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A New Magnetic Field Method to Orient Antimicrobial Nanoparticles into Dentinal Tubules of Root Canal System

A Thesis Submitted to the Council of the College of Dentistry, University of Baghdad, in Partial Fulfillment of the Requirements for the degree of Doctor of Philosophy in Restorative and Aesthetic Dentistry

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Abstract

Background: The chemomechanical disinfection procedure for root canal system may encounter some difficulties due to the presence of tiny sites in this system difficult to disinfect. This study aimed to investigate the penetration depth of iron oxide nanoparticles coated by chitosan (Chi-IONP) into dentinal tubules of root canal system under the guide of external magnetic field.

Methods: The Chi-IONP was prepared by functionalizing the 8nm iron oxide nanoparticles with glycine and coating them by chitosan.

Chi-IONP ferro-fluid was characterized by atomic force microscopy (AFM), transmission electron microscopy (TEM) and Fourier transform infrared spectroscopy (FTIR).Twenty palatal roots from maxillary first molars were sectioned to 12mm length and prepared chemo-mechanically until size F4 Pro taper Universal files system. Then all the roots were filled with (Chi-IONP) and divided into two groups. Experimental group was subjected to two opposite magnets for 3 minutes and control group without the use of magnets. After that, the roots were sectioned longitudinally into two halves, to investigate by scanning electron microscopy.

The antimicrobial sensitivity test and the minimum inhibitory and minimum microbicidal concentration MIC/MMC were investigated for three types of microorganisms (***Enterococcus faecalis, Streptococcus mutans and candida albicans).***

The histopathological study was carried out on twenty-four albino healthy male rabbits, by subcutaneous implantation of three polyethylene tubes as following: 1- Empty tube (ET), 2- tube filled with sodium hypochlorite (NaOCl 5.25%) and 3- tube filled with (Chi-IONP). Tissue biopsy specimens were collected in three periods of time 3^{rd}, 7^{th} and 21 day for histopathological evaluation.

Abstract

Push-out bond strength of obturation materials to root canal walls test. Thirty roots were divided into three groups, **G1:** Finally irrigated with distilled water. **G2:** Finally irrigated with EDTA 17%, **G3:** Finally irrigated with EDTA 17%, then flooded with Chi-IONP solution and subjected to two opposite magnets for 3 minutes.

Results: The FTIR showed chemical interaction of the materials and nanoparticles, AFM and TEM proved the change in size after coating; the resulted nanoparticles size was about 30 nm. The experimental group showed a significantly higher depth of penetration when compared to control group.

Chi-IONP showed antifungal activity higher than NaOCl 5.25%, and comparable effect to NaOCl 5.25% against bacterial isolates. The MIC/MMC were determined as following 125/250 µg/ml for ***Enterococcus faecalis,*** 250/ 500 µg/ml for ***Streptococcus mutans*** and the MIC/MFC was 62.5/ 125 µg/ml for ***Candida albicans.***

For histopathological test, at 3rd day, no statistical difference was evident among the groups. At 7th and 21 day intervals, there was significant difference between NaOCl and Chi- IONP.

For push-out test, **G3** group showed higher bond strength than **G2** without significant difference.

Conclusion: Iron oxide nanoparticles can be successfully coat by chitosan under the suggested procedure. In addition, the use of external magnetic field guide the Chi-IONP to penetrate deeply inside the dentinal tubules and Chi-IONP solution was well tolerated by the tissue with good antimicrobial properties.