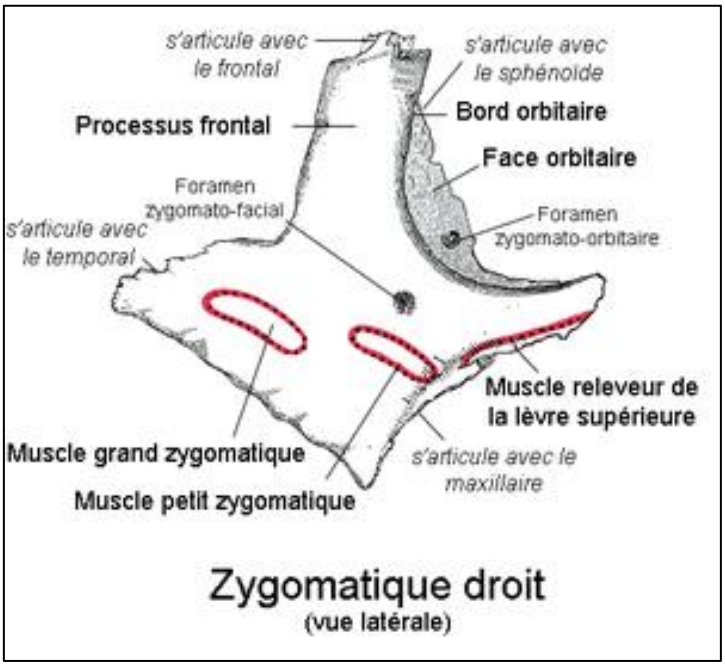
Orbital surface

Zygomatico-orbital foramen

Levator muscle of upper lip

articulates with the sphenoid

Right zygomatic bone



The zygomatic bone could be likened to a pyramid, providing a solid anatomical structure for implant anchorage. Histological analysis of this region has shown that the bone is homogeneous and dense, with very high bone density (up to 98%) (8).

According to an anatomical study, the mean length of available bone in this region is 14 mm.

3.1.5 Canine pillar

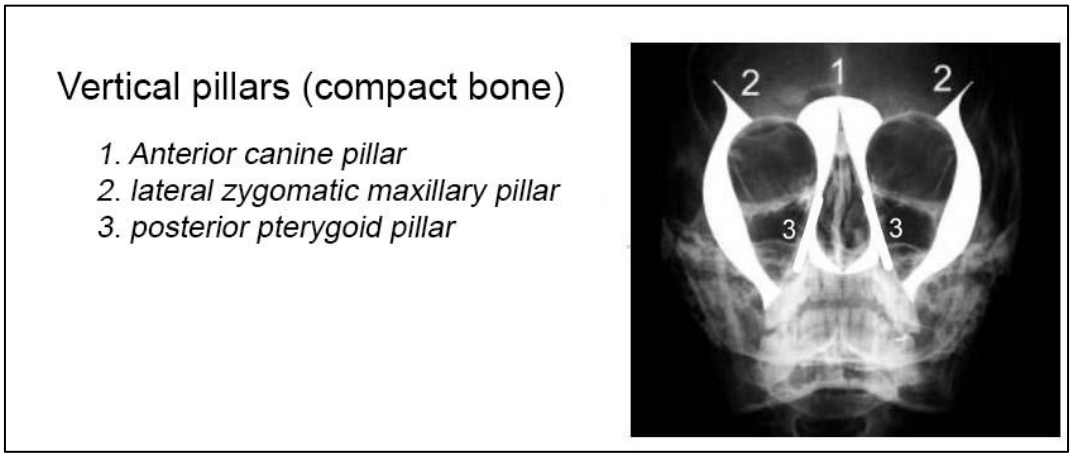
This is a pyramid-shaped space with three walls, with:

- a superficial anterolateral surface
- an anteromedial surface corresponding to the medial wall of the nasal cavities
- a posteromedial surface corresponding to the extension of the sinus
- a base which is the canine/premolar segment
- a summit which merges into the rising process of the maxilla.

This pyramid goes upwards, inwards, and slightly forwards.

The canine pillar is part of the functional anatomy of the skull, located in front of the maxillary sinus, in the lateral part of the maxillary bone. It is a bony framework by which forces applied to the teeth are transmitted to the facial skeleton (Fig. 3.9) (3, 4)

Fig. 3.9 Vertical pillars of the face



After teeth are lost, the residual bone volume retains the biomechanical property that makes it a valuable anchorage in basal implantology. However, in an individual with total or subtotal edentulousness, the bone volume is not always related to the biomechanical properties of the canine pillar. That pillar is located at the border of two air cavities, the maxillary sinus posteriorly and the nasal cavity anteriorly and medially. If there has been major bone resorption, the pillar is reduced to being a simple septum consisting of three contiguous plates, the medial wall of the maxillary sinus, the septum sinuum sphenoidalis and the lateral surface of the maxillary bone at the posterior border of the piriform aperture.

In the event of major bone resorption, anchorage will have to be found at the junction of these three bony walls.

The force lines of the canine pillar correspond to the position of the tooth in its socket. The root is located very superficially, and the labial cortical bone forming the canine eminence is very thin. This cortical bone is often damaged when a tooth is lost, increasing the effect of centripetal resorption of the alveolar crest, with the result that the implant is positioned more medially in relation to the site of the natural tooth; however, to ensure good occlusal relationships and good mechanical behaviour of the implant-plus-prosthesis assembly, it is better for canine implants to be placed as close as possible to tooth roots. This basic concept of implant biomechanics ensures that osseointegration will be maintained after loading.

Canine pillar bone is generally type II bone; a CT scan is needed to establish bone volume and identify the various bone septa bordering it.

