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Comparison of Positive-Pressure, Passive Ultrasonic, and Laser-Activated Irrigations on Smear-Layer Removal from the Root Canal Surface

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Abstract

Objective: The purpose of this study was to compare the efficacy of three irrigation techniques for smear-layer removal with 17% EDTA. ***Background data:*** Cleaning and shaping the root canal system during endodontic treatment produces a smear layer and hard tissue debris. Three irrigation techniques were tested for solution infiltration of this layer: positive-pressure irrigation, passive ultrasonic irrigation, and laser-activated irrigation. ***Materials and methods:*** Sixty extracted teeth were divided into six equal groups; 17% EDTA was used for 60 sec irrigation of five of the groups. The groups were as follows: Group 1, treated only with ProTaper™ F3 Ni-Ti files; Group 2, positive-pressure irrigation, with a syringe; Group 3, passive ultrasonic irrigation, inserted 1 mm short of the working length; Group 4, passive ultrasonic irrigation, inserted in the upper coronal third of the root; Group 5, Er:YAG laser-activated irrigation, inserted 1 mm short of the working length; and Group 6, Er:YAG laser-activated irrigation, inserted in the upper coronal third of the root. ***Results:*** Scanning electron microscopy showed that the smear layer is removed most efficiently using laser-activated irrigation at low energy with 17% EDTA, inserted either at the working length or only in the coronal upper third of the root. Amounts of Ca, P, and O were not significantly different on all treated dentin surfaces. ***Conclusions:*** Smear-layer removal was most effective when the root canals were irrigated using Er:YAG laser at low energy with 17% EDTA solution. Interestingly, removal of the smear layer along the entire canal was similar when the laser was inserted in the upper coronal third and at 1 mm short of the working length of the root canal. This effect was not observed with the ultrasonic and positive-pressure techniques.

Introduction

THE SUCCESS OF ENDODONTIC TREATMENT depends upon the complete removal of pulpal remnants, dentin filings, and microbes from the root canal system. Cleaning and shaping the root canal system with endodontic instruments produces a smear layer that covers the canal walls[1] and accumulation of hard tissue debris.[2] The smear layer is an irregular amorphous layer containing inorganic debris as well as organic materials such as pulp tissue, odontoblastic residues, necrotic debris, microorganisms, and their metabolic products.[3] The thickness of the layer ranges from 1 to 5 μm, which is thick enough to retard irrigant and sealer penetration into the dentinal tubules,[4] and, therefore, prevent adequate disinfection. Therefore, chemical disinfection through irrigation is a critical adjunct.[5]

Sodium hypochlorite (NaOCl) is a common irrigation solution used in endodontic therapy because it has bactericidal properties and dissolves organic tissue. However, this solution cannot remove the smear layer when used alone.[6] Another common irrigation solution contains EDTA, which reacts with calcium ions in the dentin to produce soluble calcium chelates,[7] and removes the mineralized portion of the smear layer.[8] Some researchers have reported that the ideal way to remove the smear layer is to alternate between EDTA and NaOCl.[9]

Irrigation can be performed via manual or machine-assisted systems.[10] Manual irrigation techniques include

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