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Drug Loaded With Biocompatible Polymer In Dental Materials

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ABSTRACT

Biomaterials applications have rapidly expanded into different fields of sciences. One of the important fields of using biomaterials is dentistry, which can facilitate implantation, surgery, and treatment of oral diseases such as peri-implantitis, periodontitis, and other dental problems. Drug delivery systems based on biocompatible materials play a vital role in the release of drugs into the tissues of the oral cavity with minimum side effects. Therefore, scientists have studied various delivery systems to improve the efficacy and acceptability of therapeutic approaches in dental problems and oral diseases. Also, biomaterials could be utilized as carriers in biocompatible drug delivery systems. For instance, natural polymeric substances, such as gelatin, chitosan, calcium phosphate, alginate, and xanthan gum are used to prepare different forms of delivery systems. In addition, some alloys are conducted in drug complexes for the better in transportation. Delivery systems based on biomaterials are provided with different strategies, although individual biomaterials have advantages and disadvantages which have a significant influence on transportation of complexes such as solubility in physiological environments or distribution in tissues. Biomaterials have antibacterial and anti-inflammatory effects and prolonged time contact and even enhance antibiotic activities in oral infections. Moreover, these biomaterials are commonly prepared in some forms such as particulate complexes, fibers, microspheres, gels, hydrogels, and injectable systems. In this review, we examined the application of biocompatible materials in drug delivery systems of oral and dental diseases or problems

Key Words: Drug delivery, biomaterials,Oral disease

INTRODUCTION

The first part of the digestive system is the mouth (oral cavity). It comprises various structures containing gum (gingiva), teeth, soft and hard palate, tongue, mucosal membrane of the cheek's inner surface, lips, and their supporting tissues(1). The oral cavity is a complicated niche for the colonization of more than 700 species of microorganisms that are responsible for oral health. The oral microbiota helps balance and stabilize oral microecology and prevent pathogenic microorganisms from growing(2,3) Some factors, including systemic diseases, change of diet, and inadequate oral hygiene, change the oral microbiota composition that plays an important role in oral microecology dysbiosis and diseases related to different oral microbiota diseases such as oral infections(4). In addition to injuries, the most common dental problems and oral diseases involve oral infections, oral malignancies, dental caries, and periodontal diseases(4,5).

Delivery systems based on biomaterials are provided with different strategies, although individual biomaterials have advantages and disadvantages which have a significant influence on transportation of complexes such as solubility in physiological environments or distribution in tissues(6). Biomaterials have antibacterial and anti-inflammatory effects and prolonged time contact and even enhance antibiotic activities in oral infections(7). Moreover, these biomaterials are commonly prepared in some forms such as particulate complexes, fibers, microspheres, gels, hydrogels, and injectable systems(8)

Controlled drug delivery (CDD) has become one of the important research areas in polymeric biomaterials during the past few years(8,9). Such delivery systems offer numerous advantages compared to conventional dosage forms including improved efficiency, reduced toxicity, and increased patient compliance. In this respect, a wide range of drug-loaded nanoparticles, with diameters between 10 and 1000 nm, have been used as CDD systems and their advantages over the microparticles are well highlighted. The nanoparticles (NPs), that can be either nano-spheres or nano-capsules, are based on biocompatible polymers and their advantages. The drug release rate from these biodegradable polymeric NPs is controlled by the biodegradation kinetics of the polymers, the physicochemical properties of the polymers and drugs, the thermodynamic compatibility between the polymers and drugs.

MATERIALS AND METHODS:

0.5g of chitosan dissolved in 25 ml of water using 1% of acetic acid solution→ 2milligram of 5-fluorouracil was added above chitosan solution→Using dialysis membrane bag for drug releasing studies in PBS and in different time interval.

AIM: To evaluate the drug loaded with biocompatibility polymer for dental applications

RESULTS AND DISCUSSION:

Chitosan as Natural Polymeric Carrier in Oral Cavity Delivery System in Dental Diseases. Chitosan has been known as a natural polymer conducted as a drug carrier due to its degradable capacity, nontoxicity, and high biocompatibility(10). Chitosan can be used in different types of formulation following the targeted function and suitable administration(11).In the structure of chitosan, the protonated amino groups on D-glucosamine enable bonding to negatively charge the mucosal layer through penetrating deep layers of epithelium and electrostatic interaction. Also, chitosan has been used as a carrier in different routes of administration, such as ocular, nasal, pulmonary, and buccal routes because of the mucoadhesive-ness feature of chitosan(12). However, chitosan has insolubility problems in the physiological surrounding as a disadvantage that impact drug delivery and change through chemical alteration containing thiolation, carboxymethylation, quaternization, and acetylation. Carboxymethylated chitosan has a high solubility in a broad range of mucoadhesive ness and pH and accordingly enhances the penetration of carried drugs(13). Various forms of drug chitosan-based carrier such as films, fibers, microspheres, sponges, gels, hydrogels, and nano/microparticles contributed to delivering antibiotics, growth factors, chemotherapy drugs, vaccines, and anti-inflammatory agents to aim cells(9). Chitosan-based drug delivery systems have been conducted in different conditions of dentistry fields, such as tooth caries, endodontics, treatment of peri-implantitis, and periodontitis and are usually used for local anesthesia. Findings have demonstrated the anti-inflammatory effects of chitosan particles on HGFs (human gingival fibroblasts) through downregulation of chemokines and cytokines, such as CXCL-8, TNF-α, and IL-1β. However, the anti-inflammatory effects of chitosan can change the dependency of various formulations and excipients(14). In addition, studies have shown the increment of cells viability and HGFs metabolic activities via chitosan nano/microparticles, which describe the significant chitosan role in the reconstruction of injured tissue, particularly gingival tissue. Chitosan-based carriers are classified into injectable devices, gels, films, fibers, and micro/nanoparticles. Microspheres of chitosan, provided through clinical and thermal cross-linking, solvent evaporation, spray drying, and techniques of emulsion, are spherical forms with a wide range of diameters (10–1000 μm) and are fabricated to include drugs or other treatment agents with uniform distribution in the matrix which are natural and polymeric. Microencapsulated therapeutic agents prepared protective effects against saliva digestive enzymes and controlled and sustained release in the subgingival area. In addition, DNA/siRNA can be attached to the surface of chitosan nanoparticles using adsorption, ionic gelation, and simple complexation. Moreover, surface and small size characteristics of chitosan particles affect their transportation by mucosal layers. Another limitation of chitosan-based drug nano/microparticles is the initial drug rupture that mitigates the encapsulation and stability efficacy which is solved by covering particles with other anionic biomaterials such as pectin, xanthan, alginate, gelatin, and hyaluronic acid. One of the strategies to enhance the controlled release of drugs in acidic surroundings is polyelectrolyte complexation that additionally reduces toxicity in comparison with cross-linked chemical formulations. For example, the chitosan-alginate polyelectrolyte complexation delivery system provided through electrostatic interaction between alginate carboxyl groups and chitosan amino groups is more functional in particulate constructions containing micro/nanoparticles such as oral cavity administration of antibiotics.indicated that microspheres of sodium alginate/calcium/chitosan contemporaneously controlled release of doxycycline and ornidazole. Also, this finding showed antibacterial, biodegradability, and mucoadhesiveness of chitosan-alginate microspheres prepared by polyelectrolyte complexation. Another procedure to prepare a microsphere/hydrogel carrier system is encircling the microspheres in hydrogels. This method has been elucidated to limit sudden releasing. Generally, various parameters impact the release of chitosan microspheres containing cross-linking density, drug content, chitosan concentration, and molecular weight. And also, chitosan has been known as one of the attractive biopolymer in inducing a transgenic response (downregulation (siRNA or microRNA) or upregulation (pDNA, mRNA)) and delivering nucleic acids intracellularly. Meanwhile, some patients have the risk of allergic cross-reactions to chitosan or other dental varnishes because of seafood allergy or other allergic conditions to chitosan or other antimicrobial vehicles. Therefore alternative selection for transport drugs is carboxymethylcellulose, which can prohibit activation of *Streptococcus mutans*, simultaneously transport drugs to aimed receptors and present antimicrobial activity

From the precious Articles, A portion of the plasma membrane invaded to create vesicles, in which nanoparticles were wrapped before being released into the interior of the cell and detached from the plasma membrane. And from another studies, Drug in the vesicles was released into the cytoplasm by enzymatic hydrolysis when they came into additional contact with the lysosomes.

SCOPE OF FUTURE RESEARCH:

The promotion of dental implant surface modification and dental pulp regeneration is another way that various types of biocompatible materials, such as metal implants, polymer-based implants, and naturally bioactive materials, display their role in the bone and wound healing process. More research is needed to create the ideal dental implant.

CONCLUSION:

Numerous biocompatible materials are employed in dental implants and prostheses because of their potential to have anti-inflammatory properties.With regard to increasing the knowledge about biomaterials and their utilization in dental problems such as peri-implantitis, bone regeneration, osseointegration, healing, dental plaque, and other related infections, different delivery systems have been schemed to improve the bioavailability and permeability and reduce the systemic side effects of the drugs or components such as antibiotics. These biomaterials include natural polymers, chitosan, alginate, calcium phosphate, gelatin, hyaluronic acids, and metal-based carriers such as titanium, gold, and silver. Changing the habits of using nonbiodegradable materials to biomaterials facilitates the control rate of drug release and receive the optimum biocompatible formulations, reduction of dosage frequency, and minimize the bacterial infections in the oral cavity. These systems and devices propose effective delivery systems for dental diseases therapyAlthough they can be physically and chemically altered, peri-implantitis cannot be cured by dental prostheses. Peri-implantitis and peri-implant mucositis are routinely treated and prevented with biocompatible antimicrobial treatments

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