The main anatomical hazards in this region are (4):

- The anterior and superior dental canal

  About five millimetres behind the emergence of the infraorbital foramen, a narrow canaliculus takes off from the floor of the canal and travels downwards, crossing the canine pillar. It provides a passage for the dental blood vessels and nerves serving the canine and the incisors on the same side.

  Damage to these arterioles during drilling may lead to non-negligible bleeding. Implant insertion will stem the bleeding immediately. The arteries are visible on axial CT sections above the floor of the nasal cavities. There is no reason to look for them routinely.

  No special precautions are needed during the procedure, as any trauma caused to them is minor. At the least, in the event of substantial bleeding, the procedure should be speeded up and the direction indicators should be replaced in the drill socket between bursts of drilling, to reduce bleeding.

- The infraorbital foramen

  This is located on the anterior surface of the upper maxilla; it terminates in front of the infraorbital canal. It is generally located five to six millimetres underneath the orbital margin, about three centimetres from the midline. A lesion of the infraorbital nerves and blood vessels causes anaesthesia or paraesthesia of the upper lip and the incisors/canines on the same side.

  In normal clinical situations, there is no risk of this structure being damaged.

- The nasal cavities

  At this level, the medial wall of the nasal cavity is the anterior medial surface of the canine pillar. There is a considerable risk of penetrating the nose during drilling, and then during implant placement. A lesion of the highly vascularized nasal mucosa may cause epistaxis (bleeding to the exterior via the nostrils, and sometimes flowing into the pharynx) and a potential risk of infection in the apical part of the implant.

3.1.6 Nasal spine

The anterior nasal spine of the maxilla is a small protuberance at the base of the nasal cavity, just above the teeth. The spine juts out slightly from the maxilla in the vertical plane and acts as an anchorage point for nasal cartilage.

By extrapolation, in cortical implantology the nasal spine region extends from the floor of the nasal cavity upwards, from the two canine eminences laterally, the palatal arch of the maxilla posteriorly and the lateral part of the premaxilla anteriorly.

In this region, the lateral part of the premaxilla may take one of two very different forms. It may either be a flat table, gradually thickening from the crest to the base of the nostrils. This situation, unfortunately the less common of the two, is very favourable for implant placement, as the implant is protected by an area of bone that gradually gets thicker. Alternatively, the lateral part of the premaxilla may be more or less concave, requiring accurate knowledge of bone volume to avoid going through the lateral part of the bone.

In fact, the main anatomical problem in the region of the incisors is not the height of the bone, which is often quite substantial, but its thickness (2, 4).

Anatomical risks of the region:

- Anterior palatine canal

  Situated behind the central incisors, its path is almost perpendicular. It divides into two canals as it reaches the bony part of the palate. The palatine canal is crossed by the nasopalatine nerves and vessels. An unavoidable consequence of damage to the anterior palatine canal is the risk of the implant not becoming osseointegrated. There is a risk of bleeding, but this is easily controlled. It may lead to transient loss of feeling in the incisive papilla. Its diameter varies; it can only be seen on axial CT sections.

- Nasal cavities

  At this level, only the floor of a nasal cavity is likely to be damaged during implant placement. The anterior part of the nasal cavity is made up of the palatine process of the upper maxilla. It is covered with periosteum and a thick mucosa with a good blood supply. In order to reinforce primary stability it is sometimes necessary to cross

the floor of the nasal cavity; if the drill slips, it may perforate the nasal mucosa and cause epistaxis (as described earlier for the canine pillar). The distance between the crest and the floor of the nasal cavity can be established by sagittal CT sections.

Regions of the retromolar triangle
Anterior part of the mandible

4. CF@O Principles and Protocol

The Cortically Fixed at Once (CF@O) approach is based on concepts that differ radically from those of axial implant placement (Brånemark). The idea of using bone width rather than height was put forward by Jean-Marc Juliet in 1972 with his T3D implant with tricortical anchorage. This founding concept of the discipline involved looking for cortical anchorages in basal bone, which is histologically and physiologically different from crestal bone.

The principles that have been used by orthopaedic specialists for decades can be transposed to the principles of CF@O, i.e. that the structure of the bone means that it can safely take a titanium implant and heal even after immediate loading and under the effect of measured stresses without shear forces (1, 3, 9).

The current principles are:

- Anatomical and physiological concepts:
    - Anchorage in the facial pillars
    - Surgery guided by the anatomy (use of existing bone)
    - Implant adapted to the existing bone (leading to the need to have a range of implants of different shapes and sizes, or even implants that can be adjusted as with hybrid plates
    - Preservation of the maxillary sinus
    - No major surgery
- Biomechanical and prosthetic concepts:
    - Primary stability is crucial
    - Immediate loading (major advantage made possible by multiple cortical anchorage in dense bones)
    - A very rigid and screw-retained external fixator that encourages bone healing (L-shaped titanium or cobalt-chromium frame)

4.1. Preparation and surgical protocol

Implant placement remains primarily a treatment for tooth loss. The cosmetic aspect is important, but above all it has to stay within the bounds of what is possible and reasonable.

- Examination of documents and articulator models
- Biochemical tests

- Analysis of radiology and CT images
- Hard copy: transparent implant placement manual
- Computer support (navigation, simulation)
- Resin modelling: stereolithographic models
- Aesthetic and functional analysis of the assembly

All these factors are involved in decisions about the final prosthesis and the number and type of implants.

Actual procedure

The patient will have been told not to arrive in a fasted state if they are to have local anaesthesia 100 mg of Atarax® ((hydroxyzine) given orally one hour before they are taken to the chair in the operating room. However, if the patient develops an infectious disease shortly before the procedure (sinusitis with discharge, sore throat, bronchitis, fever, etc.), the procedure should be postponed.

