David Yossef Benjamin AKRICH

TITANIUM, ZIRCONIUM:
WHICH IS THE FUTURE OF DENTAL IMPLANTS?

Universidade Fernando Pessoa

Faculdade de Ciências da Saúde

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Assinatura : ______________________

Trabalho apresentado à Faculdade de Ciências da Saúde da Universidade Fernando Pessoa como parte dos requisitos para obtenção do grau de Mestre em Medicina Dentaria

Universidade Fernando Pessoa

Faculdade de Ciências da Saúde

Porto, 2017

RESUMO

A minha tese pretende comparar dois tipos de implantes dentários, sendo os mais utilizados o Titânio e o Zircónio.

O objetivo é rever os desempenhos, as vantagens e as desvantagens de ambos os tipos e decidir qual o que optimizará as taxas de sucesso e melhorará a qualidade de vida dos pacientes.

Este tema torna-se importante, porque a perda de dentes pode afetar tanto a aparência como funçoes vitais, como comer e falar de uma pessoa. E por muitas razões, o paciente prefere geralmente, uma solução permanente, um implante. Além disso, esta invenção é relativamente nova, e ainda está em desenvolvimento.

Os pacientes dentários estão cada vez mais preocupados com os materiais que entram em contato com o seu corpo e o impacto que isso pode ter na sua saúde. Ao colocar o implante dentário, é sempre crucial usar o material menos reativo e tóxico possível.

Palavras Chaves : "Titânio" ; "Zircónio" ; "Zircónia" ; "Implantes Dentários" ; Osseointegração ; "Biocompatibilidade" , "Bacteriologia".

ABSTRACT

My thesis will compare two types of dental implants, the main materials that are used for this matter, Titanium and Zirconium.

The objective is to review the performances, advantages and disadvantages of both kinds, and decide which optimizes the success rates and will improve the quality of life of the patients.

This subject is important, because the loss of teeth can affect a person in his appearance and vital functions such as eating and speaking. And for many reasons, patient usually prefers a permanent solution, an implant. In addition, this invention is relatively new, and it's still in development.

Dental patients are becoming increasingly concerned with the materials coming into contact with their bodies and the impact this can have on their health. When placing dental implants, it is always therefore crucial to use the least reactive and least toxic material possible.

Key words: "Titanium" ; "Zirconium" ; "Zirconia" ; "Dental Implants" ; "Osseointegration" ; "Biocompatibility" ; "Bacteriology"

DEDICATION

A mes parents, voici l'un des fruits de votre travail. Vous m'avez prouvé que votre dévouement, votre patience et votre amour sont des ailes qui m'ont permis et me permettront d'aller de l'avant et de réaliser tous mes rêves. Vous êtes la preuve du verset biblique :

« Ceux qui sèment dans les larmes, moissonneront dans l'allégresse » (Psaume 126, 5). Je vous aime, et j'espère très vite que je pourrais vous apporter d'autres fruits récoltés.

A ma famille : je vous aime.

A Lisa, ma femme, merci pour toutes ces années magnifiques de soutien et d'amour sans limites ni frontières. Grâce à toi mes rêves se sont réalisés, en une année : un diplôme de dentiste et un diplôme de papa !

A Ashem, merci de m'avoir ouvert les portes jusqu'ici, merci pour cette chance d'avoir tout ce que j'ai, ces parents, cette femme, cette famille, ces amis et cette belle vie pleine de bonheur.

THANKS

I would like to thank my advisor Doctor Professor Jose Paulo Macedo for guiding and supporting me. You have set an example of excellence as a teacher, mentor and instructor.

Thanks to all the teachers who surrounded me during this course and from whom I learned a lot.

A mes binômes qui ont eu un rôle important ces dernières années même et surtout en dehors de la clinique.

A mes parents, grâce à qui je suis arrivé jusqu'ici. Ma mère, mon pilier, qui a su me soutenir et me secouer quand j'en avais besoin. Mon père, mon modèle, un modèle professionnel mais d'abord de père de famille et d'homme.

A mes grands-parents paternels, ceux que je n'ai pas eu la chance d'avoir à mes côtés ces dernières années mais qui ont toujours été dans mon cœur.

A ma mamie adorée, qui a toujours eu les mots pour me réconforter et m'encourager !

A mon papi chéri qui en chansons m'a donné la force de continuer.

