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An Overview of Orthopedic Implants

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INTRODUCTION

Bone defects occur due to accidents, diseases, trauma or abnormal development require a skeletal reconstruction such as grafts of natural and synthetic materials to replace lost bone or to enhance new bone formation. Biomaterials are used to make devices to replace a part or a function of the body in a reliable, safe, physiologically acceptable and economic manner to improve the quality of life, increasing mobility and reducing pain [1]. It covers a broad range of materials from metals, ceramics and polymers, to composites.

There are several requirements of metals depend on the specific implant applications. Stents and stent grafts are implanted to open stenotic blood vessels; therefore, they require plasticity for expansion and rigidity for maintaining dilatation. In orthopaedic implant applications, metals are required to have excellent toughness, elasticity, rigidity, strength and resistance to fracture. Additionally, for total joint replacement metals are needed to be wear resistance to avoid debris formation from friction. Dental restoration requires strong and rigid metals and even the shape memory effect for better results [2].

1. Type of Mostly Used Metallic Implants

Orthopedic implants are the medical devices manufactured to support a damaged bone or to replace a missing joint or bone. These orthopedic implants are mainly fabricated using metallic alloys such as stainless steel, cobalt-chromium and titanium alloys (as a permanent implants) for their superior mechanical properties (hardness, stiffness, etc.), and lined with plastic to act as artificial cartilage.

1.1 Stainless Steels: Used for implants composed of 18wt% Cr and 8wt% Ni made it more resistant to corrosion and stronger than steel. The addition of Mo further improves its corrosion resistance, known as type 316 stainless steel.

1.2 Co-Cr Alloys: These are generally known for their excellent wear resistance where they have been in use in dentistry and in making artificial joints.

1.3 Ti and Ti Alloys: Is featured by its light weight compared to other alloys [3]. The most known Ti alloys, Ti-6Al-4V, are considered as having excellent tensile strength and pitting corrosion resistance.

1.4 Biodegradable Metals: In particular cases, metallic implants are needed only temporary and are expected to support the healing process and to thereafter degrade. These degradable biomaterials may be made of Mg based-alloy [4]. Mg is biocompatible, vital for metabolic processes, and the alloys show higher strength.

2. Metallic Implants are used for Two Primary Purposes

2.1 Implant devices: Used as prostheses serve to replace a portion of the body and include devices such as total joint replacements. The surgical procedure for each implant involves removal of the damaged joint and an artificial prosthesis replacement. Osteoarthritis is the primary reason for orthopaedic implants, which also called degenerative joint disease. Orthopaedic implants are available for the hip, knee, shoulder and elbow.

2.2 Fixation devices: Internal fixation is an operation in orthopaedics that involves the surgical implementation of implants for the purpose of repairing a bone. Though a broken bone, being a living tissue, has a tendency to heal itself provided the broken bone to withhold in the correct position. In the cases where broken bones have to be fixed in the correct and appropriate position, nails, wires, pins, staples and other orthopaedic implants play important role by holding the broken bone.

3. Other Reasons

While there are several reasons hindering long-term stability of the metallic implant with surrounding bone tissue:

3.1 The biological inactivity (inertness): which causes lack in the structural biofunctions as the bone conductivity which leads to integrate slowly with surrounding bone tissue.

3.2 The corrosion of metallic implants: can adversely affect the biocompatibility and mechanical properties, it has

electrochemical reactions that result in the release of metal ions into the surrounding aqueous electrolyte (oxidation of the metal, acting as anode), involving the movement of metal ions and electrons. This dissolution reaction is coupled with a corresponding reduction reaction of constituents in the aqueous environment to maintain charge neutrality. As a basis, the used metallic implant mustn't cause any adverse biological reaction in the body.

To achieve fast and long-term bioactive surfaces, the direction goes toward the combination of the mechanically superior metals and the excellent biocompatibility and biofunctionality of ceramic which acting as a barrier against ion release [5].

Since the 1960s, calcium phosphates (Ca-P) and mainly hydroxyapatite (HA) have been widely used in bone surgeries as they easily bond with bone once they are implanted, in spite of their poor mechanical characteristics. The elaboration of bioactive ceramic coatings on metallic and non-metallic substrates implanted into the human body is, therefore, a way to combine the mechanical properties of the substrate and the bioactivity of the ceramic layer. HA is a major component and an essential ingredient of normal bone and teeth, makes up bone mineral and the matrix of teeth gives them their rigidity.

Several physical and chemical methods were reported in the literature as a coating methods to modify metallic implants surfaces such as the plasma spray, magnetron sputtering, dip- and spin coating sol-gel suspensions, soaking, electrophoresis, pulsed laser deposition, biomimetic and autocatalytic routes [5,6] .

The choice of suitable metallic implant with specific coating depends on several factors such as patient's age, sex and his illness case.

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