Typical sequences of operative stages

- Give regional and local anaesthesia.
- Make a full-thickness crestal incision (open-flap)
- Dissect the covering mucosa and periosteum and make a full-thickness labial and lingual (or palatal) flap.
- Cover the plates in the maxilla with a buccal fat pad or biomaterial
- Cover the plates in the mandible with biomaterial, PRF or MPM
- Close the mucosal and periosteal flap with interrupted sutures.
- Take an impression for immediate loading

4.2 Placement of single-piece axial implants

The axial implants used have certain characteristics: (Fig. 5.1)

- Nature and texture

  These implants are machined in grade 5 titanium with an HA/BTCP surface (hydroxyapatite/beta tricalcium phosphate)

- Implants: Shape and size

  The implants may be conical or may have a cylindrical thread and conical core; they may be single-piece implants or have a separate abutment; dimensions are generally 3–5.5 mm for diameter and 8–22 mm for length. Some axial implants are double-threaded, with a wide thread in the lower section and a narrower thread in the upper section, which gives them the advantage of being simultaneously self-tapping and compressive. So the shape of these implants already provides mechanical retention

after they have been placed. Other specific axial implants used in conjunction with bone probing allow bone crests to be expanded (6, 11).

- Mechanical properties

  These implants resist lateral movement well.

- Insertion

  The axial implants used are generally intended for the anterior part of the mandible or the maxilla (apart from pterygoid implants, which are also axial implants but will be treated separately) where there is sufficient bone height. They allow bicortical or even tricortical anchorage and provide very good stability, even in medium-dense bone.

  The practitioner should choose an implant appropriate for the bone density at the site (compressive, self-tapping) sometimes perioperatively, hence the benefit of having a wide range of axial implants available.

  Insertion of these implants is similar to that of crestal implants, but it must result in primary stability, for which a minimum torque of 35 Ncm is recommended.

  Drilling is done from the top of the crest with a low-speed contra angle handpiece. The implant is screwed into a crest > 7 mm high and > 6 mm wide. The axis of the prosthesis follows that of the crest (9).

4.3 Tuberosity and Pterygoid implants

Pterygoid implants were first proposed by Linkow in 1975. A pterygoid implant is defined as an axial implant placed through the maxillary tuberosity with fixation apically in the pterygoid process of the sphenoid bone and in the pyramidal process of the palatine bone.

The method was taken up and described by JF Tulasne in 1992. The properties of tuberosity and pterygoid implants are adapted for the region:

- They are relatively long so that they can cross the mucosa (which is often thick in this region) and the tuberosity, and then lodge the implant apex in the cortical bone of the pterygopalatine suture. According to a (cone-beam) radiology study carried out in a cohort of 100 patients (Rodriguez and co-authors, 2014), the mean length of implant site (from the tuberosity to the most apical part of the pterygoid process) is 22.5 ± 4.8 mm. This suggests that 16 and 20 mm implants would be adequate for most measurements and would allow cortical anchorage while retaining a comfortable safety margin (4–7).
- They have a pointed, self-tapping apex to ensure strong anchorage when inserted, which is done manually with under-drilling (both diameter and depth).
- They have a wide thread profile at the neck to provide compression in the region of the tuberosity, where the bone is often of low density.

Tuberosity and pterygoid implants may be single-piece (easier to handle in this region) or conventional implants.

Their use requires careful preoperative studies (stereolithography, 3D modelling software, identification of anatomical hazards, working length, trajectory), together with experience acquired in a team setting and a high skill level.

A full-thickness crestal incision is made on an edentulous crest as far as the back of the tuberosity, and extended by a vestibular releasing incision. The drill entry point is often marked 5–6 mm in front of the posterior region of the tuberosity. The drill axis runs towards the palate about 20–30° in the horizontal plane and about 45° from the maxillary plane. Drilling with a pilot drill only continues up to the pterygopalatine-tuberosity suture, which is the anchorage region for a pterygoid implant. Three different types of drills are used for insertion. All preparation is done in an underprepared mode, at a working speed of 600 rpm or manually. The implant is then inserted manually using a bone condensation technique, as it is self-tapping and compressive (Figs. 5.4 and 5.5).

Many studies carried out with this type of implant have demonstrated a very good success rate - 96.45% (Monteiro and co-authors) and 98.6% for Rodriguez and co-authors (for 454 implants), with a recommended implant diameter of 3.75 mm for 18 mm length. Depending on the actual anatomy, 3.3–4.1 mm diameter, 16–21 mm long implants may be used.

