

Magnetic Resonance Imaging in Orthodontics: Three-dimensional Localization of Impacted Teeth

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Introduction: Impacted teeth are teeth that are unable to erupt properly and remain under the gum, and are most commonly third molars (wisdom teeth) with an average eruption age of 15-21 years and permanent maxillary (upper) canines with an average eruption age of 11-13 years. Impacted teeth often become infected or damage neighbouring teeth and therefore require surgical treatment. Information about three-dimensional positioning of impacted teeth is invaluable in orthodontic diagnosis and treatment planning. However, this information is usually not available, since only two-dimensional X-ray projections are routinely acquired. The purpose of this pilot study was to assess the feasibility of MRI of three-dimensional localization of impacted teeth in children and adults.

Subjects and Methods: The study included 4 patients from the pediatric age group with impacted maxillary canines (mean age: 11.8; range: 11-13), 4 patients with indications of impacted wisdom teeth (mean age: 23.3; range: 20-26) and 8 healthy volunteers (mean age: 25.5; range: 19-32). Three-dimensional images were acquired using a 1.5 T MR scanner (Magnetom Avanto, Siemens Medical Solutions, Erlangen, Germany) in combination with dedicated RF coils. Turbo spin echo and FLASH sequences were employed. The average resolution was $0.9 \times 0.9 \times 1 \text{ mm}^3$. The measurement time was four to eight minutes. For the evaluation of the method, three different visualization techniques were used: standard cross-sectional views from the three-dimensional data sets, panoramic curved cut view and three-dimensional visualization of separately segmented teeth (semi-automatic segmentation using region growing algorithm and visualization using Amira software).

Results and Discussion: Measurement times of four minutes were well-tolerated by the pediatric age group. Localization of impacted maxillary canines was not possible in one patient because of a strong image artifact caused by metallic orthodontic braces. In all other patients, MRI yielded a clear separation between impacted teeth and the surrounding tissue, and the position and angulation of impacted teeth in all three spatial dimensions could be assessed. As an example, three cross-sectional views from a three-dimensional data set and a panoramic view remaining conventional radiographic images are shown in Fig. 1a. The impacted canine is marked with an arrow. The result of the data segmentation is shown in Fig. 1b. Due to the contrast between the teeth and surrounding tissue (gums, tongue, cheek, saliva, marrow of the jaw bones), the surfaces of each tooth could be reconstructed separately using semi-automatic segmentation.

Conclusion: Dental MRI is a safe, well-tolerated imaging method which can be used for three-dimensional localization of impacted teeth in both adults and children. Compared to the conventional X-ray-based diagnostics of impacted teeth, dental MRI provides an advantage of full volumetric morphology accompanied by complete elimination of ionizing radiation, which is particularly relevant for repeated examinations of the pediatric group.

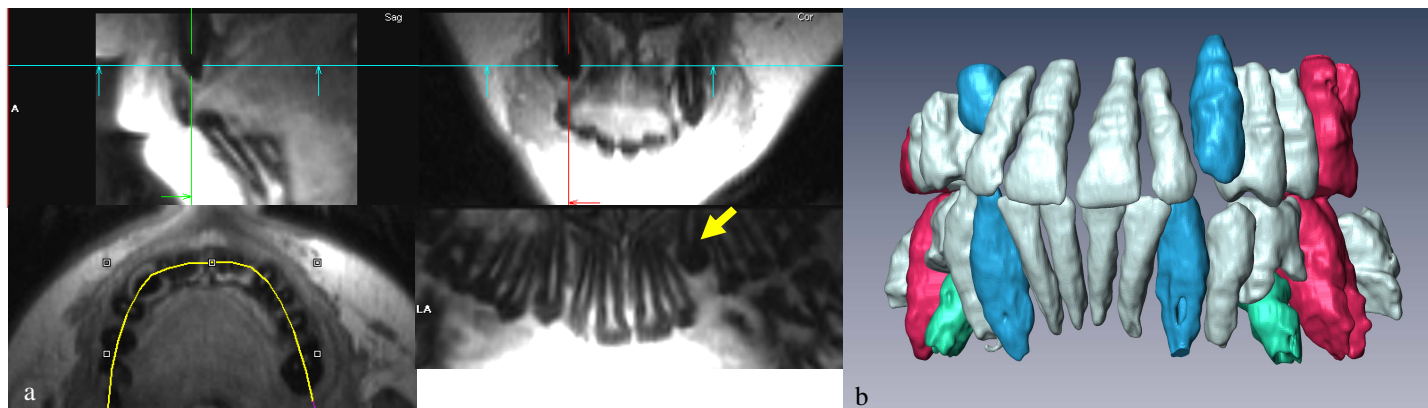


Fig. 1. a) Three cross-sectional views and a panoramic view from a 3D data set. Measurement parameters: 1.5 T, 4+4-channel multifunctional coil array (Noras MRI Products, Hoechberg, Germany), 3D TSE, TR/TE=1000 ms/10 ms, TF=17, FOV=100×60×44 mm³, matrix 128×76×44, TA= 4 min 41 s. Resolution 0.78×0.78×1 mm³. The impacted canine is marked with an arrow.

Fig. 1. b) 3D reconstruction of the teeth from the same data set.