A mes frères et sœurs, qui comptent tant pour moi. Qui, chacun à sa manière, m'ont fait croire en moi, m'ont soutenu et poussé pour en arriver là.

A Pascal et Valérie Julian, merci de m'avoir guidé vers cette magnifique opportunité. You're the best.

A mes tantes, mes oncles, mes cousines et cousins qui ont toujours été là pour moi.

A Manue, qui m'a soutenu et a cru en moi.

A ma famille portugaise qui m'a accueilli les bras ouverts et m'a accompagné toutes ces années au Portugal.

A ma famille israélienne de Jérusalem qui, depuis petit, m'a poussé à réaliser mes rêves.

A mes amis, qui se reconnaitront, car plus d'une fois ils m'ont aidé pendant toutes ces années.

A mon binôme Mathieu, qui pour moi, est bien plus que cela et avec qui j'ai passé des moments inoubliables à la clinique ainsi qu'en dehors de la fac.

A Thibault, mon vrai ami, sans qui je ne sais pas comment j'aurais fait.

A Pierre Cohen, pour son dévouement et sa patience !

A Lisa, pour son aide, son soutien, et son amour inégalable !

Merci !

QUOTES

“Spiritual in man is the will to serve higher ends, and in serving ends he transcends his needs”

Abraham Joshua Heschel.

“Yesterday is history, tomorrow is a mystery, today is a gift of god, which is why we call it the present”

Bill Keane

SUMMARY

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TITANIUM, ZIRCONIUM:

WHICH IS THE FUTURE OF DENTAL IMPLANTS?

LITERATURE REVIEW

I. INTRODUCTION

Life expectancies are growing, so is increases the demand for sustainable, effective and easy- to-process dental care. A care that will answer to the requests of the patients, about practical issues, the requirements of durability and esthetics. So far, the prevalent solution was the prosthesis, with their disadvantages, so the demand for a solution more practical, more comfortable and less constraining is gradually gaining ground.

Now more than ever, the patients feel concerned with the treatment choice as they become more and more educated on health issues, and the choice of materials used matters.

What I shall endeavour to do is to explore the strengths and weaknesses of the two mainly used materials in dental implantology, Zirconia and Titanium, based on case studies and research involving humans.

The comparison of these materials will be carried out on three main levels, physical, chemical and biological aspects. All that combined with the esthetic aspect and the ease of implementation.

I.1. Methodology :

In order to compare the chosen materials of dental implants I search in data based as Google scholar, Pub-Med, Research Gate, B-on, Scielo articles published between 2010-2017, using the words: Titanium, Zirconia, Zirconium, Dental Implant, Osseointegration, Biocompatibility, Bacteriology.

II. TITANIUM

II.1. Generalities

Titanium was discovered in 1790, by William Gregor in England. In 1795, he was named after the first generation of the gods, "Titans" in the Greek mythology, sons of Gaia and Uranus, by the German chemist Martin Heinrich Klaproth. "Titan" which in Greek means strength.

It was to take more than a century after the finding of Gregor until Matthew Albert Hunter was able, in 1910, to produce 99% pure Titanium. The professor Wilhelm Justin Kroll found the possibility of reducing the oxide of titanium to make the material less expensive and of course more accessible in 1910. Only thirty years later a chemist named Kroll develops a process for the industrial production of Titanium.

Titanium is a chemical element, a transition metal of Group IV, with symbol Ti and atomic number 22. It is a lustrous transition metal with a silver colour, low density, and high strength. and it has lightness, excellent corrosion resistance and low elasticity modulus. Titanium does not occur in its native state and must be synthesized. The major sources of Titanium are Rutile (TiO_2) and Ilménite (iron ore and titanium) (TiO_3 Fe). Its melting point stands at 1668°C (pure state Titanium). The physicochemical properties of the Titanium have made this material very interesting.

The idea of using an artificial titanium implant, came from an orthopaedic surgeon in Sweden, Per-Ingvar Branemark, in 1957. Only in 1965, he made his first titanium dental implant operation, which was successful.

Titanium, termed « pure », is an alloy, grade 4, up to a maximum of 1% of other atoms. The Titanium alloy most frequently used materials in implantology, are of Grade 4 and Grade 5. The first is a unalloyed Titanium / pure Titanium, high oxygen. The second is Titanium alloy Aluminium and Vanadium, the Aluminium content gives a better mechanical strength to the alloy. Vanadium eases the machining and the different production processes.