Fig. 5.4 Insertion axis of pterygoid implant

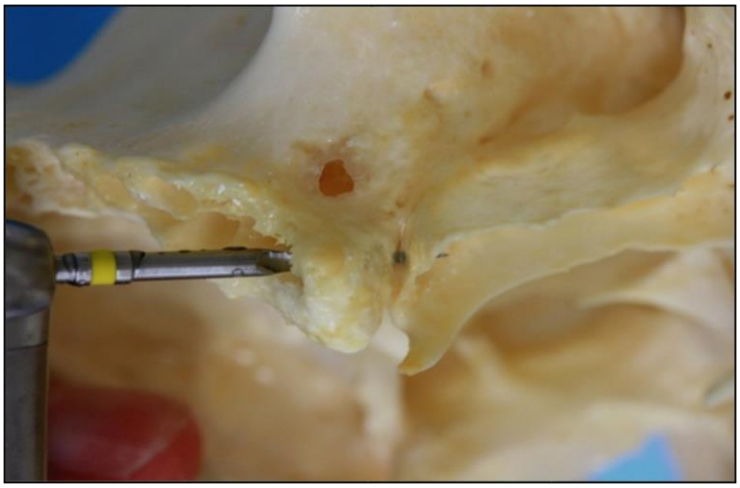


Fig. 5.5 Pterygoid implant and implant holder

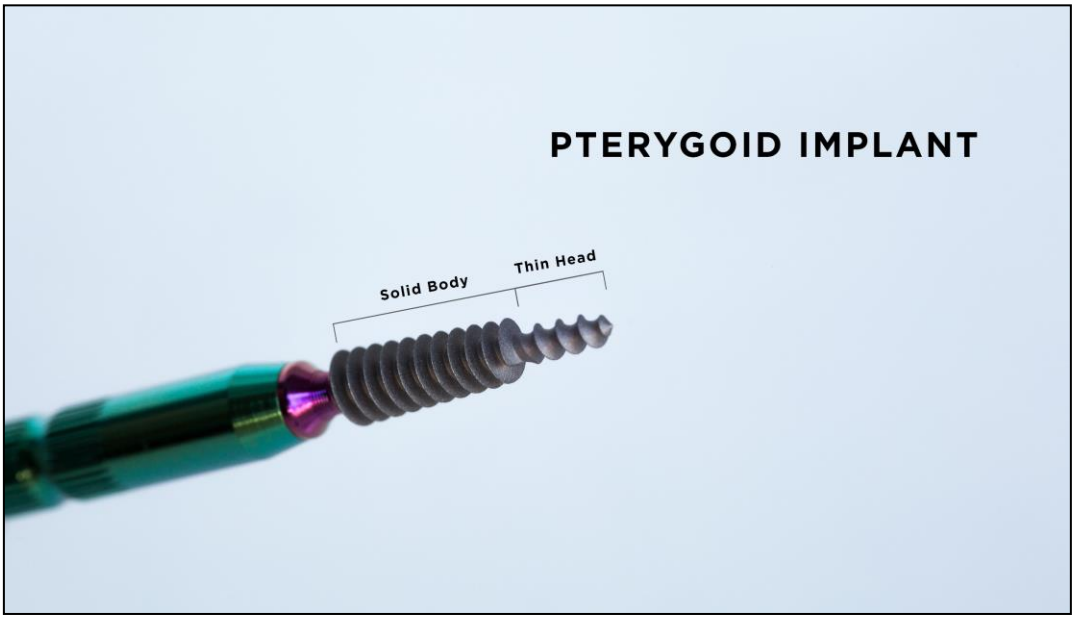
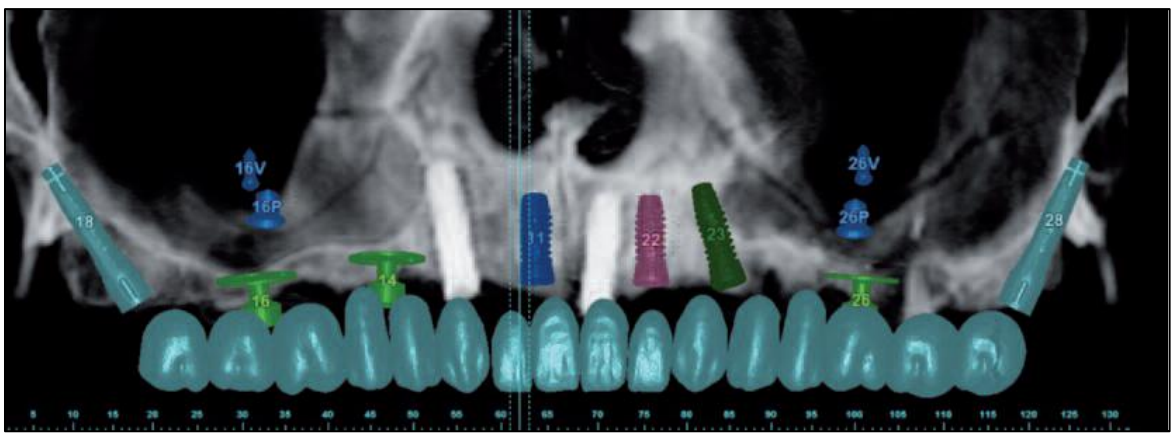
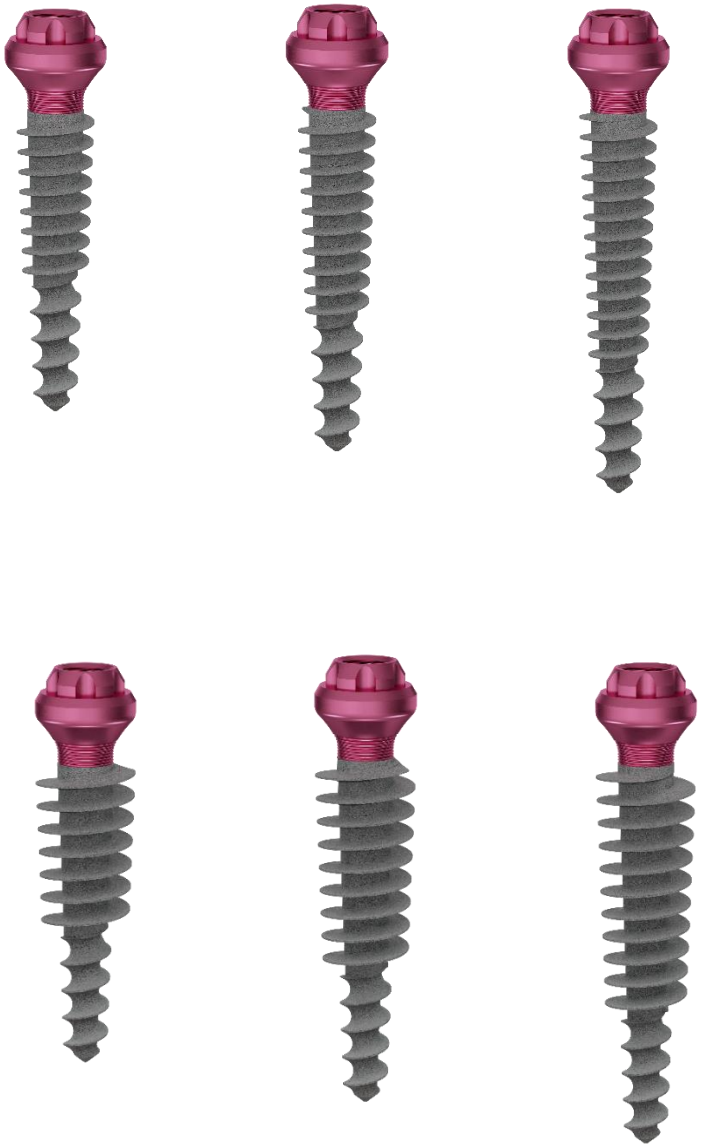


