



To smear or not to smear: controversy surrounding the removal of the smear layer in endodontics

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What is the smear layer?

The smear layer was first described by Boyde in 1963 as a layer of debris that covers a calcified tissue when it is cut with a dental hand instrument or rotary bur.¹ The smear layer's composition mirrors the composition of the instrumented surface. Deep dentin smear layer consists of odontoblastic processes, enzymes, lamina limitans, organic and inorganic dentin matrix and predentin. The debris layer is approximately 1-2 μm thick with smear plugs being created as this microscopic cutting debris is forced into dentinal tubules.²

To smear or not to smear?

The removal of the smear layer remains a controversial topic. In 2001, Moss et al. performed a survey of the dental education community as well as practicing endodontists and found that there is no clear consensus as to whether the smear layer should be removed before obturation of the root canal space.³ There are many in vitro studies on the effect of the smear layer on the endodontic goals of cleaning, shaping and obturation, often presenting conflicting results. These studies reflect the inability to accurately model in vivo conditions on the bench top. As a result, in vitro studies are considered to have a low level of clinical evidence and their impact on clinical outcomes is questionable.

What is the smear layer's effect on bonding in endodontics?

Saleh et al. found that open tubules and the absence of smear do not improve adhesion of endodontic sealers. The authors suggest that perhaps the open tubules increase stress at the sealer/dentin interface and that the calcium and phosphate-rich smear layer and plugs are potential sites of sealer adhesion.⁴ In contrast, Eldeniz et al. found the highest adhesive strength with three different endodontic sealers when the smear layer was removed. The higher bond strength is attributed to the sealer's ability to enter the tubules and increase adhesion.⁵

What is the smear layer's effect on micro leakage in endodontics?

Using a fluid filtration model Cobankara et al. found that the removal of the smear layer results in a decrease of apical leakage with various sealers.⁶ Shemesh et al. had conflicting results showing that the removal of the smear layer before obturation did not improve the sealing of the root canal system.⁷ A meta-analysis of the effect of the smear layer on the sealing ability of gutta-percha and sealer was performed by Shahravan et al. in 2007. Comparing various in vitro leakage studies, they concluded that the smear layer does improve the fluid-tight seal of the root canal system. Their analysis also concluded that obturation technique and sealer type did not have an effect on the seal of the root canal system.⁸

What is the smear layer's effect on bacterial contamination in endodontics?

Drake et al. examined the question of whether or not the smear layer contains bacteria or supports the colonization of bacteria. They found that bacteria did not colonize the smear layer well and that the removal of the smear layer allowed the bacteria access to the dentinal tubules. This supports the idea that the smear layer may interfere with the bacterial colonization of root canals by blocking the entry of the bacteria into the dentinal tubules.⁹ Although smear may limit bacterial contamination of dentin, Clark-Holke et al. found that smear increases the leakage of bacteria through the apical foramina of endodontically treated teeth.¹⁰

What is the smear layer's effect on hydroxyl ion diffusion in endodontics?

Calcium hydroxide ($\text{Ca}(\text{OH})_2$) is used in the treatment of avulsed or luxated teeth to reduce the occurrence of inflammation, surface resorption or replacement resorption. In order to be effective $\text{Ca}(\text{OH})_2$ must diffuse through the dentin to the root surface. Most recently, Saif et al. demonstrated that removal of the smear layer facilitated $\text{Ca}(\text{OH})_2$ diffusion through the dentinal tubules.¹¹

How do we remove the smear layer in endodontics?

Various methods have been advocated to remove the smear layer. It is beyond the scope of this paper to discuss all the various literature on removing the smear layer, but papers of note would include: Calt and Serper¹² and Lui et al.¹³ A commonly accepted method of smear removal includes one minute of contact time with 17% EDTA followed by 6% NaOCL irrigation.¹⁴ An in vitro study by Kuah et al. in 2009 found the use of ultrasonics for one minute increased smear removal in the apical 1/3 of the canal.¹⁵

Conclusion

The dental literature is devoid of research with high levels of clinical evidence which investigate smear layer removal and endodontic outcomes. In response to this gap in knowledge, the endodontics department at the Naval Postgraduate Dental School will begin an in vivo study to investigate the impact of intentionally removing smear during nonsurgical root canal treatment on pulpal and periapical disease healing. With evidence from patient-based studies, we will be better prepared to make meaningful treatment recommendations.

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