POST TITANE ? THE PEEK !

A new material that can support soft tissue
- Rebuild the deficits of the facial skeleton
- Rebuild alveolar ridges
- Support fixed prosthetic dental arches.

After using the various materials, with relative success (some metal alloys, ceramics, polymers and composites), bone restorative surgery experienced a revolution with the discovery the biocompatibility of titanium. This non-magnetic metal has the ability to bind directly to bone without any break in continuity at the interface bone-metal thereby allowing strong and stable prosthetic implantations in human tissue without causing immune reaction. This option is called osseointegration. But the breakthrough has not yet met all expectations. In maxillofacial surgery, when we want to reconstruct a fixed dental arch in a patient with a large bone defect, we must choose between; whether use the crestal implants made of titanium, but they can be incorporated in a previously reconstructed bone mass which presupposes rebuilding the lost bone through bone graft or sinus filling using organic materials. Or, alternatively use the basal implants which are also made of titanium and can often save the prior building structures through bone graft. The latter, the basal implants are used for over thirty years and have served thousands of patients from the early 70s until today.

Fig 1 : P-BIS 9-12-19 Implant under Stress Finite-Element Modelisation

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At the time of implant, regardless of the implant system chosen, the surgeon must have previously selected the implant after the analysis of radiographic pre-operative tests. These are tests which can determine for the implant, the geometric shape best suited to the anatomical conditions encountered, which does not prevent, the reconsideration during the intervention and thus alter his choice. This entails having different size and shape implants.

Bone tissue, being dynamic and alive reacts under the influence of mechanical stress changes, but also under vascular, endocrine and nutritional influences. Most of the properties of the bone are rooted in the constitution of its matrix organized around two of its components: the mineral part of hydroxyapatite (70%) and the organic portion of glycoproteins, proteoglycans and bone proteins (30%).

The bone should be seen as a composite material. Bone implants and dental implants, to be effective as bone and to be effective in the bone, should simulate physical properties of bone.

PEEK, which we present in this article, seems better than the titanium in that it has this inhomogeneity, the composite texture that opens the door to an individualization of the implant allowing specific needs of individual cases whether from each patient’s point of view of the geometric form or from the bio mechanical point of view to which the implant is exposed.

Fig 2: P-BIS 9-12-19 under mechanical stress

Fig 3: Implant P-BIS 7-12-19 reduced to 7mm in diameter under stress in modeling, Finite Element
Finally, this new material is clearly biocompatible, it does not generate inflammatory reactions and is devoid of antigenicity and cytotoxicity. If, it fosters the osteoinductivity, that is fine but a good design of the implant looking for the most appropriate support can allow to do without this type of benefit. Chewing submit implants to various important constraints (twisting, bending, stretching, lateralization) that comes down to two types of constraints may become unbearable for the bone: the crash that kills cells directly and shear stresses that cause cellular damage by friction. Both effects may add up.

It is through their excessive rigidity or at least, by their lack of flexibility that the materials currently used lead to cellular osteolysis mortification complicated quickly with peri-implant infections, which, in turn, lead to bone loss. It is because implants of common use today have not yet this composite texture, we meet too often this «stress shielding», which occurs when the stresses exceed the adaptive capacity of bone celllules.

A finite element analysis as well as mechanical stress tests to which we submitted PEEK, reassured us on its ability to withstand the stresses typically encountered in maxillo-facial surgery.

Fig.4: P-BIS 9-12-19 reducted to the local neccessary in form, volume and elasticity

Fig.5: The implant showed in Fig.4 in situ, the post in front of the antagonist. The vestibular surplus of the implant was trimmed and adapted to the surface of the mandible in situ
We can conclude that the many scientific publications have confirmed the PEEK material as suitable to be used for implantation in the long term in the human body.

According to our research, it appears that the pure PEEK OPTIMA is an excellent material, perfectly suited, in terms of biomechanics, able to support and transfer the usual constraints placed upon the jaws and facial bones during mastication.

PEEK OPTIMA can be used as a reinforcing material and as bone replacement and is used as backing material for soft tissue. It is able to provide the basis for the integration of implants in bone reinforced by PEEK and as Oral basal implant altogether. We have verified by analysis of finite elements and mechanical stress that the PEEK OPTIMA material is a material at least as effective as titanium and perfectly appropriate for our indications in maxillofacial surgery.

But, if we add the many advantages that even the titanium and other materials used up to now do not provide, such as radio-transparency, easy cutting in the operating room, lack of corrosion effect, the possibilities of strengthening and integration of the modulus of elasticity in individual cases, stimulation of bone formation by tight matching, then we can expect that the PEEK OPTIMA composite will very well behave in the composite host as well: the maxillofacial bone.

Bibliographie


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