Fig. 5.6 Pre-implantation study using SIMPLANT® software (15)



New Pterygoid implants were designed under the guidance of Henri Diederich, Luxembourg with the collaboration of the Swiss company TRATE.
These implants have a surface treatment HA/TCP and have a conical shape with compressive threads.



4.4 Hybrid plates

The first Hybrid Plates were introduced by G. Scortecci in July 2000; they had a large base plate (25, 33 or 43 mm long, 7, 9 or 12 mm wide) (Fig. 5.7).

The first procedure using these plates was carried out in 2000 in a patient with a fractured atrophic mandible. Insertion of these Diskimplants®name given by Scortecci with a plate into the posterior parts of the triangles made it possible to reduce the mandibular fracture, heal it and retain almost all of the implants.

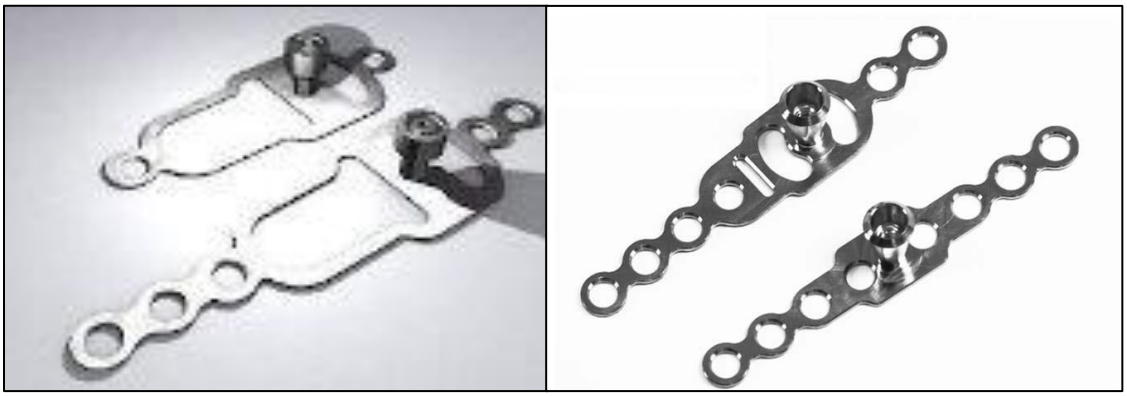
Since September 2002, they have all been fitted with osteosynthesis screws; their design is based on both asymmetrical disc- implants and the screwed-in osteosynthesis plates used in traumatology and maxillofacial surgery. Since then, the spectrum of indications for this type of implant has grown much broader than was originally intended, extending to the canine region, the region of the first molars and the zygomatic region in the maxilla, and the retromolar triangle with cortical anchorage in the ascending ramus in the mandible (3, 11) (12)

These implants were developed further and modified by Dr Ansel and Dr Diederich and PHOENIX®, Germany (Fig. 5.7).

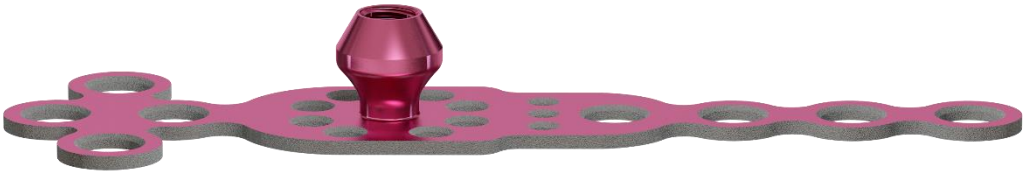
Plate implants are manufactured in grade 2 pure titanium (345 N/mm2 less mechanical resistance than grade 4 titanium at 550 N/mm2, but better malleability) (11). Their thin profile (0.6 mm section for Phoenix® plate implants) and the specific features of their manufacture make them very flexible and allow the plates to be fitted to any shape of bone.

The implants are designed to be endosseous or subperiosteal, fixed mainly by osteosynthesis screws depending on the conditions and regions concerned. They offer a screwed-in connection platform in with an external hexagonal screw (Scortecci) or morse taper (Ansel/Diederich).

Fig. 5.7 Plate implants designed by Scortecci (left) and Ansel/Diederich (right)



A new plate design is performed by Henri Diederich with the collaboration of TRATE (Switzerland) HENGG1 (Huge Efficiency No Graft Gear) (2016)



Hengg-1, Hengg-3 and Hengg-2 (left to right)

