Journal Homepage: - www.journalijar.com
INTERNATIONAL JOURNAL OF ADVANCED RESEARCH (IJAR)
Article DOI:10.21474/IJAR01/4408
DOI URL: http://dx.doi.org/10.21474/IJAR01/4408
ISSN NO. 2320-5407

RESEARCH ARTICLE

BIOCOMPATIBLE DENTAL IMPLANT MATERIALS: AN REVIEW.

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Manuscript Info

Manuscript History

Received: 07 April 2017
Final Accepted: 09 May 2017
Published: June 2017

Key words:-
Dental implants, titanium, biocompatibility, stainless steel, cobalt alloys, zirconia.

Abstract

The first choice in replacing any lost teeth has become the dental implants. It is an artificial prosthesis that can easily blend with the other natural tooth or like a natural tooth that makes you forget that you lost a tooth before. With all the advancements and developments in the science and technology, the materials available for dental implants also improved. Right from Egyptian period replacement of missing teeth have been practiced. However in due coarse of time and technology dental implant materials and procedure has been improved to meet the future generation. The following article explains you about the various dental implant bio materials.

Introduction:-

Dental implants becomes the first choice in replacing any lost teeth. It is an artificial prosthesis that can easily blend with the other natural tooth or like a natural tooth that makes you forget that you lost a tooth before. With all the advancements and developments in the science and technology, the materials available for dental implants also improved[1] . Modern dentistry is beginning to understand, realize, and utilize the benefits of biotechnology in health care. Study of materials science along with the biomechanical sciences provides optimization of design and material concepts of surgical implants[2]. An ideal biomaterial is expected to exhibit properties such as a very high biocompatibility, that is, no adverse tissue response. Also, it must have a density as low as that of bone, high mechanical strength and fatigue resistance, low elastic modulus and good wear resistance. It is very difficult to combine all these properties in only one material. Some metals are used as biomaterials due to their excellent mechanical properties and good biocompatibility. Since the metallic bonds in these materials are essentially non-directional, the position of the metals ions can be altered without destroying the crystal structure, resulting in a plastically deformable solid. This is also an advantage when thinking about the device manufacture technology[3].

History till Yesterday:-

Replacement of missing tooth with various materials dates back to ancient period of Greek and Egyptian civilization where bone, carved ivory, shells, metal and even animal teeth were used[4]. Metal Implants of Gold, Lead, Iridium, Tantalum, stainless steel and cobalt alloy were also mentioned in the early 20th century. Between these two periods a variety of polymers, including ultrahigh molecular weight polyurethane, polyamide, polymethylmethacrylate resin, polytetrafluoroethylene, and polyurethane, have been used as dental implant[5]. The first metal alloy developed specifically for human use was the “vanadium steel” but it was no longer used in implants because its corrosion resistance is inadequate in vivo. Later in the 1950s, 18-8sMo with very low carbon content (known as 316L) stainless steel was introduced and is actually widely used for implant fabrication. This alloy has a very good resistance to chloride solutions and poor sensitization. The castable CoCrMo alloy has been so popular in dentistry recently, in making artificial joints. The wrought CoNiCrMo alloy is relatively new, now used for making the stems of prostheses for heavily loaded joints such as the knee and hip. Both alloys have excellent corrosion resistance.

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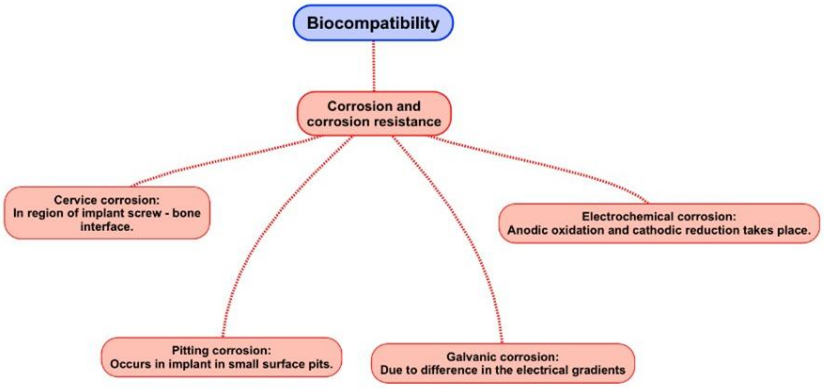
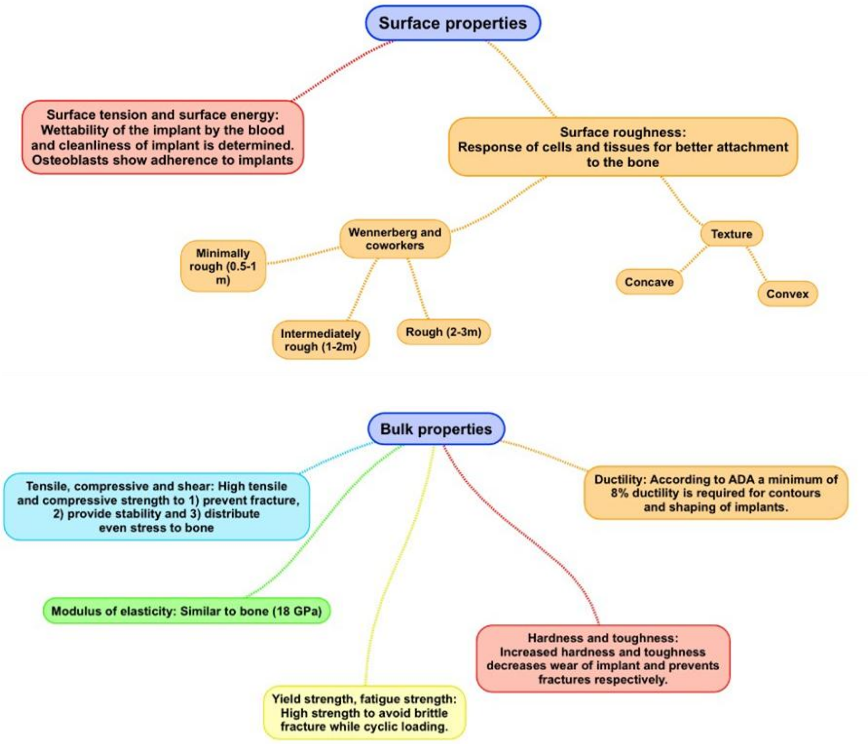


