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In-Vitro Evaluation of the Efficacy of PIPS Irrigation System on Disinfection of Type 2 Canal Systems in Molars

Abstract

Objective: This in vitro study was designed to compare the disinfection potential of an Er:YAG photon-initiated photoacousitc (PIPS) irrigation mechanism to standard needle irrigation (SNI) in eliminating biofilms from complex root canal systems.

Method and materials: Twenty-four extracted mandibular molar teeth exhibiting a Vertucci Type II canal system were selected and underwent canal instrumentation to create either a minimal (20/.04) or fully-flared (25/.06) preparation. Teeth were inoculated with bacterial plaque and incubated for 3 weeks creating a mature biofilm. Both instrumentation groups were sub-divided according to mode of canal disinfection: sterile saline or sodium hypochlorite (NaOCl) with PIPS laser-activation or same irrigants delivered with SNI. Each irrigation protocol used similar quantities of NaOCl or saline over the same time periods. Viable intracanal bacteria were quantified by MTT bacterial viability assay. Sub-groups were analyzed for statistical significance by ANOVA, followed by Scheffe's F-test (P = .05).

Results: All saline groups showed significantly more viable bacteria after irrigation than the corresponding NaOCl sub-groups. The #20/.04 sub-group that underwent PIPS and NaOCl irrigation had greater disinfection than the SNI counterpart, which was not significant (P > 0.05). The #25/.06 PIPS/NaOCl sub-group showed greater disinfection than SNI (P > 0.0008). All other groups showed no significant differences in disinfection of root canals.

Conclusion: In this in vitro study PIPS laser-activated irrigation achieved higher disinfection in #25/.06 fully-flared preparations than SNI. Although not significantly different, greater disinfection was found in the #20/.04 minimal canal preparations that were treated with PIPS irrigation compared to SNI.

Keywords: Photon-initiated photoacousitc (PIPS) irrigation; Biofilm; Type 2 canal system; Mixed bacterial oral plaque; MTT assay

Research Article

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Introduction

Apical periodontitis results from cultivable bacteria found within an infected root canal system that elicits host defences [1]. Elimination of the intracanal microbiome, or reduction to a subcritical level, is essential for periapical healing to occur [2]. Chemomechanical preparation that removes organic tissue, infected dentin and dislodges biofilms has been shown to be clinically effective in elimination of patient symptoms with concomitant radiographic healing [3,4]. Bacterial contamination related to non-healing apical lesions healing is the primary etiology of post-treatment disease requiring retreatment, periapical surgery or extraction [5]. A significant challenge for instrumentation and disinfection is the inability of contemporary techniques to address all the complexities of root canal systems [6]. A determinant factor for endodontic success is creating convenience form and canal shape that permits canal disinfection, specifically addressing areas of the root canal system that remain untouched by instruments. A recent change in the study of bacterial colonization of root canals has moved the focus from single organism laboratory-based planktonic cultures to the biofilm mode of growth [7]. Within the confines of the root canal system, residual biofilm is common even following irrigation with 5% sodium hypochlorite [8]. Furthermore, oral mixed biofilms are more resistant to removal having a greater adhesion to dentin [9]. Many alternative irrigation techniques intended to replace or serve as adjuncts to standard needle irrigation have been investigated including: passive or active ultrasonics [10,11]; sonic agitation [12]; photo-activated dyes (PAD) [13]; negative apical pressure devices [14]; and most recently photon-initiated photoacoustic streaming (PIPS) [15]. Laser activation of intra-canal irrigant creates large elliptical vapor bubbles that expand and subsequently implode, causing a cavitation and shock wave effect that promotes debridement and smear layer removal and the release of energy further down the canal [16]. Previous studies have shown PIPS to be effective in biofilm elimination [17], smear layer removal [16], and debris removal from complex nonseparated systems [18]. Apical size and taper size have been studied in the past by multiple studies, with varying conclusions reflecting the needs of obturation and irrigation techniques