Insertion of hybrid plates implants according to the implant zone

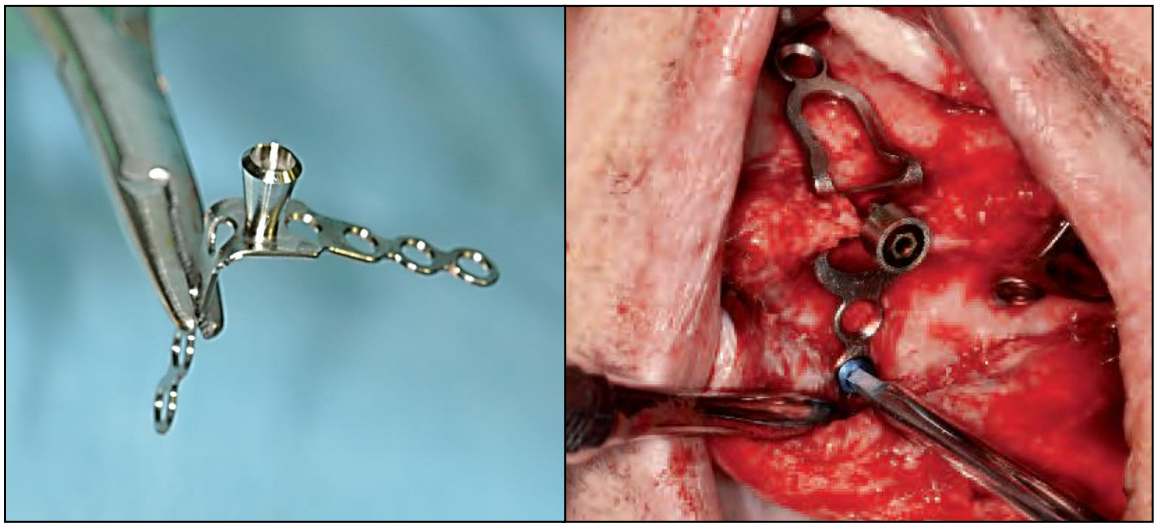
- Canine plate implant

  Insertion of a hybride-plate (in general) starts with a midline crestal incision and dissection of a mucosal and periosteal flap for maximum visibility of the region concerned.

  In the case of the canine region, the plate implant will be placed perpendicularly to the crest. When the amount of residual bone allows the creation of a bone pocket, the plate section will be inserted endosseously to provide primary stability, the arm section with holes will be fitted to and then screwed palatally into palatal cortical bone, and buccally the arm will be bent to 90° and fixed into the very compact bone of the lateral cortical bone of the canine pillar, providing secondary stability (Figs. 5.8 and 5.9).

Fig. 5.8 Bending the buccal arm to 90° (14)

Fig. 5.9 Insertion in the canine region (3)



Hybrid plates are used in the molar and premolar regions of the maxilla, when there is very substantial bone resorption often combined with pneumatisation of the sinus; the height of the residual crest is often 0–3 mm.

The longest part of these implants is subperiosteal, while they are endosseous at the crest. Two 7 mm osteosynthesis screws (true endosseous mini-implants) will give the implant primary stability, with one in the cortical bone of the zygomatic arch and the other in the cortical bone of the palatal arch.

The recommandation is to cover the branches of the plate using bone recovered from drilling combined with other filling materials (BioOss®, Interpore®, Matribone etc) and a membrane. This covering layer will support the buccal mucosa at this level. In most situations, this reduces or completely eliminates the bulky artificial gingiva characteristic of dentures used for atrophic maxillae.

The thinness of the plate makes it malleable, making it possible to fit the plate of the implant closely to the bone walls of the sinus. The implant is practically horizontal because of very substantial bone resorption in the maxilla (Fig. 5.10).

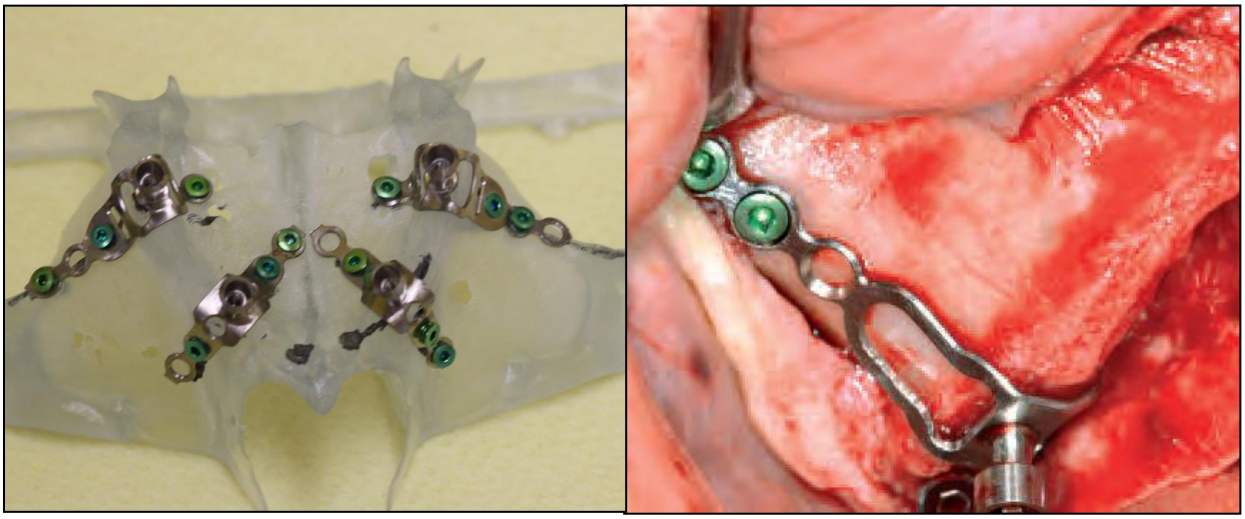
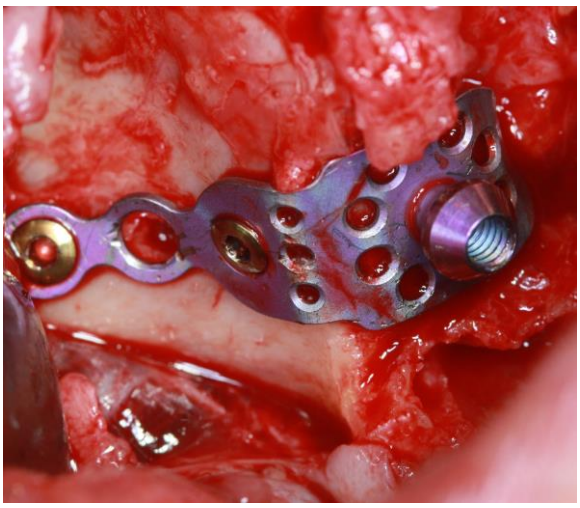
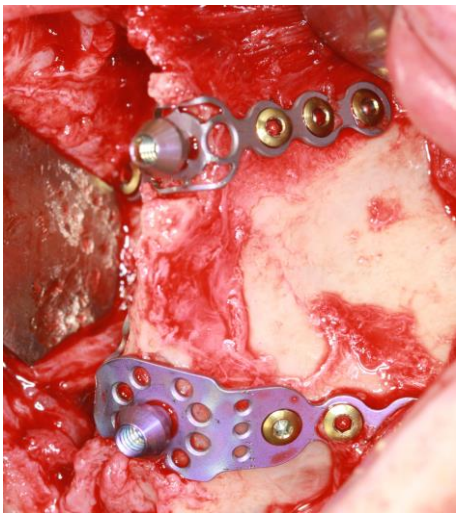