Attemps to use titanium for implant fabrication dates the late1930s. It was found that titanium was tolerated better than stainless steel and cobalt alloys. Titanium's lightness and good mechano-chemical properties are salient featurea for implant application[3].

Properties of ideal dental implant Material:-

Since their introduction by Brånemark in the 1960s, dental implants have been the idealistic choice of teeth replacement due to their properties. An ideal implant material should be biocompatible, with adequate toughness, strength, corrosion, wear and fracture resistance[6,7]. The design principles of the implant should be compatible with the physical properties of the material. Materials used for the fabrication of dental implants can be categorized according to their chemical composition or the biological responses they elicit when implanted [8]. From a chemical point of view, dental implants may be made from metals, ceramics or polymers.



A metal that met the ideal properties of dental implant: Titanium:-

Titanium has a good record of being used successfully as an implant material and this success with titanium implants is credited to its excellent biocompatibility due to the formation of stable oxide layer on its surface[9,10]. The commercially pure titanium (cpTi) is classified into 4 grades which differ in their oxygen content. Grade 4 is having the most (0.4%) and grade 1 the least (0.18%) oxygen content. The mechanical differences that exist between the different grades of cpTi is primarily because of the contaminants that are present in minute quantities. Iron is added for corrosion resistance and aluminum is added for increased strength and decreased density, while vanadium acts as an aluminum scavenger to prevent corrosion[11]. Unalloyed titanium microstructures do not contain nonmetallic inclusions due to the highly sophisticated double or triple vacuum melting practices that are used. Metallographic examination at 100X magnification typically reveals a complete absence of nonmetallic inclusions[12]. Pure titanium is a rather soft nonmagnetic material. It undergoes a crystallographic change from alpha to beta phase on heating to 883°C. Although they are stiffer than bone, their modulus of elasticity (stiffness) is closer to bone than any other important implant metal. This property leads to a more even distribution of stress at the critical bone-implant interface because the bone and implant will flex in a more similar fashion[13].

Titanium - CpTi
Titanium Alloys - Ti-6A1-4V extra low interstitial (ELI)
Ti-6A1-4V
Ti-6Al-7Nb
Ti-5Al-2.5Fe
Ti-15 Zr-4Nb-2Ta-0.2Pd
Ti-29Nb-13Ta-4.6Zr
Roxolid (83%–87%Ti-13%–17%Zr)

Modifications of Titanium Alloy:-

Aluminum, titanium and zirconium oxides: Root form or endosteal plate form, and pin-type dental implants are generally made from High ceramics from aluminum, titanium and zirconium oxides. The compressive, tensile and bending strengths exceed the strength of compact bone by 3 to 5 times. These properties combined with high moduli of elasticity and especially with fatigue and fracture strength have resulted in specialized design requirements for this class of biomaterials[14].

Titanium-zirconium alloy (Straumann Roxolid):-

Titanium zirconium alloys with 13%-17% zirconium (TiZr1317) have better mechanical attributes, such as increased elongation and the fatigue strength, than pure titanium. Growth of osteoblasts, that are essential for osseointegration is not prevented by Titanium and Zirconium. Straumann developed Roxolid that fulfills requirements of dental implantologists and is 50% stronger than pure titanium. Thin implants and implant components that can be subjected to high strains can be produced using TiZr1317 due to its better mechanical properties, provided that the material shows a similar good biocompatibility as pure titanium[15].

Conclusion:-

Dental implants gained popularity in this modern era, that it has been the first choice of artificial dental prostheses. Longevity and success rates have been seen in most cases. A few exceptionals would include peri- implantitis, failed osseointegration, sinus problems and overloading. Titanium has long been regarded as a biocompatible implant material and recently various modification of its surface has been emerging at molecular and atomic level to enhance osseointegratition. Bioceramics, besides being esthetic, its biomemetic phenomenon has also been incorporated for better bone implant contact[4].

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