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Short Commentary

Nano-Periodontics: A Step Forward In Periodontal Treatment

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Introduction

The term "Nano" refers to a unit of measurement that is equal to one billionth of a kilometer (10^{-9}). To get closer to "how much Nano is", it is worthy to know that the length of a normal human being ranges from one and a half to two meters, while, if we move to something smaller, such as a mobile phone, it can be measured by 12 cm, and if we move to smaller things, ants for example are about 2 mm long, while if we take a human hair, its diameter measures about 100 micrometers. Viruses are much smaller ranging in size between 30 and 50 nanometers, and a DNA molecule has a size of about 2.5 nanometers. Taking into account that the approximate size of the sun is 1.4 billion meters, this means that a nanoparticle for a human is the same as the size of a human in relation to the sun [1].

Nanotechnology is the science of engineering and technology that is practiced at the nanoscale and ranges between 1 and 100 nanometers. The ideas and concepts of nanotechnology began to appear in 1959, while the modern practice of it actually began in 1981 [2].

One of the factors associated with miniaturization and nanotechnology is the surface-to-volume ratio. This criterion is of great importance and fundamental in applications that include Nano and chemical stimulus in physical process. In general, the surface-to-volume ratio increases with the decrease in the dimensions of the material and vice versa, so the lower the volume of the material, we find a larger part of the atoms on the surface compared to the atoms on the inside, and since chemical reactions occur on the surface, nanoparticles are much more effective than other materials made up of larger particles [1].

Nanotechnology in Periodontics

Nanotechnology has become a thriving field in human medicine and dentistry in recent years, as the use of nanotechnology in periodontology referred to as "Nanoperiodontics". The Nanoperiodontics works to maintain oral health by linking nanomaterials with biotechnology, and although they are in the initial stages, they have a significant impact on clinical outcomes on one hand, and commercial availability of materials on the other hand. The applications of nanoparticles in periodontics can be discussed according to 3 main headings; namely prevention, detection, and treatment.

Prevention

Mouthwashes built in nanorobots and selenium nanoparticles can control halitosis by destroying the volatile Sulphur compounds produced by bacteria.

Toothpastes combined with nanorobots can destroy the pathogenic flora and at the same time preserve more than 500 types of commensal organisms, but it is still under study at the present time [3].

Detection

Introducing the Lab-on-chip concept which is a small chip, that does more than one measuring device, can give us the concentrations of Interlukin-1ß (IL-1ß) [4], C-reactive Protein (CRP) [5], and Tumor Necrosis Factor-α (TNF-α) [6], which are proteins found in saliva that increase in the presence of periodontitis from a single saliva sample [3].

Treatment

In a clinical study conducted on the effect of slider nanoparticles on patients with chronic periodontitis [7], patients were divided into 3 groups; Group A: Scaling and root planning (SRP) with sub-gingival delivery of silver nanoparticles gel, Group B: SRP with sub-gingival delivery of tetracycline gel, and Group C: SRP alone. Diagnostic indices were recorded for each patient before and after application of the gel, which included Plaque Index (PI), Gingival Index (GI), Probing Pocket Depth (PPD) and Clinical Attachment Level (CAL). The results showed that the effectiveness of using silver nanoparticles is similar to the effectiveness of using tetracycline gel, but the use of silver nanoparticles compared to other materials used was non-toxic, easy to apply, and showed no side effects.

Curcumin (CUR) is a natural polyphenolic compound that has been studied for its antioxidant effects. In a study conducted by Pérez-Pacheco CG et al. (2021), prepared buccal discs containing CUR-loaded lipid nanocarriers confirmed the ability of nanostructured lipid (NLC) to enhance CUR penetration through lipophilic domains of the mucosa [8].

The advantages of high drug loading, specific site release, and prolonged drug action have also made nanomaterials very promising for treating periodontitis [9].

In another study, Shaheen et al. (2020) found that nanomaterials loaded with antioxidants can be administered locally into periodontal pockets to effectively treat periodontitis [10]. They prepared a micellar nanocarriers containing coenzyme Q10 by a modified nanoprecipitation method and then evaluated the treatment effects of this innovative system in moderate periodontitis. Loading Q10 into ultra-small size nanoparticles could improve its aqueous dispersibility and bioavailability. In their study, Q10 was formulated in nano-micelles (NMQ10) that was incorporated *in situ* gelling systems, followed by injection into the periodontal pockets of periodontitis patients. The results showed that the NMQ10 was able to penetrate into the required site well. Periodontitis patients who received the administration of NMQ10 obtained a significant therapeutic effect, with significantly reduced oxidative stress markers and improved periodontal evaluation parameters.

In terms of Nanomaterials for periodontal tissue engineering, several biomaterials are used in periodontal tissue engineering in order to obtain a three-dimensional scaffold, which can promote bone regeneration. A systematic study conducted in 2020 on the use and efficacy of a chitosan-based scaffold (CS-BS) in the process of alveolar bone regeneration showed that the potential for periodontal regeneration is higher in the case of CS-BS scaffolds combined with other polymeric biomaterials and bio-ceramics [11].

Conclusion

Periodontitis is one of the most common diseases involving tooth and its supporting structures. Management of periodontitis is important for improvement of quality of life of the patient that ultimately has its impact on overall health of an individual. With improvement of various treatment methodologies for treatment of periodontitis, nanotechnology has evolved as a promising mode of treatment. Nanotechnology is an emerging field in medicine and dentistry that would extend its horizons right from the diagnosis to the treatment and rehabilitation phase.

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