

A dedicated 4-channel RF receiving array for orthodontic examinations

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INTRODUCTION

MRI is used in many fields of human medicine. The demand of MRI applications in orthodontics also increases. For this reason potential of MRI in orthodontic diagnostics is being studied [1], but no dedicated Hardware is available so far. Therefore, our work was to develop a dedicated receiving coil array for orthodontic examinations.

METHODS AND MATERIALS

An anatomically adapted RF-coil array was designed. In order to obtain a good fit of the array to the upper jaw, it was necessary to leave a notch for the nose. To get high SNR the receiver unit was built as an array of four single coils. As the array was designed for orthodontic examinations of children, the size of coil elements was chosen to 4.2 cm × (5.3-8.5) cm. To fit the array to various jaw sizes a semi-flexible foil was used. To maintain the flexibility the coupling network was placed about 17 cm away from the receiving loops (Fig.1). The receiving loops were connected to the coupling network by additional RF lines. Cable traps were used to eliminate standing waves in the RF lines. In order to capacitive decouple neighboring coils, capacitors were inserted into the common conductor. The remaining coupling between non-neighboring coils was reduced by connecting the coils to low input impedance preamplifiers [3].

In order to proof the quality of the developed array, SNR measurements were performed on a specially designed phantom (Fig. 2). A plaster cast representing patient's teeth was placed in a glass head filled with 2 % agar H₂O solution doped with 5 g/l NaCl and 1, 25 g/l NiSO₄. The SNR was determined in a ROI next to molar teeth (Fig.2), because this region is challenging in term of penetration depth. The obtained data were compared to data from 8-channel Head array (Siemens). Furthermore in vivo measurements were performed (Fig. 3).

All measurements were executed on a 1.5 T whole body scanner (Siemens Avanto). Measurement parameters were: 3D TSE, TR/TE=1000 ms/10 ms, TF=17, mm³, matrix 128×76×44, TA= 4 min 41s, FOV (Phantom) =100×60×44, FOV (In vivo) =77×130.

RESULTS AND DISCUSSION

By capacitive decoupling an isolation of the single coils of more than 30 dB was achieved. Decoupling of non-neighboring coils by the preamplifiers was more than 20 dB. This allowed every single coil element to receive NMR signals independently from each other. Figure 2 shows images from all single elements and the combined sum-of-squares image. The SNR of our Dental array was determined as 118 while the SNR of the Head array was 28.

Thus, a significant improvement of the signal-to-noise ratio compared to standard head coil was achieved. The in vivo images show detailed structures of teeth and jaw and a good coverage of the complete jaws was achieved.

CONCLUSION:

In vivo measurements demonstrate the possibility to obtain high resolution images of teeth and jaws in short measurement times with the developed dedicated dental array. The improved SNR and anatomic coverage achieved with this array can facilitate detailed orthodontic examinations.

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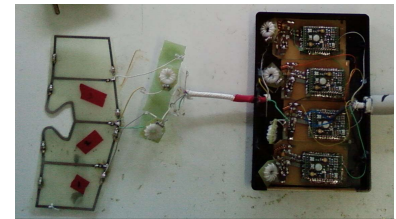


Fig. 1: Array and coupling network.

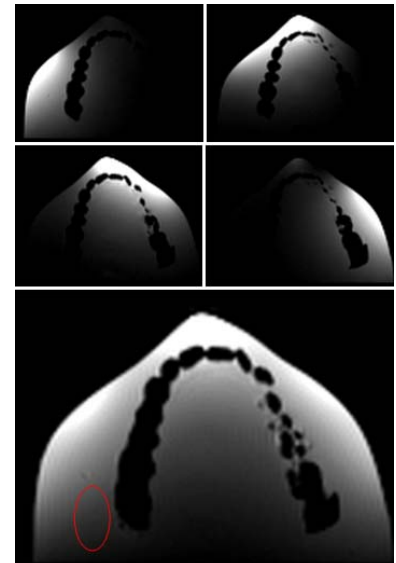


Fig. 2: Images obtained using the dental array. The four images on top show the single coil images. The sum-of-square image is shown at the bottom. The red circle represents the ROI.

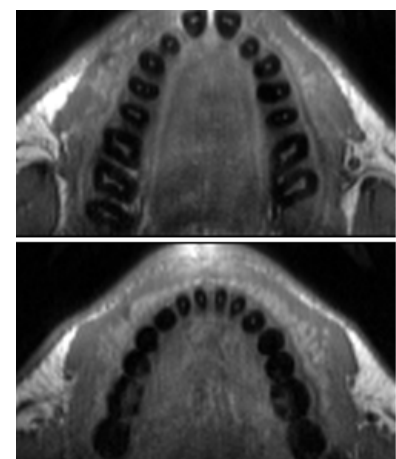


Fig. 3: In Vivo images from upper and lower jaw.