Trophimus Gnanabagyan Jayakaran et al /J. Pharm. Sci. & Res. Vol.5(12), 2013, 277 - 278

ISSN:0975-1459
Journal of Pharmaceutical Sciences and Research
www.jpsr.pharmainfo.in

Nanocomposite Hydrogels as Local Drug Delivery in Periodontics

Trophimus Gnanabagyan Jayakaran[1], Radhika Arjunkumar[2]

[1]*Student,Saveetha Dental College, Chennai*
[2]*Senior Lecturer,Department of Periodontics, Saveetha Dental College, Chennai*

Abstract:

Nanotechnology is predicted to revolutionize the control over materials and properties at ultrafine scales and the sensitivity of tools and devices applied in various scientific and technological fields. Dentistry as an individual healthcare unit is not exempted, having already been targeted directly with novel 'nano-materials' at the same time as indirectly enjoying the benefits of nano-related advances in the electronics industry through the ongoing computerization of the modern practice. This short communication examines current practical application of nanocomposite hydrogels as local drug delivery in the field of periodontics along with the proposed application in the future from this novel multi-disciplinary science.

Keywords: Local drug delivery, nanocomposites, nanodentistry, nanotechnology, Periodontics.

INTRODUCTION:

Periodontitis is a disease involving supportive structures of the teeth which prevails in all groups, ethnicities, races and both gender. It is multi-factorial in etiology, and bacteria are one among these etiologic agents. Thus, an essential component of therapy is needed to eliminate or control these pathogens and restore the periodontium to a normal functional state. This has been traditionally accomplished through mechanical means such as scaling and root planing (SRP), open flap debridement, procedures aimed at regenerating the periodontium and by the use of chemical agents such as mouth washes and dentrifices. Systemic antimicrobials have been used as an adjunct along with such traditional procedures. The use of such antibiotics, although effective, cannot be completely justified. This is because, periodontal disease is site-specific in nature and subjecting the patient to therapeutic concentrations of antibiotics for short periods of time forces repeated dosing for longer periods. To overcome the limitations of conventional therapy with systemic antimicrobials, locally delivered, anti-infective pharmacological agents, most recently employing sustained-release vehicles, have been introduced. These locally delivered antimicrobials are designed with the concerned drug impregnated in a vehicle and available in the form of fibers, chips, gels, ointments and microspheres. The advent of nanotechnology has improved the way in which these drug delivery systems have been designed and delivered.

In 2000, Freitas echoed the 1959 prediction in the popular lecture by the late physicist Richard P Feynman. This prediction accompanied the birth of nanotechnology's definition and vision: that the atomic-level precision afforded by molecular devices operating at the nanoscale was an inevitable technologic eventuality [1]. Nanotechnology which is also known as molecular engineering is the production of functional materials and structures in the range of 0.1 to 100 nanometers by various physical and chemical methods. In recent days, the revolutionary development of nanotechnology has become the most highly energized discipline in science and technology[2].Polymers or microparticle-based hydrogels have been applied in dentistry and periodontics in specific until now, which can affect the rate of release because of their structure, and so the development of more refined means of delivering medications at therapeutic levels to specific sites is an important clinical issue [3,4].

PREPARATION OF NANOPARTICLES:

Nanocomposite hydrogels are synthesized as model systems for in situ cured local drug delivery devices for the treatment of periodontal infections. The composite include the following components: nanoparticles, a matrix gel and the suitable antibacterial drug. The nanoparticles were obtained by free radical initiated copolymerization of monomers, 2-hydroxy methymethacrylate (HEMA) and polyethyleneglycoldimethacrylate in aqueous solution. The same monomers were used to prepare crosslinked matrices by photopolymerization. Nanocomposite hydrogels were obtained by mixing nanoparticles, monomers and the drug in aqueous solution then crosslinked by photopolymerization. These nanoparticles are suitable for incorporation into a hydrogel matrix and to design new drug delivery devices for dental and periodontal application.

ADVANTAGES OF NANOCOMPOSITES [5]

1. Highly dispersible in aqueous medium
2. Uniform distribution of the active agent over an extended period of time
3. Controlled release of the drug
4. Reduces frequency of administration
5. Increased stability
6. Penetrate regions inaccessible to other delivery systems

Harunganamadagascariensis leaf extract (HLE): Harunganamadagascariensis leaf extract (HLE) investigated

by Moulari et al, on oral bacterial strains used to treat gingival infections and dental caries. HLE loaded Poly (lactide-coglycolide) nanoparticles were prepared using interfacial polymer deposition following the solvent diffusion method. Incorporation of HLE into a colloidal carrier improved its antibacterial property and diminution of the bacterial concentration was seen [6].

Biodegradable nanoparticles:

Shefer and Shefer patented a controlled release system for site specific delivery of biologically active ingredients for an extended period of time. This system of delivery is a multicomponent release systemwith biodegradable nanoparticles having bioadhesive properties encapsulated within a moisture sensitive microparticle. The bioadhesive properties of the nanoparticles are attributed to the positively charged surfactant entrapped on the particle surface [7]. These multi-component release systems can be incorporated as gels, chewing gums, tooth paste and mouthwash for the treatment and prevention of periodontal disease.