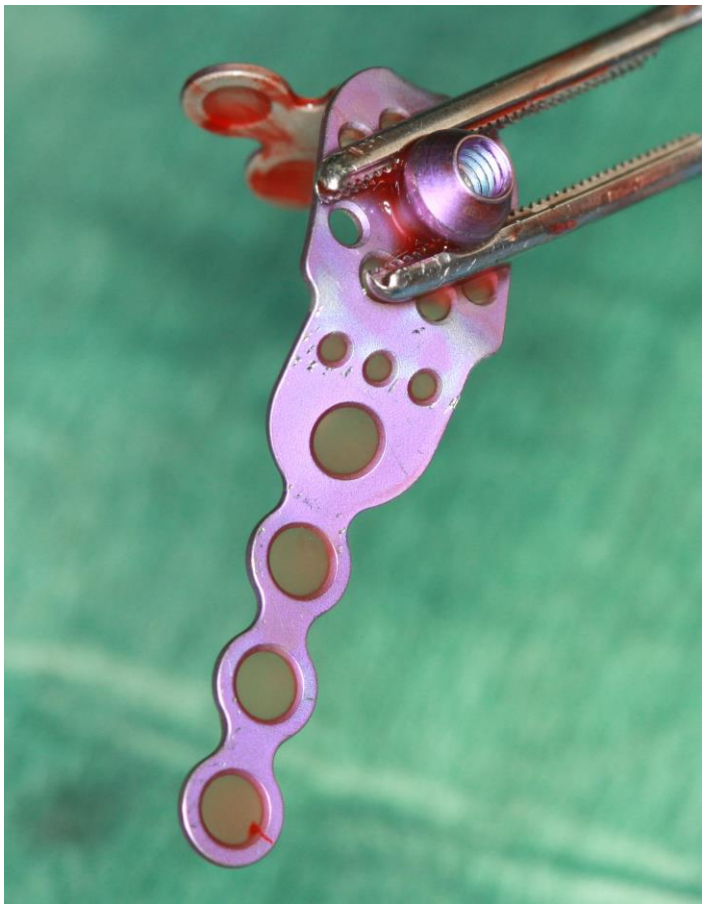
Fig. 5.10 Fitting the plates onto a stereolithographic model and insertion in the zygomatic arch (3–4)



Hengg-1 in place



Hengg-1 and Hengg-2 in place



Hengg-1 prepared

- Hybrid plates in the mandible

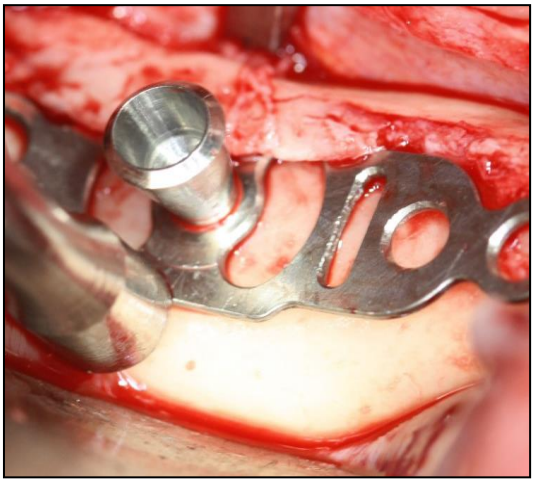
  These plates are designed to be inserted lengthways along the axis of the crest in the retromolar triangle region in patients with advanced recession of the mandibular crests and/or involvement of the tooth canal, which avoids a procedure to move the latter.

  The plate implants come in two widths (7 and 9 mm) and the number of holes may be adjusted to fit the space available, or they may be twisted to follow the shape of the bone.

  In this area, plates are inserted laterally if possible, in a bone “pocket” created for the purpose using an osteotome; so they are endosseous in some places and subperiosteal in others; 4–6 mm osteosynthesis screws are then fixed in cortical bone through the holes to provide stability (Fig. 5.11).

  Because of their lengthways position in the mandible, these plate implants must be combined with axial implants to minimize the impact of shear forces on them.

Fig. 5.11 Placement of the implant in a bone pocket created for the purpose (14)



5. The Prosthesis in Cortically Fixed At Once

In CF@O, the prosthesis has to satisfy a specific and very demanding list of specifications in terms of speed of execution and precision of the work.

The effectiveness of the prosthetist and practitioner team is crucial to the success of the prosthesis, which in the end is the only visible and measurable part of cortical implantology.

Immediate loading (within two weeks of insertion placement) is both an advantage and a requirement in cortical implantology; the prosthesis acts as a rigid external fixator for the implants, so ensuring optimal osseointegration.

