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ANALYSIS OF DRUG DELIVERY SYSTEM IN IMPLANT DENTISTRY

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Abstract:
Infections associated with implantable devices, also known as biomaterial-associated infections (BAIs) pose a serious problem in contemporary regenerative medicine and traumatology. In recent years, the number of procedures which make use of different biomaterials in oral and maxillofacial surgery (OMFS) have significantly increased. The basic aim of the study is to analyze the drug delivery system in implant dentistry. This meta-analysis was conducted in Demontmorency College of Dentistry, Lahore during 2018. A customized electronic search for published literature of last ten years was done and all the articles on dental implants as drug carriers were carefully analyzed. The trend of research on dental implants as drug carriers has been increasing over last few decades as demonstrated in the graph below. In a recent study, a biodegradable nanoporous bioceramic system was used as a highly bioresorbable matrix for drug delivery. This study emphasized the efficacy of hydroxyapatite-based material having interconnected nanoporosity as a vehicle for a therapeutic agent. It is concluded that Dental implants can be used successfully as drug carriers. Most successfully delivered and tested therapeutic agents via dental implants are bone morphogenetic proteins.

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INTRODUCTION:

Infections associated with implantable devices, also known as biomaterial-associated infections (BAIs) pose a serious problem in contemporary regenerative medicine and traumatology. In recent years, the number of procedures which make use of different biomaterials in oral and maxillofacial surgery (OMFS) have significantly increased [1]. This is mainly due to an increase in the number of accidents of major magnitude which require diversified materials and techniques to restore the esthetic and functional integrity of the craniofacial area [2]. Despite efforts being made in bioengineering to improve the biocompatibility of metallic biomaterials, which constitute a major part of reconstructive surgery, the problem of bacterial settlement and infection development still poses a serious threat to treatment outcome [3].

Several methods are used for drug loading and release from scaffolds [4]. However, the basic aim for drug release is to reduce infections and bacterial load to the site of implant, but if the drug is released too quickly, there could be a chance of infection because the entire drug has drained from the scaffold in the initial time itself [5]. Similarly, if there is too much delay to drug release, infection can set in further, making it more difficult to manage the healing of wounds. Hence, better options for drug release would incorporate higher antibiotic release at the initial time and sustained release at an effective rate to inhibit the risk of infection from bacteria in the scaffold at an effective level [6]. Different techniques have been used for drug loading to the scaffold, and controlled release has been studied. One of the simplest strategies is the application of biodegradable polymer coatings loaded with specific drugs onto the scaffold structure. The other methods reported for coating the drug-loaded polymer have included solvent casting, thermally induced phase separation, evaporation, freeze drying and foam coating [7].

Aims and objectives

The basic aim of the study is to analyze the drug delivery system in implant dentistry.

MATERIAL AND METHODS:

This meta-analysis was conducted in Demontmorency College of Dentistry, Lahore during 2018. A customized electronic search for published literature of last ten years was done and all the articles on dental implants as drug carriers were carefully analyzed. The trend of research on dental implants as drug carriers has been increasing over last few decades as demonstrated in the graph below. The graph was plotted with number of articles published per five years. After a careful evaluation, 17 articles which strictly adhered to the topic of this systemic review and fulfilled the inclusion criteria were included.

RESULTS:

In a recent study, a biodegradable nanoporous bioceramic system was used as a highly bioresorbable matrix for drug delivery. This study emphasized the efficacy of hydroxyapatite-based material having interconnected nanoporosity as a vehicle for a therapeutic agent. An in vitro experiment was conducted with the goal of assessing this material and comparing it with commercially available gentamicin-loaded PMMA cement [8]. It was found that the nanoporous bioceramic granules could act as antibiotic carriers, exhibiting a high initial burst effect followed by sustained low-level release for 3 weeks. It was very effective, confirming that the concentration of drug eluted was greater than that needed to maintain bactericidal levels [9].

Calcium phosphate ceramics

The calcium phosphates have been widely studied due to their biocompatibility, tailorable bio-absorbability and bioactivity. Calcium phosphates have been used as novel delivery carriers for antibiotics, anti-inflammatory agents, analgesics, anticancer drugs, growth factors, proteins and genes [8]. Nanotechnology-derived calcium phosphates have also successfully maintained a sustained and steady drug release over time. Calcium phosphate scaffolds not only provide initial structural integrity for bone cells but also direct their proliferation and differentiation and assist in the ultimate assembly of new tissue [10]. Therefore, ceramic nanoscaffolds are usually 3-D and porous, although in some cases they consist of 2-D coatings or films. They mimic the in vivo environment of cells more completely than nanoparticles.