Commercially pure titanium (4 TI CP stage) and extra low interstitial Ti-6Al-4V (ELI) are classified as biologically inert. (Elias, C. et al., 2008).

Ti-6Al-4V alloy is widely used to manufacture implants. Alloying elements enables Titanium to have a wide range of properties because aluminium tends to stabilize the alpha phase and vanadium the beta phase, lowering the temperature of the transformation from alpha to beta. (Oldani, C.; et al., 2012).

TCP is known for its biocompatibility, which is probably due to the oxide layer covering it. This is very adherent, very stable in the oral environment and has excellent resistance to corrosion. The TCP is at least 99.5% pure and contains some impurities (N, C, H). It is an alloy of titanium and oxygen and the classification includes 4 types of titanium, with an increasing rate of incorporation of oxygen : TCP grade 1 (lowest in O_2) > TCP grade 2 > TCP grade 3 > TCP grade 4 (the richest in O_2 and the most mechanical-resistant). Advantages of the TiAl6V4 alloy - Improved mechanical properties thanks to aluminium. The TiAl6V4 alloy has a higher mechanical strength than TCP. With vanadium and titanium oxide layer, the corrosion resistance is improved. Moreover, this layer of TiO_2 has a large thickness, so the metal is never in contact with the biological molecules. (Benech, C., 2007).

II.2. Properties

II.2.1. Chemical Properties

Titanium shows, at a high temperature, a strong affinity for oxygen, nitrogen, carbon and hydrogen. This feature is essential in the dental implantology. Its ability to passivate (through the development of a Titanium oxide protector film) gives to this material an incredible corrosion and chemical attacks resistances. It perfectly withstands all natural environments (atmosphere, sea water, saliva) and has a biocompatibility very high compared to other metals. The Titanium corrosion-resistance and its biocompatibility are similar to those of ceramic, without its fragility.

II.2.2. Physical Properties

The physical properties of Titanium clearly distinguish it from other metals (Seraphin, 1995). Low density (4,5); Low thermal conductivity (21,6W/mK); High fusion temperature (1670°C); Low thermal expansion coefficient ($8,5 \times 10^{-6}$ K^{-1}); Non-magnetic. Titanium has a less than 40% lower density than these of carbon steel. Thanks to its abundant properties, Titanium imposed as state-of-the-art material in dentistry, particularly thanks to its light weight, to its low thermal conductivity (less than 14 times than gold), or also its lack of savour (Belov et Williams, 1982).

II.2.3. Mechanical Properties

Titanium has a low level of elasticity Young Modulus (100 GPa) compared to the non-precious-metals alloys (117-220 GPa). Its stiffness may be compared to these of precious alloys.

The yield strength, greatly advantageous for Titanium (350MPa-1GPa, according to the type of alloy), reflects the alloy ability to withstand forces sustained by Titanium, without any permanent deformation. Titanium mechanical resistance may be boosted by adding alloys elements as aluminium (Al) and Vanadium (V).

II.3. Osseointegration

The meaning of "osseointegration" has evolved since the first definition, given by Branemark, in 1977, as a direct osseous deposition on the implant surface (Brånemark et coll., 1976), then she took the denomination of "Functional Ankylosis" (Schroeder et coll., 1977). This term is evolving and its definition is not precise yet. (Dimassi, O., 2011). Nowadays, the definition broadly accepted « an anatomic and direct functional connection between reshaped living bone and charging implant surface » (Brånemark et coll., 1985).

The structure of the implant surface

Improvement of implant-bone interface promotes efficient osseointegration. Modification of the implant surface has been proposed as a method for enhancing osseointegration, because Titanium and its alloys don't, straightly, bond with living bone. (Anil, S., et al., 2011).

The methods used for surface modifications of implants can be broadly classified into three types: mechanical, chemical and physical. These different methods can be employed to change the implant surface chemistry, morphology, and structure. (Anil, S., et al., 2011).

