

## Original Research

### Efficacy of Er,Cr:YSGG Laser in Removing Smear Layer and Debris with Two Different Output Powers

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#### ABSTRACT:

**Background:** This study was conducted to assess the efficacy of Er,Cr:YSGG Laser in Removing Smear Layer and Debris with Two Different Output Powers. **Material and methods:** A total of sixty extracted teeth were incorporated into the study. Following instrumentation, the samples were categorized into three experimental groups along with one positive control group that received no additional treatment. In group 1, a final irrigation was conducted utilizing ethylenediaminetetraacetic acid (EDTA) followed by sodium hypochlorite (NaOCl), in that order. Group 2 involved the application of a 2.78  $\mu$ m Er,Cr:YSGG laser operating at an output power of 1.5 W. In group 3, the same laser was employed, but at a higher output power of 2.5 W. Scanning electron microscope (SEM) images were obtained from the coronal, middle, and apical thirds of the roots and were assessed for the removal of both smear layer and debris by three blinded observers. **Results:** The findings indicated that there were no significant differences in the quality of smear layer removal between groups 1 and 2 across all regions. Nevertheless, the 2.5 W laser was ineffective in adequately removing the smear layer. In terms of debris removal, the use of EDTA and NaOCl irrigation demonstrated markedly superior results (adjusted  $p < 0.05$ ) in all areas. **Conclusions:** In the context of this research, it can be inferred that the irrigation activation systems (laser and ultrasonic) employed in this study were more effective in eliminating the smear layer compared to the traditional irrigation technique. The findings indicate that NaOCl activation using laser technology has proven to be successful in smear layer removal. However, achieving total elimination from the apical region of the root canal continues to pose a considerable challenge, as none of the irrigation protocols resulted in root canals that were completely free of smear layers.

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#### INTRODUCTION

The objective of root canal therapy is to eradicate all possible irritants from the root canal system. These irritants encompass microorganisms, their byproducts, and remnants of pulp tissue. Historically, it has been established that a smear layer develops on the dentinal walls during the mechanical instrumentation of root canals.<sup>1,2</sup> This smear layer comprises organic and inorganic particles of dentin, remnants of pulp tissue, microorganisms, endotoxins, and blood cells.<sup>2</sup>

Research indicates that the smear layer obstructs the penetration of antimicrobial irrigants, medicaments, and sealers into the dentinal tubules, thereby potentially undermining the seal and disinfection of root canals throughout the treatment process.<sup>3</sup> A relationship has been identified between the removal

of the smear layer and enhanced periapical healing. Various techniques have been employed to eliminate the smear layer, with current eradication methods including chemical agents, ultrasonics, and laser irradiations.<sup>4,5</sup>

Ethylenediaminetetraacetic acid (EDTA), a calcium chelating agent, is frequently utilized to eliminate the smear layer. Prior studies have shown that a final irrigation with 17% EDTA, followed by sodium hypochlorite (NaOCl), completely removes the smear layer.<sup>6</sup>

Recent investigations have suggested lasers as an alternative approach for disinfecting root canals and removing smear layer and debris. The erbium, chromium: yttrium-scandium-gallium-garnet (Er,Cr:YSGG) is a water-absorbing infrared laser that

possesses the capability to clean root canals at various output powers ranging from 1 to 3 W.<sup>7</sup>

The removal of the smear layer using an Er,Cr:YSGG laser has been previously examined employing different techniques and under varying conditions. However, discrepancies in the sizes of firing tips and apical preparation in some of these studies raise concerns regarding the actual depth of laser irradiation.<sup>8</sup> The impact of laser-driven irrigation utilizing Er,Cr:YSGG lasers for the purpose of cleaning root canal walls has been investigated by Peeters and Suardita.<sup>5</sup>

**MATERIAL AND METHODS**

A total of sixty extracted teeth were incorporated into the study. Following instrumentation, the samples were categorized into three experimental groups along with one positive control group that received no additional treatment. In group 1, a final irrigation was conducted utilizing ethylenediaminetetraacetic acid (EDTA) followed by sodium hypochlorite (NaOCl), in that order. Group 2 involved the application of a 2.78 μmEr,Cr:YSGG laser operating at an output power of 1.5 W. In group 3, the same laser was employed, but at a higher output power of 2.5 W. Scanning electron microscope (SEM) images were obtained from the coronal, middle, and apical thirds of the roots and were assessed for the removal of both smear layer and debris by three blinded observers.