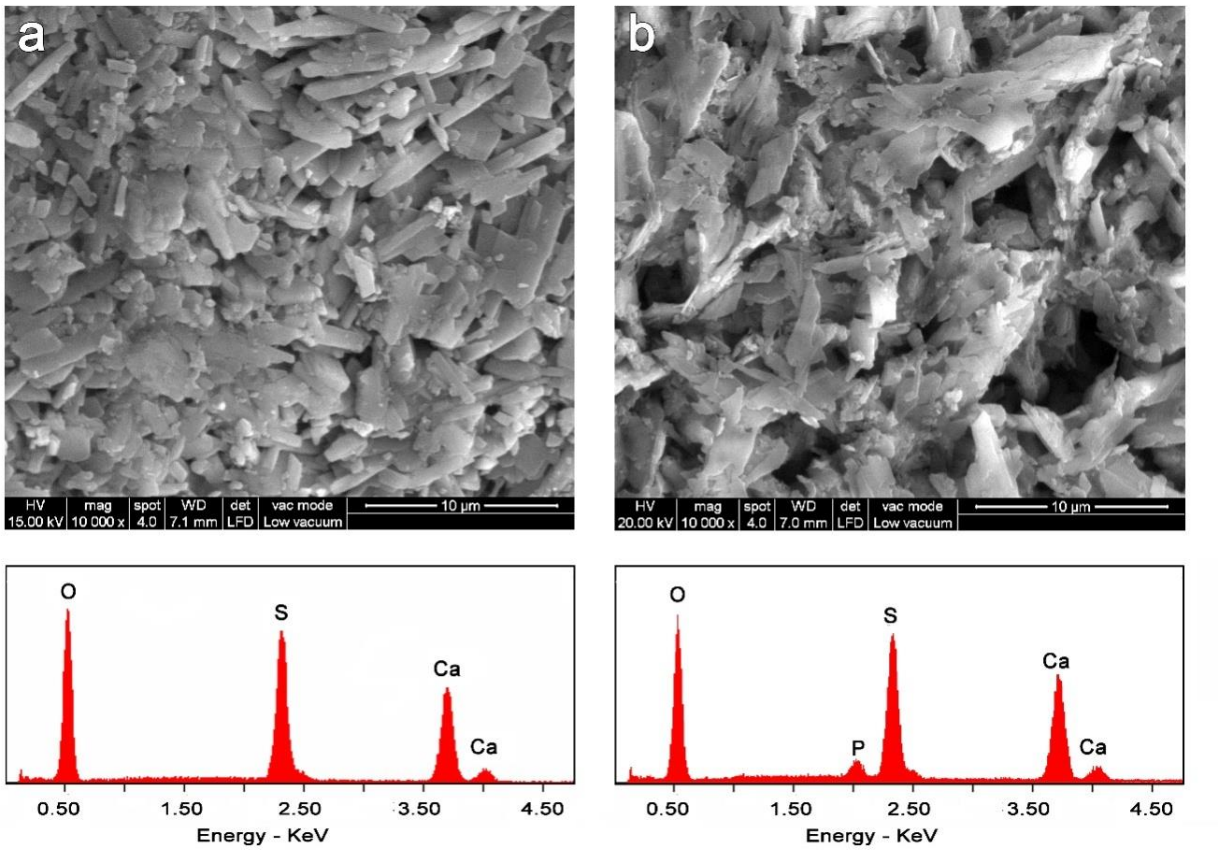

Figure 1. The micromorphology (SEM) of calcium sulfate-phosphate injectable cement.

Porous spherical hydroxyapatite granules for drug delivery

Calcium phosphate-based bioceramics, such as hydroxyapatite (HA), are known for their excellent biocompatibility due to their similarity in composition to the apatite found in natural bone [11]. Various forms of HA bone grafts, such as dense and porous blocks, dense and porous granules, and powder forms, are available as bone substitutes [12]. The porous matrices enable cell migration and provide favorable conditions for nutrient transport, tissue infiltration, and vascularization. The spherically shaped particles are suitable for implantation as injectable bone cements, and the inter-granular space promotes cell migration and the growth of extracellular matrix [13].

Antimicrobial Agents

Only two articles were found on dental implants as carriers of antimicrobial agents, among which one was a review article which didn't meet the inclusion criteria. A gap in research on implants as antimicrobial agent carriers has been identified. Targeted antimicrobial release may solve the issue of peri-implantitis [14]. Another critical need is to investigate ways for controlled drug release over longer periods of time. Most of the studies have established methods for drug delivery over a period of days or weeks, but the release of drugs for durations longer than that still needs to be investigated. It might play a vital role in extending the durability of an implant in function [15].

CONCLUSION:

It is concluded that Dental implants can be used successfully as drug carriers. Most successfully delivered and tested therapeutic agents via dental implants are bone morphogenetic proteins.

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