The main objective of these techniques is to improve stimulation of bone formation to enhance osseointegration, removal of surface contaminants, and improvement of wear and corrosion resistance. The first method is the mechanical, it includes grinding, blasting, machining, and polishing. These procedures involving physical treatment generally result in rough or smooth surfaces which can enhance the adhesion, proliferation, and differentiation of cells. The second is the chemical methods of implant surface modifications, as treatment with acids or alkalis, hydrogen peroxide treatment, sol-gel, chemical vapour deposition, and

anodization. The last one, the physical methods of implant surface modification include plasma spraying, sputtering, and ion deposition. (Anil, S., et al., 2011).

Titanium oxide surface layer forms instantly as the reason for implant osseointegration with bone. The most common coating process using a plasma sprayed hydroxyapatite (HA) or $Ca_{10}(PO_4)_6(OH)_2$ produces a roughened surface texture that increases surface area to improve osseointegration bone attachment. (Petersen, R. C., 2014)

The mineral phase for bone is approximately 60% chiefly as HA with traces of other minerals and the remaining being 25% water and 15% organic compounds. (Petersen, R. C., 2014)

On the other hand, contamination or destruction of the TiO_2 layer leads to a pathological loss of osseointegration called peri-implantitis (Dohan Ehrenfest, D.M.; et al., 2010).

The biological effects on the surface of titanium are mainly related to the architecture of the TiO_2 layer. Implants with a thick layer of TiO_2 such as anodized implants have a strong bone response; they increase mineral matrix precipitation on the surface of the implant. However, the chemical changes currently made on the implants can also induce a strong bone response (Dohan Ehrenfest, D.M.; et coll., 2010).

II.4.Biocompatibility

Corrosion is a diffusion interfacial electron-transfer process that occurs on the surface of metals.

Titanium implants are significantly inert and corrosion-resistant, thanks to the protective layer of oxide film coating its surface. In the oral environment, extreme acidic conditions do not exist but the constant aqueous environment coupled with the biofilm effect, fatigue forces and possible interaction with other metals in the mouth may affect the passive surface oxide film. (Gittens, R. A., 2011).

Many agents like hydrogen ion, sulfide compounds, dissolved oxygen, free radicals, and chloride ion, can generate corrosion, resulting in the metal surface breakdown and a consequent adverse tissue reaction.

Two essential features determine corrosion of an implant, the first is the thermodynamics corrosion. The application of chemical thermodynamics is primarily related to the redox reactions. The second is the kinetics corrosion, the electrochemical kinetics include factors that physically obstruct corrosion from taking place. These factors tend to prevent the various electrochemical reactions going in the system either through

concentration, temperature or velocity kinetics in the system. The most common forms of corrosion occurring in Titanium implants are kinetics, galvanic corrosion or dissimilar corrosion (Bhola, R., et al., 2011).

Cell Mitochondria produces more electrons and also acid during periods of lower oxygen concentrations, this might induce breakdown conditions of the generally corrosion-resistant passive TiO_2 oxide layer to reinitiate more corrosion. In addition to metabolic mitochondrial acid, the pH might lower from inflammation and infection, particularly if oxygen is blocked. When acid breaks down the passive TiO_2 oxide layer on a flat surface pitting corrosion occurs. Friction between the TiO_2 oxide layer against another surface causes fretting corrosion. When titanium is in direct contact with a dissimilar metal, galvanic corrosion occurs. Titanium particles found in adjacent soft tissue have been known to produce inflammation, fibrosis and necrotic tissue while infection was found to be a key reason for implant failure where pain was further noted as a clinical concern. Microbial influences can also increase corrosion. Electrochemical corrosion products from metal implants damage the peri-implant tissues. Low intensity electromagnetic fields can inhibit osteoblast growth. Aseptic loosening of implants is occurring as a reaction to metal particles from corrosion that can produce an electric appearance with electromagnetic field where acidity next to a titanium implant needs to be closely monitored (Petersen, R. C., 2014).

Tribocorrosion is a term used to qualify the irreversible transformation of a material caused by a simultaneous action of chemical, mechanical (wear), and electrochemical (corrosion) interactions on surfaces subjected to a relative contact movement (Julio, C., et al., (2015)

The wear phenomenon, known as fatigue, describes a rupture of intermolecular bonds and a zone of subsurface damage caused by the movement of surface molecules under cyclic loads. Fretting is also an important wear mechanism that can occur between contacting surfaces under small-amplitude oscillatory movement. Friction on titanium, during chewing process, can destroy the TiO_2 film that leads to a material loss and possible failures of dental implants. As a result from corrosion and wear processes, metallic ions are released, and wear particles originating from Titanium were found in the surrounding tissues and associated to inflammatory reactions (Julio, C., 2015).

