Diagnosis of Dental Abnormalities in Children Using MRI

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Introduction: Different genetic and environmental factors can cause abnormalities in tooth development that manifest as change of the size, shape, position and number of teeth. Radiographs are routinely used for diagnosis of dental abnormalities as well as for orthodontic treatment and surgery planning. However, radiographic images provide only limited information especially in case of overlap of dental structures. The purpose of this study was to assess the feasibility of MRI of dental abnormalities in children.

Subjects and Methods: The study included 38 orthodontic patients of mean age 12.4 (range 8 - 18 years) with abnormalities of the size, shape, position and number of teeth. Three-dimensional images were acquired using a 1.5 T MRI scanner (Magnetom Avanto, Siemens Medical Solutions, Erlangen, Germany) in combination with a 4-channel multifunctional coil array (Noras MRI Products, Höchberg, Germany). Measurement parameters were on average: 3D TSE, TR/TE=1000 ms/10 ms, TF=17, FOV=100×60×44 mm^3, matrix 128×76×44, TA= 4 min 41 s. To provide full information necessary for treatment and surgery planning, the obtained data were semi-automatically segmented using region growing algorithm and the surface of the structures of interest was rendered in 3D (Amira, ZIB, Berlin, Germany).

Results and Discussion: Measurement times of four to five minutes were well-tolerated by all children. Diagnosis of dental abnormalities 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 the tooth substance and surrounding tissues, the position and shape of malformed teeth could be assessed in all three spatial dimensions. Supernumerary teeth were diagnosed in 26% of the patients, gemination in 3%, dilaceration in 3%, transposition in 3% and various tooth impactions in the rest 63% of the patients. Examples of 3D rendering of dental abnormalities are shown in Figs. 1 - 5.

Fig. 1   mesiodens (supernumerary tooth in the midline of maxilla)
Fig. 2   gemination (development of two crowns from a single germ)
Fig. 3   dilaceration (severe bend of the tooth root)
Fig. 4   transposition (change of places of adjacent teeth)
Fig. 5   supernumerary central incisors

Due to the contrast between the teeth and surrounding tissue (gums, tongue, cheek, saliva, marrow of the jaw bones), the surface of each tooth could be reconstructed using semi-automatic segmentation. Dental pulp gave a high MR signal and therefore could be visualized inside the tooth substance, providing in many cases valuable diagnostic information.

Conclusion: Dental MRI is a safe, well-tolerated imaging method which can be used for diagnosis of dental abnormalities in children as well as for orthodontic treatment and surgery planning. Compared to the conventional radiographs, dental MRI provides an advantage of full volumetric morphology accompanied by complete elimination of ionizing radiation, which is particularly relevant for repeated examinations of children.

Fig. 1

Fig. 2

Fig. 3

Fig. 4

Fig. 5