

Summary and Conclusions

New *in vitro* and *ex vivo* methodologies were presented in this thesis that measure, image and explore the root canal walls and related interfaces. Numerous experiments were conducted and could lead to a better understanding of the influence of endodontic procedures on the root canal wall and vice versa. This will help to improve current practices that seem to fail in providing a reliable, predictable outcome.

In chapter II Different experiments were presented using the glucose penetration model. The ability of this model to detect leakage patterns through different materials, set ups and conditions was tested.

- The glucose penetration model was more sensitive in detecting leakage along the root canal filling as compared to the fluid transport model. Removing the smear layer before filling did not improve the sealing of the apical 4 mm of filling. Resilon, a recently introduced resin type filling material, allowed more glucose penetration but the same amount of fluid transport as gutta percha root fillings in the apical 4 mm of the root, while no difference in leakage was detected with both models when the coronal 9 mm of the filling was tested.
- When glucose penetration and fluid transport were used to measure the leakage through coronal root structures no leakage was detected. This confirms the assumption that root structures do not allow penetration of water or glucose through them.
- Root fillings with gutta percha and AH26 using the warm vertical compaction sealed the root canal better when passive ultrasonic irrigation had been used.
- Portland cement, MTA, Ca(OH)₂ and Sealer 26 react with glucose solution. This may result in less detectable glucose in the penetration test. Therefore, these materials should not be evaluated for sealing ability with the glucose leakage model.

In chapter III New endodontic applications for novel imaging techniques were suggested. Ultrasound scan to image live biofilms without damaging the delicate 3D structures and vitality of the biofilms and optical coherence tomography for intra-canal imaging showing the root canal walls and related structures non destructively and without using ionized radiation.

- Three dimensional structural imaging of *streptococcus mutans* biofilms of various thicknesses and on different substrates was possible without damaging the biofilm layer in a quick and

easy manner and can therefore be used to evaluate biofilms longitudinally as a function of time.

- Optical coherence tomography proved to be a reliable method to image root canals and root dentin in a nondestructive way. This technique holds promise for full *in vivo* endodontic imaging. Furthermore, it is a promising non destructive imaging method for the diagnosis of vertical root fractures. The sensitivity and specificity of this technique to diagnose vertical root fractures is high and a tendency for even higher specificity was demonstrated in canals where the smear layer was first removed.

In chapter IV the formation and incidence of dentinal defects in the root canal wall after different preparation and filling procedures was evaluated. It was concluded that some procedures cause more damage than others and that caution should be exercised with the use of rotary Ni-Ti files and lateral compaction of gutta percha.

- Root canal preparation and filling of extracted teeth created dentin defects such as fractures craze lines and incomplete cracks. Canals filled with the lateral compaction technique showed more defects than those filled with non compaction methods.
- Some endodontic preparation methods might damage the root and induce dentinal defects. Rotary Ni-Ti instruments damaged the teeth more than hand-filing. The new S-Apex system was the only rotary system that did not result in dentinal defects probably due to the inverted taper design.

New knowledge on the different aspects of the root canal wall, further research on the mutual influence of these structures on endodontic procedures and availability of novel non destructive imaging methods will hopefully help to improve the clinical outcomes and predictability of the endodontic treatment.