Tribocorrosion tests revealed a low friction on titanium covered with biofilms. The lowering of pH enhanced by microbial species adversely affected the corrosion resistance of titanium surfaces. Failures in implant-supported systems can be caused by a wear-corrosion

process, taking place during sliding titanium-based contacting surfaces in a corrosive environment.

The main events linked to Titanium implant degradation in the oral environment seem to be related to: (1) Electrochemical factors, acidity related to the presence of inflammatory processes, oral bacteria or solutions used that can attack the surface of the implant; (2) Mechanical factors, induced by mechanical loads that can lead to fretting and the surface wear excess; and (3) Interactivity of electrochemical and mechanical factors (tribocorrosion) (Rodrigues, D. C., et al., 2013).

II.5.Bacteriology

Implant surfaces are exposed to a bacteria-rich environment and rapidly become colonized by oral bacteria that can compete with epithelial and connective tissues and cells for binding to the implant surface (Dorkhan, M., 2014). Bacterial accumulation may result in infection, destruction of the tissue-implant integration or even implant failure; accordingly, inhibiting bacterial adhesion would be supportive to the success and survival of implants (Klinge, B., Meyle, J., 2006).

Many experimental and clinical studies have put forward a positive correlation between plaque accumulation and peri-implantitis bone loss. Factors such as surface roughness were found to be unsupportive in the plaque accumulation prevention. Hence, to prevent plaque accumulation, the ideal is a smooth surface of transmucosal implant enabling the formation of an epithelial seal. *Aggregatibacter actinomycetemcomitans* and *Porphyromonas gingivalis* are two bacteria that are the most related with periodontitis and peri-implantitis. Those bacteria have been observed in human buccal epithelial cells in vivo (Rabelo de Oliveira, G., 2012). On the Titanium surface, a plaque forms, made up of a few cocci and a higher proportion rods and filamentous shaped bacteria (Scarano, A., et al., 2010).

Oral fluids and biofilms in the implant can be one of the factors responsible for a loss of mechanical integrity of the abutment screw. Furthermore, as a result of biofilm growth, there is a release of acidic substances from carbohydrates metabolism that can hold sway over pH and the oxygen content. However, the pH of the oral surfaces surrounding media can be lower than the ones reported leading to a localized corrosion of titanium (Julio, C., et al., 2015). The

pH level plays also a bacteriological role. Many bacteria favour acidic growing conditions to metabolize organic compounds, able to dissolve hydroxyapatite as enamel and dentin.

II.6. Advantages and Disadvantages of Titanium

II.6.1. The advantages

As reported above, titanium implant system is the achievement of a fast and tight interconnection between the implant surface and the bone tissue owing to its low thermal conductivity, low density, lower elastic modulus mismatch compared to bone, high hardness, outstanding biocompatibility and remarkable corrosion resistance. Titanium presents good biocompatibility, resistance to corrosion, and excellent mechanical properties, as its strength (one of the strongest and most durable metals on the planet). Titanium has the highest strength-to-density ratio of any metallic element on the periodic table. Its natural resistance to rust, corrosion and chemical attack. Titanium abutments respond favourably to gum tissue and have favourable mechanical properties. The titanium implant is strong, durable and less dense what's making it the golden choice (Oldani, C., et al., 2012).

II.6.2. The disadvantages

A concern is growing about titanium hypersensitivity reactions but there is not sufficient data to prove that it can be a factor responsible for implant failure. Although Titanium is coated with a thin oxide layer, that cannot corrode, a corrosion has been clearly identified on titanium surfaces, exposed to particular acids. This effect has been observed when fluorinated varnishes and gels were used. (i.e. tooth decay prevention use) (Özcan, M., et al., 2012).

Corrosion agents may cause a loss in the coating surface, releasing metallic ions in the peri-implant tissues (Galvanic corrosion) (Petersen, R. C., 2014). Implant on bone micro-movements can induce fretting corrosion. (Julio, C., et al., 2015)

From an esthetic point of view, Titanium implant is not the best choice, because he may give to the soft tissue, an unnatural bluish appearance. due to a lack of light transmission, avoiding a gum in-depth lightening. (Ozkurt, Z., et al., 2011).