Chitosan loaded-Tripolypeptide (TPP): Antisense oligonucleotide- loaded chitosan-tripolypeptide (TPP) were prepared by adding TPP after the formation of chitosan/oligonucleotide complex, which showed sustained release of oligonucleotides and are suitable for local therapeutic application in periodontal disease [8].

Triclosan loaded Nanoparticles: Pinon-Segundo et al produced a novel delivery system with triclosan loaded nanoparticles by the emulsification- diffusion process, for the treatment of periodontal disease. The nanoparticles were prepared using poly (D,L-Lactide-coglycolide),poly (D,L-Lactide) and cellulose acetate phthalate. Poly vinyl alcohol was used as a stabilizer. Solid nanoparticles of less than 500nm in diameter were obtained. Triclosan nanoparticles behave as a homogenous polymer matrix-type delivery with the drug triclosan molecularly dispersed. Release kinetics indicates that the depletion zone moves to the center of the device as the drug is released. This suggests that the diffusion is the controlling factor of the release. A preliminary in vivo study was performed in dogs with only the gingival index and bleeding on probing being determined and it was concluded that triclosan nanoparticles were effective in reducing gingival inflammation of the experimental sites [9]. This study has specifically tackled periodontal management, nanomaterial including hollow spheres, core shell structures, nanotubes and nanocomposites have been widely used for controlled drug release. Drugs can be incorporated into nanospheres composed of a biodegradable polymer, and this allows for site specific drug delivery.

ANTIBIOTIC FREE DELIVERY SYSTEMS:

These systems have been tried for periodontal infections due to the increase in microbial resistance to multiple antibiotics. Due to antibiotic resistance, the use of antigen-based antiseptics that may be linked to broad spectrum activity and far lower propensity to induce microbial resistance than antibiotics have been used. Antigen nanoparticles can be used as microbial growth inhibitors for treating periodontal disease.

ANTIMICROBIAL ENZYME:

Sathish kumar et al developed a system using hens' egg lysozyme (antimicrobial enzyme) which is attached to two types of polystyrene latex nanoparticles: positively charged, containing aliphatic amines surface groups and negatively charged, containing sulphate and chloromethyl surface group.these particles showed lower activity when compared to free enzymes, but can be explored for targeted antimicrobial activity [10].

CONCLUSION:

Recent developments in nanomaterials and nanotechnology have provided a promising insight into the commercial applications of nanomaterials in the management of periodontal disease [11]. It can be said that the antibiotic-free, mucoadhesive, biodegradable nanoparticle technology has an immense opportunity for designing a novel, low dose, and effective treatment method by the use of intra-pocket controlled devices, that are more convenient, easy to use and more effective than the regular drugs and medicines which act systemically. Although many studies have been published concerning nanocomposites, it will become of increasing importance to specifically develop nanocomposites as local drug delivery to manage periodontal disease.

REFERENCES:

1. Freitas RA Jr. Nanodentistry. *J Am Dent Assoc* 2000; 131(11):1559-1565.
2. Schulz W. Crafting a national nanotechnology effort. *ChemEng News* 2000;78(42):39-42
3. Levy BM. Is periodontitis a disease of the aged? *Gerodontology* 1986:5:101-107.
4. Page RC. Periodontal disease in the elderly: a critical evaluation of current information. *Gerodontology* 1984:3:63-70.
5. Goodson JM et al. Monolithic tetracycline-containing fibres for controlled delivery to periodontal pockets. *J Periodontol*. 1983;(54):575-579.
6. Moulari B, Pellequer Y, *et al.* (2007). In vitro antimicrobial activity of the leaf extract of Harunganamadagascariensis Lam. Ex Poir. (Hypericaceae) against strains causing otitis externa in dogs and cats. *Acta Vet. Hung.* 55 (1): 97-105.
7. AdiShefer, Shmuel David Shefer, et al, Biodegradable bioadhesive controlled release system of nano particles for oral care products. May 20, 2003. *United States Patent.*
8. Dung TH et al. Chitosan-TPP nanoparticles as a release system of antisense oligonucleotide in the oral environment. *J Nanoscience* .Nanotechnol 2007; 7:3695-3699.
9. Pinon SE. et al. Preparation and characterization of triclosan nanoparticles for periodontal treatment. *Int.J.Pharm* 2005;294:217-232.
10. Swaminathan, Rajaram and Ravi, Vijay Kumar and Kumar, Satish and Kumar, MattaparthiVenkataSatish and Chandra, Nividh Lysozyme: A model protein for amyloid research. *Adv in Protein Chemistry and structural Biology*, 2011: Vol 84 *[Book Chapter]*
11. Bartold PM, McCulloch CAG, Narayanan AS, Pitaru S. Tissue engineering: a new paradigm for periodontal regeneration based on molecular and cell biology. *Periodontol 2000* 2000:24:253-269.