Zirconia dental implants

Alain Clairet
Paris, France

Osseous and dental tissues present similar proprieties that justify the use of biomaterials with resemblant proprieties in surgery. The first biomaterials used in dental implantology were only metallic alloys, noble or not.

The main difficulties related to the use of metals as biomaterials derive from the great difference existent between their mechanical properties and those of tissues they replace, and, on the other hand from the greater or lesser degree of corrosion in contact with the surrounding living environment, which is aggressive thorough content in water, cells, proteins and enzymes. The corrosion products of different metals and alloys can be very toxic for the host, acting locally or at distance.

Titanium-based alloys, due to their good resistance at corrosion and also to their important mechanical resistance, are the most commonly used nowadays. In order to increase the compatibility of these alloys, different techniques of covering their surface with other materials with better compatibility have been created.

The present trend is to use ceramic materials, with better compatibility, not only to cover the surfaces, but also to fully realize the dental implants.

The future is represented therefore by the development of a new ceramic - ZIRCONIA - or its derivatives, these being in fact endowed with remarkable mechanical proprieties and with a real capacity of colonization of osseous tissue at their level, having also a significant capacity to adhere to living tissues.

As to compare, we must remember that only the peripheral titanium-oxide layer is responsible for the integration properties of titanium implants.

ZIRCONIA

Zirconia is a ceramic: zirconium oxide (ZrO_2). Zirconium is the element with atomic number Z=40, atomic mass M=91, and symbol Zr. Zirconium is a transition metal, belonging together with Titanium and Hafnium (which is very much alike) to the fourth column of Mendeleev table. It was discovered in 1789 by Klaproth and was isolated and purified for the first time in 1824, by the Swedish chemist J. J. Berzelius.

It was not greatly used before the development of the nuclear industry, which is an important consumer of Zirconium. It is a metal found in nature in abundant quantities (3 times more than copper).

It is obtained industrially by the procedure described by Kroll, which realizes a reduction reaction of Zirconium tetrachloride with Magnesium.

Zirconium is a relatively abundant element in the terrestrial crust, representing 0.028% of its composition, being extremely dispersed (Australia, Sri Lanka, USA).

Zirconia appears as a crystalline compound obtained by combustion. Zirconia is presented under three stable crystalline forms, depending on the combustion temperature, being generally stabilized by use of certain additives, which are also oxides: MgO, CaO, Y_2O, Al_2O_3. The percentage of additives included is 5-10%. Its quality depends on its purity, density, porosity, granules dimension, crystalline structure (the proportion of tetragonal, cubic and monoclinic phase), and its resistance to flexion.

Zirconia is a bioceramic of the future, much more dense than aluminium, showing much better mechanical proprieties.

Zirconia presents more polymorph varieties, whose transition temperature from the monoclinic phase to the tetragonal is 1100-1200 Celsius degrees, and from the tetragonal to the cubic is 2400-Celsius degrees.

Important research emphasized the extraordinary qualities of mineral implants, ceramic having a similar structure to that of osseous tis-

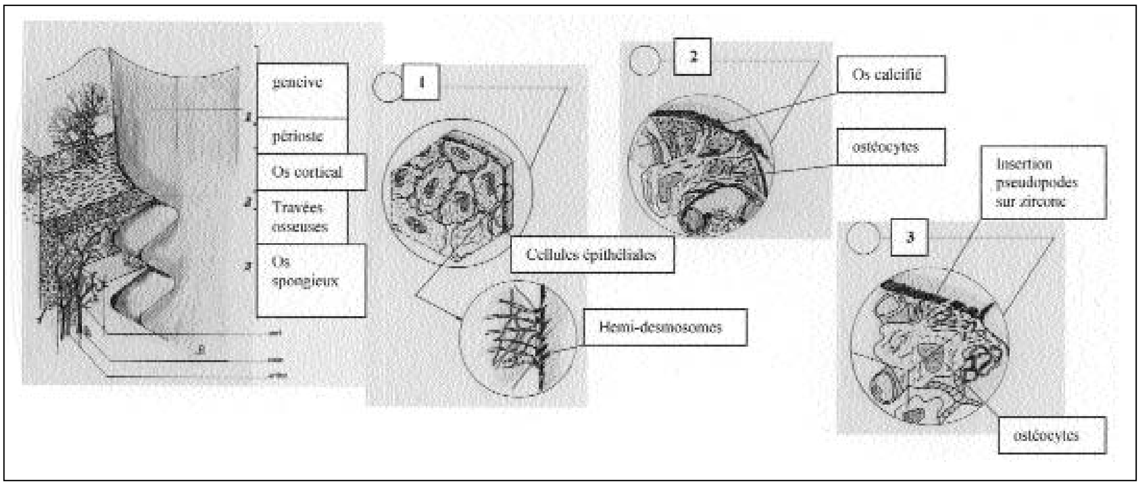

Figure 1.

