World Academy of Science, Engineering and Technology
International Journal of Biomedical and Biological Engineering
Vol:11, No:07, 2017

Investigations into the in situ Enterococcus faecalis Biofilm Removal Efficacies of Passive and Active Sodium Hypochlorite Irrigant Delivered into Lateral Canal of a Simulated Root Canal Model

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Abstract : The issue of apical periodontitis has received considerable critical attention. Bacteria is integrated into communities, attached to surfaces and consequently form biofilm. The biofilm structure provides bacteria with a series protection skills against, antimicrobial agents and enhances pathogenicity (e.g. apical periodontitis). Sodium hypochlorite (NaOCl) has become the irrigant of choice for elimination of bacteria from the root canal system based on its antimicrobial findings. The aim of the study was to investigate the effect of different agitation techniques on the efficacy of 2.5% NaOCl to eliminate the biofilm from the surface of the lateral canal using the residual biofilm, and removal rate of biofilm as outcome measures. The effect of canal complexity (lateral canal) on the efficacy of the irrigation procedure was also assessed. Forty root canal models (n = 10 per group) were manufactured using 3D printing and resin materials. Each model consisted of two halves of an 18 mm length root canal with apical size 30 and taper 0.06, and a lateral canal of 3 mm length, 0.3 mm diameter located at 3 mm from the apical terminus. E. faecalis biofilms were grown on the apical 3 mm and lateral canal of the models for 10 days in Brain Heart Infusion broth. Biofilms were stained using crystal violet for visualisation. The model halves were reassembled, attached to an apparatus and tested under a fluorescence microscope. Syringe and needle irrigation protocol was performed using 9 mL of 2.5% NaOCl irrigant for 60 seconds. The irrigant was either left stagnant in the canal or activated for 30 seconds using manual (gutta-percha), sonic and ultrasonic methods. Images were then captured every second using an external camera. The percentages of residual biofilm were measured using image analysis software. The data were analysed using generalised linear mixed models. The greatest removal was associated with the ultrasonic group (66.76%) followed by sonic (45.49%), manual (43.97%), and passive irrigation group (control) (38.67%) respectively. No marked reduction in the efficiency of NaOCl to remove biofilm was found between the simple and complex anatomy models (p = 0.098). The removal efficacy of NaOCl on the biofilm was limited to the 1 mm level of the lateral canal. The agitation of NaOCl results in better penetration of the irrigant into the lateral canals. Ultrasonic agitation of NaOCl improved the removal of bacterial biofilm.

Keywords : 3D printing, biofilm, root canal irrigation, sodium hypochlorite
Conference Title : ICODS 2017 : International Conference on Oral and Dental Sciences
Conference Location : Paris, France
Conference Dates : July 20-21, 2017