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Short Communication

The Process of Osseointegration After Orthopedic Surgery

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DESCRIPTION

With an ageing population, Osteoarthritis (OA) is more common. Global age-standardized incidences of hip and knee OA were 3.8% and 0.85%, respectively, in 2010, according to the Global Burden of Disease (GBD), and these rates are projected to rise quickly in the upcoming years. In order to lessen discomfort and restore joint function, Total Joint Replacement (TJR) has emerged as a viable option. In this circumstance, implants play an ever-increasing role in contemporary orthopedic surgery. However, implant failure and, in this situation, the requirement for revision continue to pose considerable clinical challenges, with much greater death and complication rates than with the first TJR. One of the most crucial elements for successful orthopedic surgery in the field of endoprosthesis is the long-term and secure fixation of implants. Osseointegration (OI), the physical bond between bone and implants, is regarded as a crucial step in the fixation and integration of cementless implants, respectively. Numerous factors, including the characteristics of implants, have an impact on OI. In contemporary orthopedic medicine, the alteration of implants' surfaces for better OI has drawn more and more attention.

The most frequent cause of revision procedures, accounting for one-third of them, is aseptic loosening. Over the past few decades, various *in vivo* investigations have shown Osseointegration (OI) to be a substantial option for the long-term and reliable fixation of implants. "A direct structural and functional link between living bone and the surface of an artificial implant" is the definition of OI. Since OI's significance has been acknowledged, numerous methods for speeding up OI and achieving a more rapid fixation have been devised. It has been shown that a range of parameters, which can be broadly classified into two categories: The environment of the bone-implant interface and the design of the implant itself, can affect the OI process. Loading circumstances, host bone characteristics, interface distance, the concentration of local osteoblast and osteoclasts, and systemic disease are among the environmental influences (diabetes, rheumatoid arthritis, and smoking). The second factor includes the implants' materials, topology, surface coating, macro, micro, and nanostructures, among other things.

A variety of manufacturing techniques have been used to alter the surface of implants in order to alter the environment and improve OI.

The dynamics of OI, which include a series of cascading reactions, heavily depend on the characteristics of the implant surface. A series of intracellular and extracellular biological activities play a part in the bone healing process around implants [1]. As soon as the implant is inserted into the body, an inflammatory reaction occurs, causing the production of several proteins such as growth factors and cytokines that cause a blood clot. The proteins and lipids in the blood clot will soon be absorbed by the implant surface. These surface-coated proteins might serve as a cue for cell migration and growth [2]. The specific types of proteins and degree of adhesion rely primarily on the topographic characteristics, roughness, and hydrophilicity of the implant's surface. Blood platelets then help in the formation of the fibrin matrix, which acts as "a bridge" for cell attachment and migration [3].

Macrophages and neutrophils cling to the implants through the "bridge" 2-3 days after implant insertion, clearing away infections and necrotic tissue and dissolving the blood clot to make way for new blood vessels. After four days, nondifferentiated Mesenchymal Stem Cells (MSCs) assemble around the vessel structure as angiogenesis takes place in the space between the implant and host bone. Under the influence of growth hormones and cytokines, MSCs can differentiate into osteoblasts, which can create the extracellular matrix and build immature woven bone. MSCs can also develop into fibroblasts, which may promote the establishment of a fibrous membrane on the implant site and obstruct the ingrowth of new bone [4]. It is impacted by the surface characteristics and intercellular interactions nearby. Woven bone growth continues over the next one to two weeks following implantation. The newborn woven bone fills in the bone-implant gap after two weeks, and bone apposition and remodeling are the next OI processes. Osteoclasts resorb the freshly created bone during this process to fill up microcracks and prepare the surface for lamellar bone. Osteoclasts create a sealing zone and different micro-and nano-topographies, which store biochemical data and help osteoblasts

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locate the area that requires the production of new bone. Together, osteoblasts and osteoclasts work to gradually change the brittle temporary braided bone into parallel-fiber bone and finally into lamellar bone.

CONCLUSION

Long-term fixation requires the constant presence of this dynamic process for at least a year. The main causes for the failure of orthopedic implants are now aseptic loosening and fibrous encapsulation. In order to enhance OI and improve therapeutic outcomes, surface modification is required to transform the physical, chemical, and biological aspects of implants' surface.

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