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CORROSION AND ITS PREVENTION IN THE FIELD OF BIOMATERIAL IMPLANTATION

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Abstract: *Biomaterials are used in the field of biomedical that can functionally interact with biological systems to concur for longer service with less failure. Corrosion of biomaterial is a very crucial & common factor. Biomaterials are required for the survival of the human beings suffering from critical diseases like heart, dentistry, arthritis, osteoporosis and other joint problems. This study discusses various points which are associated with biological corrosion of different kind of implant in the biomedical filed. Corrosion is one of the main factors that affect the life and service of biomaterial devices, which are manufactured by metals and alloys. It has been observed that biomaterials are continuously in the contact of fluid in the human body. Due to this phenomenon they often fail and finally fracture due to corrosion. This study insight the corrosion process in order to surface improvement of bio material implantation. Surface improvement is the best solution to reduce the corrosion and enhance the life of bio implant product and by applying this process can achieve better bio compatibility for better result. The recent advancement in the surface modification is the advanced surface coating techniques of nano materials. They provide the better mechanical properties and improved bio compatibility for the implantation of the biomaterials*

Key Words: *Biomaterials, bio corrosion, Surface modification, nano coating and Bio compatibility.*

1. INTRODUCTION:

The area of biomaterial is very important for the mankind because some of them are less fortunate human beings. Even some people at the time of birth are born with congenital heart disease and also for the old population, who are required biomedical implants to increase their life period. In the current scenario arthritis is one of the main diseases generally faced by the older and even at that times younger people are also affected by this disease. It makes the life very difficult of those, who are affected by arthritis due to arthritis it is very difficult to move and creates and unbearable pain. While the sciences have tremendous scientific advancement but still causes of diseases remain unknown even today. Not only diseased people even young and dynamic people like sport persons sometimes need the replacement due to fracture and excessive strain. Especially after the World War the demand of biomaterial was actually felt and now in the current global terrorism biomaterial assumes much more significance & requirement [1].[2]

The fundamentally and most important requirement to choose the biomaterial is its compatibility with human body. The implanted material should not cause any adverse effect in human body like allergy, inflammation and toxicity after surgery or under post operative conditions. Secondary biomaterial should posses' sufficient mechanical strength to sustain the forces to which they are subjected. So that they should do not undergo fracture and failure .The main importantly thing is that a bio implant should have very high corrosion and wear resistance in very highly corrosive body environment and varying loading conditions. A biomaterial should remain unchanged for a long period and should not fail until the death of the user. So the requirement demands a minimum service period of 15 to 20 years in older patients and more than 20 years for younger patients. The success of biomaterials of an implantation is highly dependent on 3 main factors (i) The mechanical, chemical and tribological properties of the biomaterial (ii) biocompatibility of the implant (iii) The health conditions of the patient and the competency of the Doctor. So out of all these issues the failure of an implant due to corrosion has remained one of the challenging clinical problem. [3]. [4]

