

Aims

- To investigate methods of gently removing saw-generated smear layers from horizontal sections of root dentine during the investigation of sub-surface changes caused by root canal irrigation.

Introduction

Cut dentine surfaces are usually covered by a tenacious smear layer (1, 2). In order to visualise the underlying dentine, this smear layer must be removed (3 & 4).

Clinical methods of smear layer removal, such as the application of strong acids, may damage the underlying dentine and overwhelm subtle changes caused by other dentine treatments under investigation.

We are currently investigating sub-surface dentine changes caused by root canal irrigation with NaOCl and EDTA. Following root canal irrigation, horizontal root sections are prepared with a mechanical saw for analysis by SEM, EDAX and Atomic Force Microscopy (AFM).

This study sought to find a method of removing visible smear layer without damaging the underlying dentine.

Methods

Eighteen horizontal sections of dentine were prepared from the cervical third of human roots with a circular diamond saw running at 5rpm under constant water irrigation (Figure 1).

Sections were divided into 4 groups:

Group 1 (n=3) +ve control of smear development, ultrasonicated in distilled water only.

Group 2 (n=5) ultrasonicated as previously, then brushed with a soft nylon toothbrush & distilled water in a mechanical brushing machine for 15mins, followed by a further episode of ultrasonication for 15mins in distilled water.

Groups 3 & 4 (n=5) as group 2 but in 5% SDS and 100% methanol respectively.

All sections were fixed in 2% glutaraldehyde and prepared for SEM. Remaining smear layer was scored at 500x magnification using the Hülsmann scoring system (5).

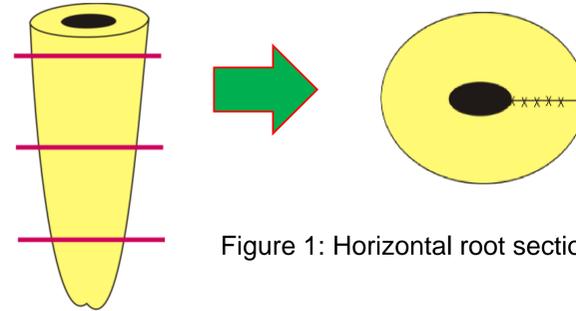


Figure 1: Horizontal root sections

Figure 2: Median smear layer scores

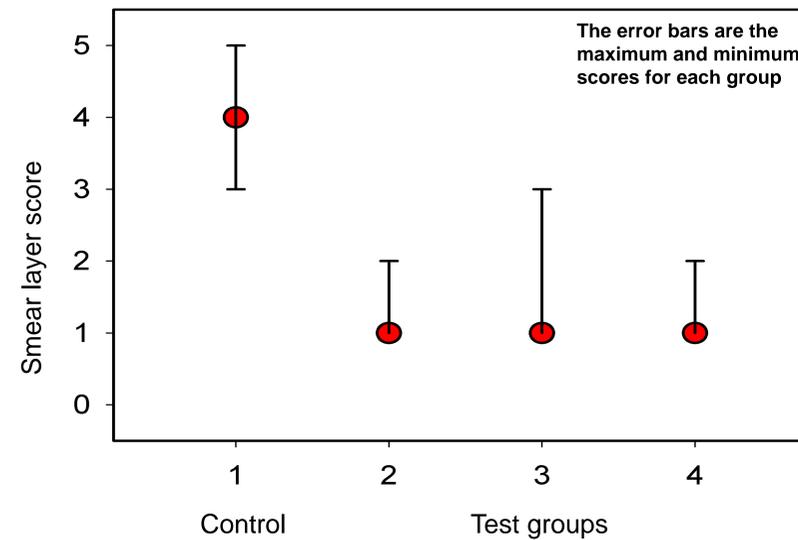
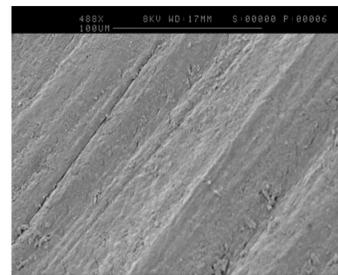
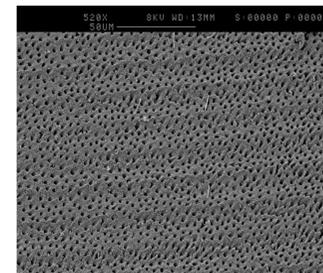
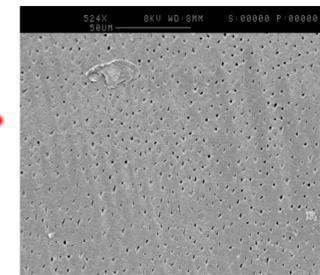


Figure 3:

a. Horizontal root section with complete smear layer (Group 1: Hülsmann score 4)



b. Smear layer removal after brushing & ultrasonication in distilled water (Group 2: Hülsmann score 1)



c. Image from pilot study with 6% citric acid, showing smear removal but with dentine erosion

Results

Median smear layer scores and interquartile ranges are summarised in Figure 2.

Samples in Group 1 (Fig 3a) exhibited complete surface coverage by a homogenous smear layer, with no open dentinal tubules (median score 4, interquartile range 2).

Groups 2, 3 & 4 had a median score of 1 with interquartile ranges of 0, 2 & 1 respectively; all significantly lower than the control ($p < 0.05$). All were suitable for analysis of the underlying dentine by SEM, EDAX and AFM (Fig 3b).

Discussion

In pilot studies, we have attempted to remove the smear layer from root sections with different concentrations of citric acid, phosphoric acid, NaOCl, EDTA, and combinations. All caused visible changes to dentine surfaces, such as acid erosion (Fig 3c).

Organic solvents such as 100% methanol, 100% ethanol, 100% propanol, 100% acetone and detergents such as 5% SDS in combination with ultrasonication were ineffective in smear layer removal.

The addition of controlled brushing allowed predictable smear layer whether the solution was distilled water, 100% methanol or 5% SDS. Macroscopic dentine damage was not apparent.

Conclusions

- Smear layers generated during the sectioning of dental root specimens can be removed by a simple protocol, involving ultrasonication and controlled brushing of specimens in distilled water.

References

- Violich DR, Chandler NP (2010). The smear layer in endodontics – a review. *International Endodontic Journal*. 43:2-15.
- Rocha PI, Borges AB, Rodrigues JR, Arrais CAG, Giannini M (2006). Effect of dentinal surface preparation on bond strength of self-etching adhesive systems. *Brazilian Oral Research* 20:52-58.
- Kubínek R, Zapletalová Z, Vůjtek M, Novotný R, Kolářová H, Chmelíčková H, et al. (2007). Sealing of open dentinal tubules by laser irradiation: AFM and SEM observations of dentine surfaces. *Journal of Molecular Recognition* 20:476-482.
- Dogan H, Çalt S (2001). Effects of Chelating Agents and Sodium Hypochlorite on Mineral Content of Root Dentine. *Journal of Endodontics* 27:578-580.
- Hülsmann M, Rummelin C, Frank Schäfers F (1997). Root canal cleanliness after preparation with different endodontic handpieces and hand instruments: A comparative SEM investigation. *Journal of Endodontics* 23:301-306.