III. ZIRCONIUM

III.1. Generatities

Zirconium is one of the oldest terrestrial solid. The finding date of Zirconium is 1789, by the German chemist Martin Heinrich Klaproth, who discovered Titanium. The medical field first use of Zirconium oxide took place in 1969 in orthopaedic surgery, whereas in the dentistry sector, Zirconium first appeared by the years 1978-1980. Since 1990, Zirconium the area of its application is gradually extended to the whole dental care sector.

Zirconium is a chemical element, a transition metal of Group IV, with symbol Zr and atomic number 40. As it oxidizes, it forms Zirconium dioxide, sometimes known as Zirconia. Zirconia is a dioxide, high density pure polycrystalline ceramic. In natural state, Zirconium is found in a single mineral, Baddeleyite. Zirconia is a white, opaque structural ceramic that has high flexural strength (800-1000 MPa), high fracture toughness (6 to 8 MPa·m), and high hardness (1600-2000 VH). The addition of a low percentage of oxides (MgO, CaO, Y2O3) stabilizes the cubic and/or tetragonal to ambient temperatures. We have then a stabilized Zirconia. The physical properties of zirconia are attributed to its single phase polycrystalline structure and its very small (<0.4 μm), uniform size and shape crystals. Currently, there are three different types of zirconia ceramics available for biomedical applications, 3y-TZP, yttrium-stabilized tetragonal zirconia polycrystals, is the most common form of zirconia used in the dental industry. (Lughi, V., et al., 2010).

III.2. Properties

III.2.1. Chemical property

In the case of adding 2 to 3% of yttrium oxyde (Y2O3) as a stabilizing agent, allows the zirconia to obtain a structure made of 100% small metastable and fine tetragonal grains. Must of the time, this zirconia (Y2O3), which is used for dentistry because it offers an interesting compromise between toughness and breaking stress.

III.2.2. Physical Properties

Density: 6.05 = Very dense materials.

Granulometry: 0.2 micrometer = Thin grain size.

Porosity: 0,1 =Low porosity

WEIBULL Module: 10-12 =WEIBULL high, indicating a disparity of weak defects.

III.2.3. Mechanical properties

The origin of the exceptional mechanical properties of this zirconia lies in its dense micro-grain structure and without defects. Those properties depend on its purity, its porosity, the size of its grains and the proportion of tetragonal and monoclinic phase.

Flexural strength (Mpa): 1200 => Feasible Long-range part.

Young Elasticity Modulus (Gpa): 220 => relatively low, indicating an elastic deformation capacity before brittle fracture. This shows that Zirconia absorbs a certain amount of constraints.

Vickers Hardness (VH): 1200 => Extremely hard material.

Toughness Value (NPam-1): 7-10 => Good behaviour in response to rupture in case of notch.

III.3. Osseointegration

A set of tests proved that Zirconia firmly integrates into the bone. In this field, the implants surface state is essential. Thus, studies showed that the bone apposition is just as much on Titanium implants than on those of Zirconia. Various surface treatments are proposed, for instance a laser-machined surface can achieve a surface enlargement thanks to an increased micro- and macro-roughness. The laser rough surface is the patented and unique process of a single brand of implants. This technique greatly improves osseointegration. The survival rate currently exceeds 98% and is comparable to that of the leading titanium implants. (Eppe, P., 2016).

Various chemical and physical surface modifications have been developed to improve osseous healing. To enhance surface properties, two main approaches may be used, such as optimizing the microroughness (sandblasting, acid-etching) or applying bioactive coatings (calcium phosphate, bisphosphonate, collagen). Although Zirconia may be used as an implant material by itself, zirconia particles are also used as a coating material of titanium dental implants. (Özkurt, Z., et al., 2011).

III.4. Biocompatibility

The electrochemical problem, due to titanium, does not exist with ceramic implants of Zirconium oxide. Zirconia is an inert bioceramic with excellent biomechanical properties, with no heat transmission, inducing no galvanic corrosion, electrical insulator, its white colour favours esthetic restorations. Zirconia is a biocompatible material with no effect on immune system. According to different studies, neither incompatibility nor allergies related to this material have been shown (Eppe, P., 2016).