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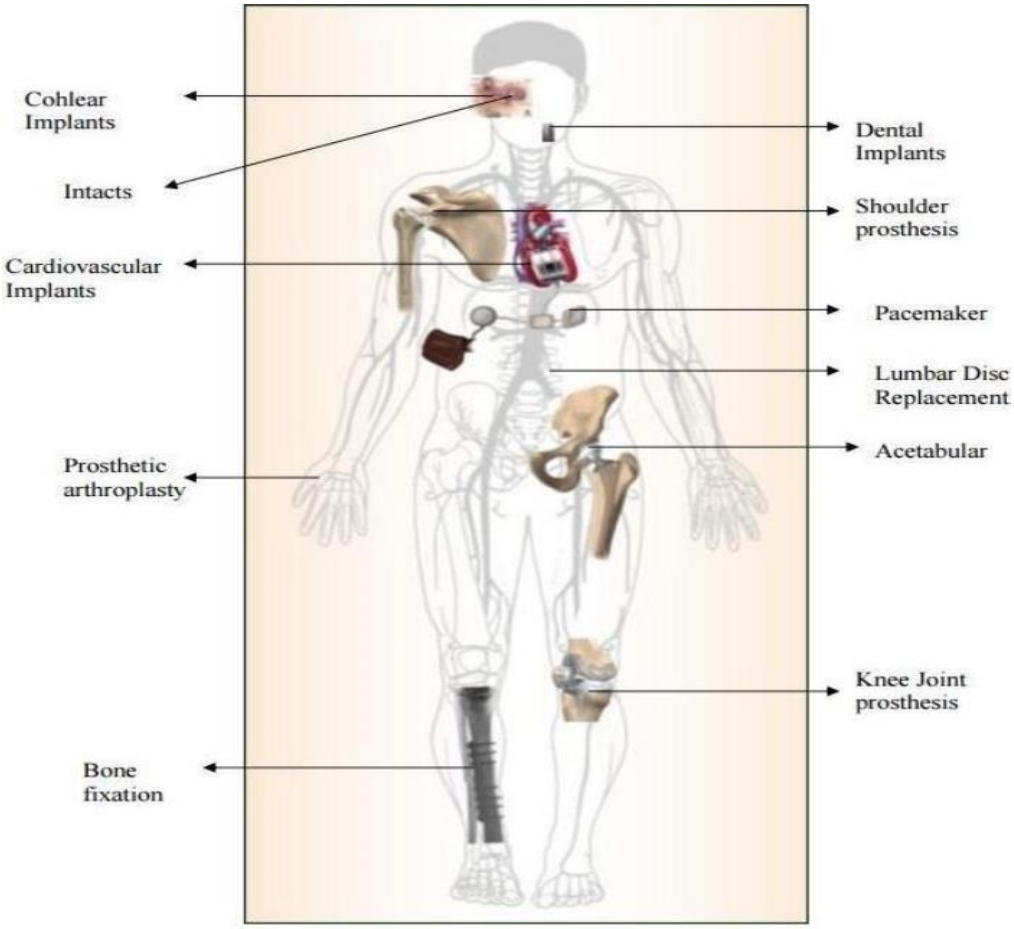

Figure 1: Biomaterials for Human Application [18]

2. BIOMATERIAL CORROSION:

Corrosion is one of the important problems when metals and alloys are used as biomaterials in the human body. Biomaterial deteriorates over time. The metals and alloys are highly susceptible and polymers also suffer from degradation. Corrosion of biomaterial is an important feature for biocompatibility. The noblest metals like gold and platinum group metals or the most passive titanium or chromium metals have corrosion rates within acceptable levels. The metallic biomaterials behaviour in bio liquids depends on many parameters related to surface preparation and environment specific composition including the special influence of chlorine or fluorine anion or the effect of organic compounds [Demetrescu & Popescu, 2003; Yu & Zhao, 1993; Reclaru &Meyer, 1998; Born et al, 1998]. [5-8] Corrosion of implants in the aqueous medium of body fluids takes place via electrochemical reactions (Shreir, 1994) that's why it is very necessary to understand the electrochemical processes that are most relevant to the corrosion processes. The electrochemical reactions occur on the surface of the surgically implanted alloys. This was observed that during exposure to seawater (namely, aerated sodium chloride). The metallic components of the alloy are oxidized to their ionic form and the dissolved oxygen is reduced to hydroxyl ion. The types of corrosion in the used alloys are pitting, crevice, galvanic, intergranular, stress corrosion cracking, corrosion fatigue and fretting corrosion. [9-11]

3. EFFECT OF CORROSION ON BIOMEDICAL IMPLANTS: The Biomedical implants due to corrosion in the human body affect several biological parameters. When an implanted bio material starts to corrode dissolution of metal will lead to erode on that causes leads to brittleness and it tends to fracture of the implant material. When the Bio-material fractures corrosion get accelerated due to the huge amount of exposed surface area and loss of preventive oxide thin layer. If the implants are not surgically taken out further dissolution and fragmentation can take place they may be result in inflammation of the surrounding tissues. Due to the corrosion in biomaterials lots of the effects in human body takes place like due to Nickel- affects skin, cobalt-Anaemia, Chromium-Ulcers, Aluminium-Alzheimer's diseases and Vanadium-toxic in the elementary state. Cobalt-chromium alloy which is commonly used for biomaterial that consists the elements cobalt, chromium, nickel and molybdenum. It is felt that the corrosion of cobalt-chromium in the wet and salty surroundings of the human body. It releases toxin into the body leads to the

formation of cancerous tumour. We always required developing new and secure materials which have extremely high corrosion resistance quality. [12]

4. SURFACE MODIFICATION IN BIOMATERIAL FOR CORROSION CONTROL & ITS PREVENTION: To handle & for prevention, we required a systematic methodology that includes- design, selection of material, surface modification, material modification by adding alloying element or heat treatment, electrochemical techniques-cathodic protection and anodic protection.

