

## MRI as a Diagnostic Tool in Conservative Dentistry

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### Introduction

Quantification of carious lesions and measurement of the distance to the pulp is an important task in conservative dentistry. This information can improve identification of cases with the potential for maintaining pulp vitality and monitor treatment success of indirect pulp capping. In the procedure of indirect pulp capping the nearly exposed pulp is covered with a chemical (usually calcium hydroxide) to protect it from additional injury and stimulate formation of secondary dentin. Recently an *in vivo* technique for 3D visualization and quantification of carious lesion using MRI has been proposed [1]. The technique is based on penetration of the surrounding liquids, such as oral contrast medium, into porous demineralized tooth substance, which causes signal increase in proton MRI. On the other hand, dental pulp, containing nerves and blood vessels, gives signal in proton MRI and thus can be visualized inside the tooth substance. The purpose of this paper was to investigate the potential of dental MRI to determine spatial relationship between carious cavity and dental pulp.

### Subjects and Methods

Four volunteers with six carious lesions were examined on a 1.5 T whole-body MRI scanner (Magnetom Avanto; Siemens Medical Solutions, Erlangen, Germany). The dental MRI procedure with the use of an oral agar-based contrast medium and an intraoral RF receive coil was performed as described in [2]. A 3D TSE was used with TR/TE=400 ms/12 ms, TF=5, average FoV=60×30×17 mm<sup>3</sup> and nominal resolution 310×310×350 μm<sup>3</sup>, reconstructed to 60×60×70 μm<sup>3</sup> by means of Fourier interpolation. The total measurement time was 8 min. The obtained MR datasets were segmented and the surface of the tooth of interest and its pulp were rendered using 3D visualization software (Amira; ZIB, Berlin, Germany). The minimal distance between the carious cavity and dental pulp was quantified.

### Results and Discussion

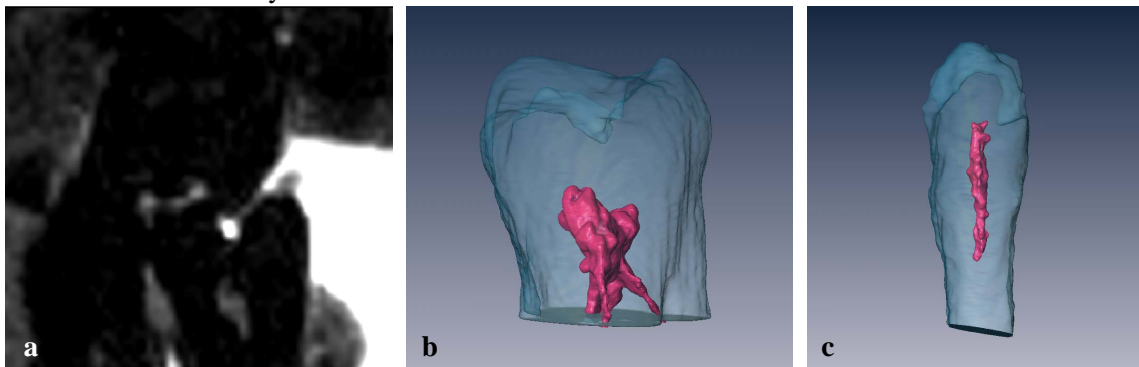
The measurement procedure was well-tolerated by all volunteers. One slice from a 3D MRI dataset and two examples of carious tooth rendering are shown in Fig. 1. The distance between the carious cavity and dental pulp was determined in all cases:

Carious cavity	Distance to the pulp [μm]
1	2200±60
2	3000±60
3	2200±60
4	2800±60
5	2600±60
6	300±60

Among all six cases the smallest distance to the pulp, 300±60μm, had the volunteer undergoing procedure of indirect pulp capping (Fig. 1c).

### Conclusion

The presented results demonstrate feasibility of dental MRI to visualize and quantify the distance between the carious cavity and dental pulp in all three spatial directions. To the authors' knowledge, MRI is the only modality that can perform this task non-invasively.



**Fig. 1.** (a) Fragment of a slice from a 3D MRI dataset. 3D rendering of a molar (b) and premolar (c) with a carious lesion and of the tooth pulp based on MRI datasets.

**References:** [1] Tymofiyeva O et al. Proc. ISMRM, Toronto, Canada, 2008, abstract 2007. [2] Tymofiyeva O et al. Concept Magn Reson B: Magn Reson Eng 2008, 33B, p. 244-251.