Studies attested a high biocompatibility of zirconia, especially when it is completely purified of its radioactive contents. However, particles from the Degradation of Zirconia at Low Temperature (LTD) or from the manufacturing process can be released, promoting an immune localized inflammatory reaction. (Angela, Cl., et al., 2010).

As a result of its biocompatibility, Zirconia, thanks to its radio-opacity properties, provides a lot of properties, such as high resistance to corrosion, chemical inertia, no “flash” effect during CT and MRI exams, absence of toxicity, bimetallism, excellent tissue tolerance, better anti-plaque properties, very low erosion coefficient (Courcier, L., 2011).

III.5. Bacteriology

In Zirconia implants, lesser plaque accumulation has been reported. Bacteria such as *S sanguis, Porphyromonas gingivalis,* short rods, and cocci have shown lesser adherence to zirconia. (Ananth, H., et al., 2015).

Bacterial cultures on the surface of zirconia and titanium samples of the same roughness revealed a lower bacterial colonization on zirconia surfaces, resulting in a lower inflammatory response after quantitative analysis. Numerous in vivo studies confirm these results, the precise mechanics leading to these findings have yet to be demonstrated (Sanon, C., 2014).

The epithelial tissue adapts better to zirconia than metal and the risk of peri-implantitis is very low. The bacterial colonization of zirconia is indeed very weak. This limits the bone loss around a zirconia implant. Recent scientific studies have demonstrated a greater rate of bone and gingival healing around zirconia.

Bacterial colonization usually been found around the natural tooth due to humid environment and constant temperature inside the oral cavity. Since the microflora around implants is similar to that of natural teeth, microbial pathogens (i.e. *Actinobacillus actinomycetemcomitans, Porphyromonas gingivalis,* or *Prevotella intermedia*) associated with periodontitis may contribute to implant failure (Apratim, A., et al., 2015).

III.6. Advantages and Disadvantages

III.6.1. Advantages

Zirconium seems to be a suitable dental implant material because of its toothlike color, mechanical properties, and therefore biocompatibility. The use of Zirconium implants accedes to the request of many patients for metal-free implants. The material also provides high strength, fracture toughness, and biocompatibility. The inflammatory response and bone resorption induced by ceramic particles are less than those induced by titanium particles, suggesting the biocompatibility of ceramics. (Ozkurt, Z., et al., 2011.)

Zirconia, electrically neutral, shall not be subject to any reduction, long-term guarantee of durability. Zirconia has an outstanding mechanical capacity, needed to be used in the abutments machining. Zirconia is also the best dental material for thermal insulation, enhancing patient comfort.

Thanks to the semi-opacity of Zirconia, it allows a gum retro illuminating effect, that gives a natural rendering of implant restorations. In addition, Zirconia may be coloured with a choice of four or five hues. (Stephanus, D., 2011)

Zirconia based ceramics are chemically inert materials, allowing good cell adhesion, and while no adverse systemic reactions have been associated with it. (Claudia Angela et al., 2010). Regarding the crown, the benefit of using is to not reflect a greyish light through the ceramics coronary restoration, especially visible on the anterior teeth. Zirconia provides a better compatibility, and thus a stronger gingival structure, better quality and without underlying color. Zirconia allows a much slower cratering phenomenon than with Titanium. It also restricts gingival recession as long as an optimal hygiene level is maintained.

On biological grounds, Zirconium favors soft tissues. A lower level of inflammation had been highlighted, around the surrounding soft tissues, compared to Titanium. Without a real

connective tissue attachment, we have a mechanical barrier against bacterial attacks. Zirconium ring systems also allow to prevent a gum discoloration.

III.6.2. Disadvantages

The clinical use of Zirconium dental implants is limited because fabrication of surface modifications is difficult, and smooth implant surfaces are not beneficial for osseointegration because of poor interaction with tissues. The implant spatial positioning remains the most important key to esthetic accomplishment.

Most Zirconia dental implants cannot heal under the gums because of their "one-piece" design, meaning that they do not have a removable abutment but one that is fixed to the implant. When Zirconia is adjusted, micro-cracks form and can cause fractures. Zirconia implants with a small diameter are prone to fracture. Zirconia implant crowns can generally only be cemented. Full-mouth treatments cannot be completed with one-piece abutments (Kyle, S., et al., 2016.).