5. DESIGN: Design engineers must consider the loads to be placed on the implant. That's why can design for sufficient structural integrity and stability.

6. SELECTION OF MATERIALS: This is the most common method to overcome the problem of biomaterial corrosion. The widely used biomaterials can be classified into three main categories- metals, polymers and ceramics but in the recent trends composite are also being demand for certain biomedical application.

7. BIO-MATERIAL: The basic criteria for choosing a metallic implant material is its biocompatibility. Metals and alloys are widely used in various forms as implants. They provide the required mechanical strength and corrosion resistance. We have a large number of biomaterial ranges for choosing the materials for implantation like-of austenitic stainless steels, cobalt-chromium alloys, and titanium its alloys, Nitinol, Polymers, Bio ceramics, Calcium Phosphate Ceramics (CPC), Composite, nano ceramics etc.

8. LATEST AND FUTURE DEVELOPMENT:

The field of corrosion with respect to dental implants, orthopaedic implants and cardiovascular implants faces infinite challenges as there are still a lots of problems to be rectified. As our bones, tooth, cartilage etc are natural composites, latest research is focused on the development of composite bio materials for implant utilization, which will imitate the nature. However, more studies are to be made to understand the behaviour of composite materials in vivo as their bio fluid absorbing behaviour, interfacial bonding between the matrix and reinforcement under loading are not clear at present in vivo conditions. Ceramics materials are other types of materials which have very high biocompatibility and have very good corrosion resistance. These biomaterials are widely used in today's era for hip replacement, heart valves, dental implants, knee implants & restorations, bone fillers and scaffolds for tissue engineering, but ceramics materials are very brittle, have high elastic modulus and can fracture easily as they posses low plasticity. When these materials are oxidized they deliver ions into the human body & this may lead to degradation of the implant bio materials. Alumina & zirconia are considered to be as substitute for metallic bio materials for load bearing utilization purpose as they show no corrosion in the human body & also posses very high wear resistance quality. But mechanical failures of these bio implants are also being reported & hence very extensive research is required in order that these classes of materials are being suggested for the final applications. Bioactive glass material which was first found in 1969 is now used for bone repair and bone regeneration. Fused quartz, alumina silicates, certain borosilicate, alkali resistant glass, soda-lime glass, Titania frit, arsenic trisulphide, lithium and magnesium alumina silicate, glass-ceramics, and calcium fluorapatite all appear to be well tolerated & acceptable for soft tissue implantation. [13-14] The current simulators scientist should also include the testing facilities to measure the tribological corrosion to have the actual picture of the various processes. Though there are lots of reports, which produce the very unpleasant effects of the corrode materials and that's why still, there is a need to create a technology to evaluate the actual concentrations, the form of the metals that will induce toxicity and other unfavourable effects.

9. COATING FOR SURFACE MODIFICATION: We have several technologies available for coating of a material. In biomaterial coatings are used because they enhance the corrosion resistance to material without affecting any properties. There are several techniques like hydroxyapatite coating (Lin et al, 2001; Chu et al, 2001; pfaff et al, 1993), bio ceramic (Hench, 1991; Lugscheider et al, 2001), sol-gel coating (Chai et al, 2001), quasi crystal coating (Symko et al, 2001), functionally graded material coating (Khor & Wang, 2001), composite coating (Wang et al, 2000; Breme et al, 2000) and bio mimetic coating (Li et al, 2001; Li et al, 2002). The nano ceramic material has tremendous properties so they can be used to obtain orthopaedic and dental implants with much superior property compared to the conventional coating. The nano ceramic HAP coating is used to enhance the osteointegration. Nanostructured graded metallo ceramic coatings also used to achieve better adhesion between the metal and ceramic

coatings and thus nano ceramic coating are gradually receiving greater attention in the field of bio implantation. [15-21]

10. CONCLUSION: The study of biomaterial and corrosion show the significant progress and limitation in the human body. Biomaterial corrosion is restricted to metal, alloy and it is take place via electrochemical reaction. There are number of corrosion processes associated with biomaterial and they can be minimized by using several techniques. The current area is surface modification of metal and alloys by novel method and process. They enhance the corrosion resistance and biocompatibility of biomaterial implantation. The polymeric materials can be used as inject able which are degradable but are highly biocompatible. Implants have been gaining popularity amongst the patients day by day and frequently are being considered as a first line of treatment option. In the previous decade implants have dominated the other treatment modalities and moved into the mainstream of bio medical practice. "We have come a long way but there is still more to find out the solution bio materials implantation.

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