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Review

Recent Advancements in Metallic Drug-Eluting Implants

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Abstract: Over the past decade, metallic drug-eluting implants have gained significance in orthopedic and dental applications for controlled drug release, specifically for preventing infection associated with implants. Recent studies showed that metallic implants loaded with drugs were substituted for conventional bare metal implants to achieve sustained and controlled drug release, resulting in a desired local therapeutic concentration. A number of secondary features can be provided by the incorporated active molecules, including the promotion of osteoconduction and angiogenesis, the inhibition of bacterial invasion, and the modulation of host body reaction. This paper reviews recent trends in the development of the metallic drug-eluting implants with various drug delivery systems in the past three years. There are various types of drug-eluting implants that have been developed to meet this purpose, depending on the drug or agents that have been loaded on them. These include anti-inflammatory drugs, antibiotics agents, growth factors, and anti-resorptive drugs.

Keywords: implants; localized drug delivery; bioactive coatings; infection; biomaterials; bone tissue engineering

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1. Introduction

The volume of orthopedic surgeries is quickly increasing due to the aging population and osteoporosis' significant increase, so the development of novel orthopedic implants is crucial [1,2]. Orthopedic implants accounted for $46.7 billion in the U.S. market in 2018, and are expected to grow to $66.0 billion by 2026 [3]. Joint reconstruction represents the largest share (41.2%) of the market, followed by spinal, trauma, orthobio-logics, and dental implants [4]. Approximately 22% and 16% of implant-related failures are caused by stress-shielding (i.e., Wolff's principle) and infection, respectively [3,4]. A majority of orthopedic implants are made of metals and their alloys, such as titanium (Ti), tantalum (Ta), magnesium (Mg), zinc (Zn), stainless steels, and cobalt (Co)-based alloys, due to their low-cost and stability [5,6]. They offer an excellent combination of plasticity and toughness, along with favorable mechanical properties, that make them highly efficient [7]. There are two types of implants: temporary fixation devices, such as bone plates, pins, and screws, and permanent implants, such as total joint replacements in orthopedics [8]. There is the clinical application of common metal implants as shown in Figure 1 [9].

Implant stabilization and long-term success, largely depend on the quality of integration with the surrounding tissue [10]. The implant material, the quality and quantity of formed surrounding bone tissue and the presence of microbial infection all play a crucial role in the integration of the surrounding tissue with the implant [11]. "Stress shielding" effect can be mentioned among other factors that are responsible for implant loosening.