IV. Discussion

A better attachment appears in titanium implants, because of the oxide layer that forms immediately after an osseointegration. (Petersen, R. C., 2014). The thicker is the layer the stronger the bone response is. But a case of contamination or destruction of this layer can cause a peri-implantitis. (Dohan Ehrenfest, D.M., et coll., 2010).

A histological osseointegration of Zirconium is similar to titanium's and he has a survival rate apparently close to these of Titanium. Several authors agree that, in the event of Zirconium-connective tissue contact zone, the collagen fibbers cerclage is denser and more reliable. (Brodiez, P., 2013). Various modifications have been made in the surface to improve osseous healing. (Özkurt, Z., et al., 2011).

The oxide layer on titanium implant has also an important role in corrosion, thanks to it the implant is inert and corrosion resistant (Gittens, R. A., et al., 2011). The titanium implant is corrosion resistant, however his coating can be damaged by numerous factors, electrochemical, mechanical and tribocorrosion. (Danieli, C., et al., 2013). Ti-6Al-4V and commercially pure Titanium, both are biologically inert (Elias, C. N., 2008).

The electrochemical problem, due to titanium, does not exist with ceramic implants of Zirconium oxide, for this reason zirconium implant have no impact on the immune system. (P. Eppe, 2016). The main weakness of Zircinia is the risk of degradation at low temperature or

from the manufacturing process, that can cause a local inflammation. (Claudia, A., et al., 2010).

Different bacteria can appear during the implant treatment, they may affect the abutment and/or the implant itself. Comparing the surface roughness of commercially pure titanium surfaces with the Ti-6Al-4V surfaces used in our study. It is established that the roughness of the Ti-6Al-4V surfaces were to be meaningfully lower than that of the commercially pure titanium surfaces, suggesting that titanium alloys may host fewer bacteria (Rabelo de Oliveira, G., 2012).

Sensitivity reaction is one of the concerns in Titanium implant, even though there is no sufficient data to confirm it. In zirconium implants there is an absence of allergic reactions. (Brodiez, P., 2013).

Many studies have been made to compare bacterial adherence on titanium and zirconium implants. Here are some examples: a clinical testings concerning functional, study permucosal Zirconia and Titanium abutments, no difference in bacterial colonization was identified. Short-term discrepancies in clinical factors about the soft tissues adjacent to Zirconia and Titanium abutments did not appear. (Brakel, V., et al., 2010–2011 ; Salihoglu, et al., 2011). Another study shown that in biofilm formation intra-orally for a day, plaque accumulation has less grown on Zirconia discs than Titanium discs. (Nakamura, et al., 2010 ; Salihoglu et al. 2011).

During the treatment with titanium, the surgical act is two times more invasive than Zirconium, as a result the risk of contamination grows. (Brodiez, P., 2013).

Bacteriology can also affect the esthetic point of view of the implant. Although plaque seems to advantage Titanium surfaces (Nakamura, et al., 2010), this does not seem to bear especially clinical relevance and tissues are evenly healthy. More soft tissue colour difference was noted between natural teeth and implants provided with titanium compared to implants endowed with zirconia abutments (Bressan, et al., 2011). The improved esthetics in the presence of thin gingiva, gingival recession or visualization coils when periodontal disease is observed. Indeed, Titanium may lead to a greyish coloration under these circumstances. (Eppe, P., 2016).

V. Conclusion

Both titanium and its alloys, based on their physical, chemical and biological properties, appear to be especially suitable for dental implants. For the construction of endosseous implant devices, titanium and its alloys have become well-accepted and can be considered the materials of choice. Surface activation or tuning of titanium surfaces will certainly improve biological integrity in critical situations, increasing clinical service of implant therapies even further. But despite these qualities, some disadvantages of this material, such as problems in bacteriology and esthetics, have led to the research and development of zirconium implants. Zirconium meets these two problematical criteria of Titanium implants, a ceramic that is less likely to cause contamination, of natural colour that allows a nearly perfect esthetics. However, the Zirconium itself, also has certain disadvantages, such as the risk of fracture, the impossibility of welding and retouching (leading to premature aging). It should also be noted that there is currently only a small clinical decrease in a large scale use. It is therefore currently difficult to know whether zirconia is a material of choice for a long-term use.

For this reason the research is continuing in this area, for instance studies on hybrid implants, which are being developed to create an implant without the risk of inflammation or rejection, and which will have an esthetic very close to natural teeth.

VI. Bibliography

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