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STUDY OF BIOMECHANICAL PROPERTIES OF DIFFERENT TYPES OF DENTAL IMPLANTS

Allma R. PITRU*[1], Alina DUȚĂ[2], Dragoș Laurentiu POPA[2]
[1] University of Medicine and Pharmacy, Faculty of Dental Medicine, Craiova, Romania
[2] University of Craiova, Faculty of Mechanical Engineering, Romania

Keywords
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Modulus of elasticity
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Tissue response

Abstract
Dental implantology that become a predictable and highly acceptable treatment modality for the restoration of the human dental and oral apparatus, has need not even for a series of surgical, prosthetics and periodontal skills of the dentists, but also synthetic substance for tissue replacements that combine different design and materials concepts for surgical implants.

Our aim was to study implant biomaterials that, for optimal performance, should have suitable mechanical strength and biocompatibility, that induce predictable, control-guided and rapid healing of the interfacial tissues both hard and soft.

1. Introduction

History of dental implant has begun from ancient civilizations. Many materials have been used to put instead of missing tooth, including wood, seashells and carved ivory. Apart from artificial materials, transplantation of teeth from animals or other humans also has been reported.

J. Maggiolo was the first that described a tooth-root shaped implant casts from 1-carat gold, inserted into fresh extraction sockets (Ring 1995).

The variety of implant devices was due of beginning of experimental implantology and research into tissue biocompatibility.

First implants were manufactured from chrome alloys, Vitallium, ceramics, sapphire, vitreous, carbon and methyl methacrylate. (Spiekerman 1995). In the 1950's Branemark, during experimental work, observed the fussion of titanium chambers to bone, an accidental discovery, that led to the modern era of implantology.

Nowdays, materials used for fabrication of dental implant can be categorized in two different ways:
- Chemical point: metals, ceramics
- Biological point: biotolerant, bioinert, bioactive

2. Osseointegration

Branemark was first that described the phenomenon of 'osseointegration' and defined it as the direct structure and functional connection between ordered living bone and the surface of a load-carrying implant (Branemark *et al.* 1987, Figure 1).

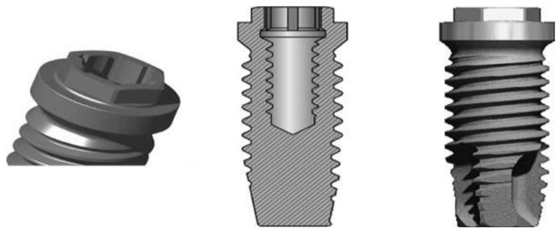

Figure 1 The Branemark implant system

Now, osseointegration is defined as the close approximation of bone to an implant materials and can only be achieved if bone is viable. This is dependent on the interrelationship of the various component that include: material biocompatibility, implant surface, implant design, the surgical technique and patient-related factors associated with the status of the implant site and the loading conditions endured by the implant.

3. Factors affecting implant biomaterials

Factors affecting biocompatibility are related with chemical (corrosion), mechanical, electrical and surface specific properties.

1. Corrosion

1.1. General corrosion occurs when a metal is immersed in an electrolyte solution

1.2. Pitting corrosion occurs in an implant with a small surface pit placed in a solution. This type of corrosion can exist if proper material and surface conditions do not exist.

1.3. Crevice corrosion occurs around bone-implant interface or an implant device where an overlay or composite type surface exists on a metallic substrate in a tissue/fluids environment with minimal space

* Corresponding author: allmapitru75@yahoo.com

2. Mechanical properties

2.1. Modulus of elasticity which represents elastic response to mechanical stress, such as externally applied forces of occlusion or muscle action

2.2. Tensile or compressive forces change the dimension of the bone or biomaterials when a force is applied

2.3. Elongation that represents the bone or the implant deformation and influencesthe surrounding tissue integration

2.4. Ductility that permits to different metals to be coined or squeezed into desired shapes

3. Surface of implant

3.1. Hydroxyapatite (HA) – coated replicate the inorganic phase found in tooth and bone, but there is an inability to predict and maintain bond strength of the coating to the metal so the long-term stability of many HA-coated implants is uncertain.

3.2. Roughened surface can be creating by blasting with a variety of materials, including titanium dioxide, or grit, sand blasting or acid etching. An optimal surface has been defined as one with roughness created by surface pits or holes ranging from 1,5 to 5 micrometers (Hansson 2000). The response of osteoblasts to roughened surface is more favourable and that there can be better interlocking between implant and bone at the micrometric level. (Natali 2003)

3.3. Hydrogen fluoride incorporated into the crystal structure of the titanium dioxidemay changethe biological response to the implant.

Figure 2 Axial load distribution. The morphology of the threads can have an influence on the nature of compressive force created within the bone around a machined implant (figure adapted from Palacci et al. 1995)

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4. Conclusion

The current trend towards titanium is based on a general consideration of the desirable properties mentioned above. As a lightweigh metal, it offers a high strength, to weight ratio, with good fatigue resistance and the ability to be corrosion resistant due to its tenacious surface oxide which provides a stable interface for bone depositions.

Osteoblasts, osteoid and mineralized matrix have been observed adjacent to the lamina limitans suggesting that bone can be deposited directly on the surface of the implant, extending outward from the biomaterial, but bone-implant interface has not yet been fully characterized.

In dentistry, titanium is available in four grades, according to American Society for Testing and Materials (ASTM). Grade I is the purest and softest form, which has moderately high tensile strength.

Long-term studies and clinical observations establish that titanium does not corrode when using in living tissue. When coupled with metals that are not strongly passive, such as stainless steel, it may corrode by the mechanism of galvanic corrosion, that's why should be taken into consideration when selecting surgical instruments for the placement of titanium implants.

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Conflict of Interest

No conflict of interest was declared by the authors.

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