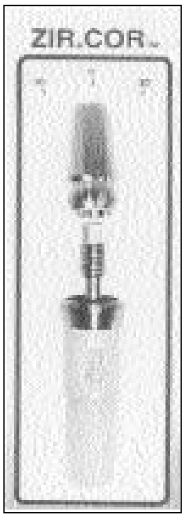

Figure 2.

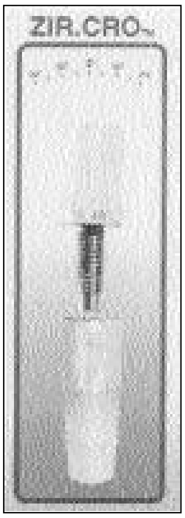

Figure 3.

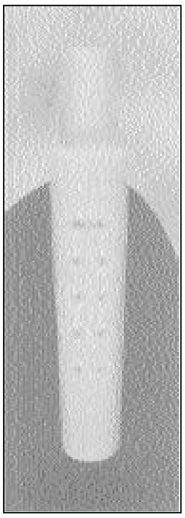

Figure 4.

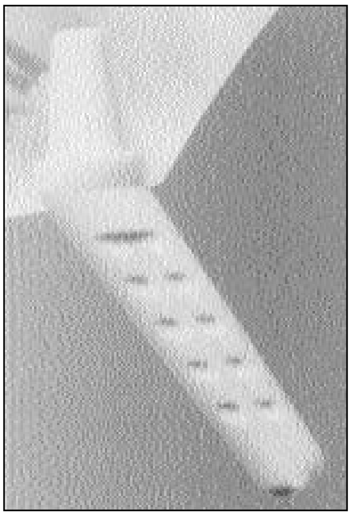

Figure 5.

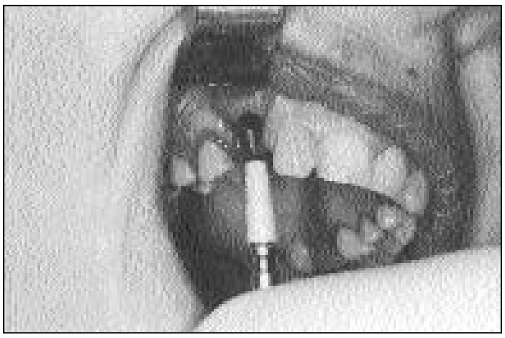

Figure 6.

Figure 7.

Figure 8.

sue, being used under the zirconium oxide form, which shows an excellent biocompatibility.

The concept of bio-inert ceramic refers to the material behavior in the host tissue, ceramic being from this point of view very stable, the quantity of waste product being very small, thus not generating destructive effects. Zirconia belongs to the bio-inert ceramics. Having a very great resistance to all forms of corrosion, Zirconia shows a perfect biocompatibility, excluding the galvanic and electrochemical phenomena, while the migration of metallic ions that is present in Titanium, does not exist.

Experimental studies made at Tubingen University, Germany, prove that, as compared to other materials used in implantology, Zirconia has better anti-plaque properties and a significant affinity for the periodontal soft tissue. The perfect resemblance with the color of dental tissue avoids the trans- or supragingival unpleasant coloring.

Another advantage, maybe the most interesting, is represented by the greater speed of cicatrisation around this material, allowing an osseous integration in a shorter period of time than metallic materials. An additional quality of this ceramic is the neutral behavior to radiological investigations, such as computerized tomography (they do not generate vicinity artifacts and illegible areas, as in metallic implants).

Presentation of Zirconia implants

Zirconia is perfectly biocompatible, having a very good mechanical resistance and constituting nowadays a preferred ceramic in implantology, due to:

- excellent behavior towards gingival tissue, without retaining dental plaque;
- it is not bioactive in the biological sense of the word, but on the opposite presents a great affinity for the active proteins in the osteogenesis process and high capacity to attract calcium ions.

These two qualities trigger an excellent bone response, of osseous integration type, in a very short time.

The integration time, much more reduced than in Titanium, allows immediate loading, on certain conditions to ensure a positive result. The operatory technique is similar to that used for the insertion of Titanium implants. To illustrate, a DIAMOND IMPLANT PELTIER system has been used.

The evolution conducted to the obtaining of a mono-block form, which has the emergence profile of different inclinations, an original system of intra-osseous screwing, the possibility of remodeling the osseous contour to realize the scalloping of the alveolar bone in order to realize the biological space and a perfect esthetic result leading to a dento-gingival harmony. This concept will be adapted only in cases of immediate but progressive prosthetic loading.

Correspondence to: Dr. Alain Clairet, Port van Gogh, 2, quai Aulagnier, 92600 Ansieres sur Seine, France. E-mail: alainclairet@wanadoo.fr