**RESULTS**

**Table 1: Frequency Distribution of Debris Scores in All Areas of the Root Canal Walls of the Specimens**

Debris	Group scores	NaOCl+EDTA	1.5 W	2.5 W	Control
<b>Coronal</b>	1	10	6	2	0
	2	5	8	11	0
	3	0	1	2	0
	4	0	0	0	0
	5	0	0	0	15
<b>Middle</b>	1	9	4	1	0
	2	6	6	3	0
	3	0	5	8	0
	4	0	0	3	0
	5	0	0	0	15
<b>Apical</b>	1	7	3	1	0
	2	8	4	2	0
	3	0	6	4	0
	4	0	2	6	0
	5	0	0	2	15

In the coronal third of the canals, the efficacy of debris removal was markedly superior in group 1 compared to group 2 (adjusted p<0.05), and group 2 also demonstrated significantly better results than group 3 (adjusted p<0.05). In the middle and apical thirds of the canals, group 1 exhibited significantly improved outcomes compared to both laser groups (adjusted p<0.05). There was no notable difference in debris removal between the laser groups in the middle and apical thirds of the canal walls. In all experimental groups, the SEM analysis of the apical third of the canals revealed the highest levels of residual debris.

**DISCUSSION**

Eliminating the smear layer while preserving the integrity of root structure has been a significant challenge. The combination of irrigation with EDTA followed by NaOCl has been established as an effective technique for smear layer removal. In the current investigation, group 1 achieved smear layer removal through the application of 2 mL of 17% EDTA, succeeded by 5 mL of NaOCl for a duration of 3 min.<sup>9</sup>

Data analysis validated the effectiveness of this approach in eliminating debris and the smear layer. Nonetheless, recent research has highlighted potential adverse effects of this method on dentinal walls and the overall tooth structure. Uzunoglu et al.<sup>10</sup> demonstrated that the application of EDTA for smear layer removal diminishes the fracture resistance of root canal treated mandibular incisors. Furthermore, utilizing EDTA for more than 1 min can lead to erosion and damage of root dentin. The long-term implications of EDTA irrigation on the longevity of root canal treated anterior teeth warrant additional investigation.

In this study, in the coronal third of the canals, the efficacy of debris removal was markedly superior in group 1 compared to group 2 (adjusted p<0.05), and group 2 also demonstrated significantly better results than group 3 (adjusted p<0.05). In the middle and apical thirds of the canals, group 1 exhibited significantly improved outcomes compared to both laser groups (adjusted p<0.05). There was no notable difference in debris removal between the laser groups in the middle and apical thirds of the canal walls. In all experimental groups, the SEM analysis of the

apical third of the canals revealed the highest levels of residual debris.

Bolhari B et al.<sup>11</sup>The purpose of this study was to evaluate the effectiveness of the erbium, chromium: yttrium-scandium-gallium-garnet (Er,Cr:YSGG) laser in removing debris and the smear layer using two different output powers on the apical, middle, and coronal segments of root canal walls. Previous literature has failed to evaluate the exclusive effect of Er,Cr:YSGG laser on the quality of smear layer and debris removal in all three segments of the root canal space. Sixty extracted teeth were included in the study. After instrumentation, samples were divided into three experimental groups and one positive control group with no further treatment. In group 1, a final irrigation was performed using ethylenediaminetetraacetic acid (EDTA) and sodium hypochlorite (NaOCl), sequentially. In group 2, the samples were treated with a 2.78  $\mu$ m Er,Cr:YSGG laser with an output power of 1.5 W. The same laser was used in group 3, but with an output power of 2.5 W. Scanning electron microscope (SEM) images from the coronal, middle, and apical thirds of the roots were prepared and evaluated for both smear layer and debris removal by three blinded observers. The results showed no differences between groups 1 and 2 regarding the quality of smear layer removal in all areas. However, the 2.5 W laser failed to remove the smear layer effectively. Regarding debris removal, the EDTA and NaOCl irrigation showed significantly better outcomes (adjusted  $p < 0.05$ ) in all areas. This study raises questions about the overall cleaning abilities of Er,Cr:YSGG lasers.

## CONCLUSION

In the context of this research, it can be inferred that the irrigation activation systems (laser and ultrasonic) employed in this study were more effective in eliminating the smear layer compared to the traditional irrigation technique. The findings indicate that NaOCl activation using laser technology has proven to be successful in smear layer removal. However, achieving total elimination from the apical region of the root canal continues to pose a considerable challenge, as none of the irrigation

protocols resulted in root canals that were completely free of smear layers.

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