However, it is often better to include a stage of making a temporary resin prosthesis, to introduce occlusal loading of implants gradually and to visualize the amount of artificial gingiva required to compensate for any bone loss following the procedure, while retaining harmonious dental proportions. The final ceramic or zirconia prosthesis is manufactured after osseointegration has been checked, in 12–24 months.

The frame supporting the prosthesis is manufactured in a single piece, and must provide good rigidity to the whole assembly. It is usually made of cobalt-chromium, with an L-shaped section and sufficient thickness (Fig. 6.2).

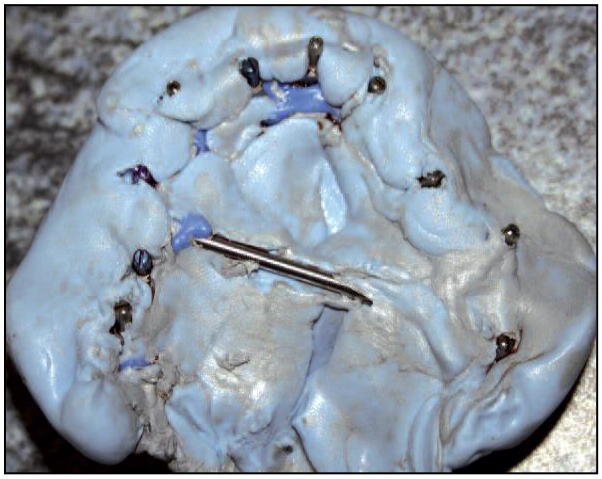
The temporary prosthesis is screwed flat onto the implants, irrespective of their orientation. The two pterygoid implants are the most obvious representation with an orientation of 45° in the mesiodistal and buccolingual direction.

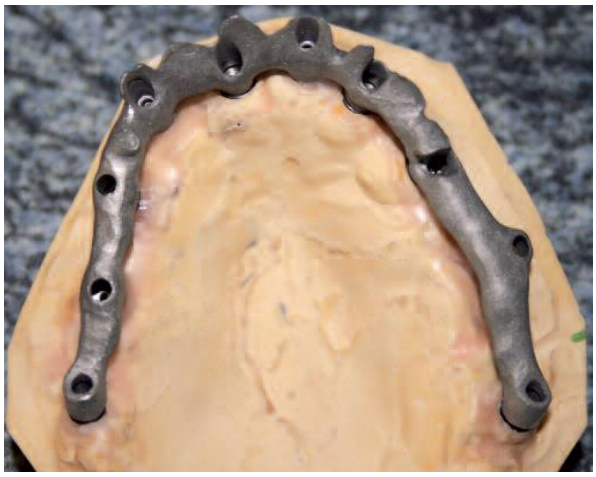
Prosthetic protocol: (directly after suturing if the situation so allows, or the same day) (3, 9, 19, 12, 15)

- Place screwed-in transfers (pick-up transfers) onto the implant abutments
- Take an open impression (without impression tray) using DuraLay® resin (or other material with very low shrinkage).
- Inject light silicone (or alginate) around the implants and underneath the stabilizer bar; apply silicone putty to the rest of the arch, covering it completely (leaving space around the spaces for the screws)
  Impression with a closed tray may be used too.
- Record the VDO using a replica of the ideal assembly (or old denture if available) made of transparent resin filled with alginate in the inside of the arch on the healing abutments and wedged in occlusion with silicone.
- Cast the master model with extra hard stone analogues.
- Mount on an articulator using the occlusion model
- Cast the frame in rigid alloy with an L-shaped profile to increase resistance to bending. The inside of the framework arch is designed to take rings machined in titanium. This system of flat connectors allows the titanium connecting rings to be screwed flat so that they fit perfectly onto the head of the implants irrespective of axis (the titanium rings will be cemented in using special cement and will allow the prosthesis to be screwed-in uniformly while avoiding the corrosion related to using two different metals) (Fig. 6.2)
- Make a temporary prosthesis in resin with an artificial gingiva in contact with the crest. The bite model is made using a balanced occlusion method.
- A temporary prosthesis is screwed-in manually to 10 Ncm, the gold screws will be tightened again after 24 hours (about 1,000 bite cycles), the access holes will be filled with composite after the screw heads have been protected with wax or Teflon.
- Once implant osseointegration has been verified, the final prosthesis (in ceramic or cosmetic-grade zirconia) is made using the temporary prosthesis as a model (the frame may be kept or changed for another in zirconia, depending on the case) (Figs. 6.3 and 6.4).

Fig. 6.1 Taking the pick-up impression (15)

Fig. 6.2 L-profile Cr-Co framework (15)





Figs. 6.3 and 6.4 Final zirconia bridge showing the titanium rings allowing the assembly to be screwed-in flat (15)

6 Conclusion

For a long time, basal implantology was regarded as a risky procedure, but today there is a market increase in interest by both practitioners and patients attracted by its many benefits. As a result of all the hard work by the founders the discipline and its most experienced practitioners, Cortically Fixed at Once has a well-established protocol and offers reproducible results.

This means that it can incorporate the whole range of treatment procedures available to the implantologist, and it has become a reliable alternative or addition to bone grafts in situations where there is substantial bone resorption.

CF@O adapts to the volume of residual bone volume by exploiting it in all directions, thanks to the concept of tricortical support anchorage. With its foundations in the fundamental

concepts of modern osseointegration, the contribution of orthopaedic surgery and clinical experience, CF@O today allows immediate loading with restoration of function and aesthetics within a few days for edentulous patients who used to be rejected for treatment.

However, in spite of the contribution of modern imaging methods, the wide range of implants used, and the different specific insertion methods into the appropriate anatomic regions, Cortically Fixed at Once remains an essentially surgical discipline, requiring a long learning curve.

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