High Resolution MRI of the Parotid Gland and Duct at 7 Tesla

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Introduction: While X-ray sialography is considered the standard of reference in assessing major gland diseases, it has certain drawbacks such as the use of ionizing radiation or invasive cannulation for contrast agent injection through the narrow ducts. Recently, MR techniques have been reported as an alternative to conventional sialography [1]. However, MR sialograms, while clearly demonstrating the main duct and primary branching ducts, often fail to demonstrate higher order branches [2]. High field systems (7T) may address this issue by providing new contrasts coupled with increased SNR and hence higher spatial resolution. To our knowledge, no measurements of the parotid gland at 7T have been reported. Therefore, our study aimed to optimize sequences for high-field MR imaging of the parotid gland and duct at 7T and show the potential of high field imaging.

Methods: All measurements were performed on a Magnetom 7T whole-body scanner (Siemens Medical Solutions, Erlangen, Germany) with a 10-cm-diameter transmit/receive single loop coil (Rapid Biomed, Wurzburg, Germany). Various PD and T2 weighted spin and gradient echo sequences were optimized and tested on six (four male, two female, mean age 28 years) healthy volunteers. We acquired high-resolution images and compared them with 1.5T images acquired with a 17-cm-diameter receive-only loop coil (Siemens Medical Solultions, Erlangen, Germany). Signal-to-noise (SNR) and contrast-to-noise ratios (CNR) were calculated between duct and surrounding tissue.

Results and Discussion: Due to SAR restrictions, enhanced susceptibility artifacts, and different relaxation times, extensive adjustments of the sequence parameters are needed to take full advantage of the higher SNR at 7T. For the 2D GRE multi-echo data-image combination (MEDIC) sequence, a combination of TR/TE = 1590/15 ms, α = 30°, and fat suppression yielded best image quality with a resolution of 0.35x0.35x1.5 mm^3. Additionally, a double echo TSE sequence with PD (TE = 28 ms) and T2 (TE = 111 ms) weighted contrasts was implemented. Due to the large flip angle of 150°, a variable-rate selective excitation (VERSE) pulse [3] had to be chosen to overcome SAR restrictions. The TSE yielded highest resolution at 0.30x0.30x1.0 mm^3. Both sequences provided excellent contrast and image quality of the parotid duct and gland in all six volunteers.

At 1.5T, spatial resolutions of 0.6x0.6x3.0 mm^3 for the MEDIC and 0.7x0.7x3.0 mm^3 for the PD/T2 TSE were achieved. Additionally, a short TI inversion recovery (STIR) sequence with TR/TE/TI = 4300/56/160 ms had to be employed at 1.5T for imaging the duct in cases in which the duct was not visible with the MEDIC or PD/T2 TSE at 1.5T. However, at 7T the STIR sequence could not be used due to SAR limitations and B1 inhomogeneities.

The MEDIC sequence yielded highest SNR of the duct (89.5) at 7T, which was 3.5 times higher than at 1.5T. Furthermore, the MEDIC achieved highest CNR of all sequences between duct and gland (71.5). While the duct was not visible at 1.5T with the PD/T2 TSE at all, moderate CNR values were achieved between duct and gland at 7T (35.9 for PD-w and 25.8 for T2-w). Additionally, CNR values were calculated between duct and muscle: the T2 TSE provided highest CNR at 7T (28.0) followed by PD TSE (18.3) and MEDIC (12.0). At 1.5T, the STIR sequence performed best with CNR between duct and gland of 51.5 and between duct and muscle of 37.6.

Figure 1 shows a comparison of 7T (upper row) and 1.5T (lower row) images. The main duct as well as up to fourth-order branches are clearly delineated and show high contrast to the surrounding tissue in the 7T MEDIC image (A), but are more poorly visualized in both the 1.5T MEDIC image (C) and in the 1.5T STIR image (D). In (B) the PD-w TSE image of the duct and gland is shown.

Conclusion: MR imaging at 7T provides excellent image contrast and resolution of the parotid gland and duct. While the MEDIC sequence is advantageous for displaying the duct and branches, the gland tissue can be better characterized with the PD/T2 TSE. The proposed sequences provide a non-invasive examination within about 20 minutes and may in the future replace standard X-ray sialography. Of course, further studies are needed to discuss the clinical impact of this technique for the assessment of patients with symptomatic xerostomia or salivary gland inflammation, for example. We are currently in the process of continuing this study in patients as well as of building a dedicated multi-channel coil which will allow for parallel acquisition techniques to take even better advantage of the available SNR at 7T.

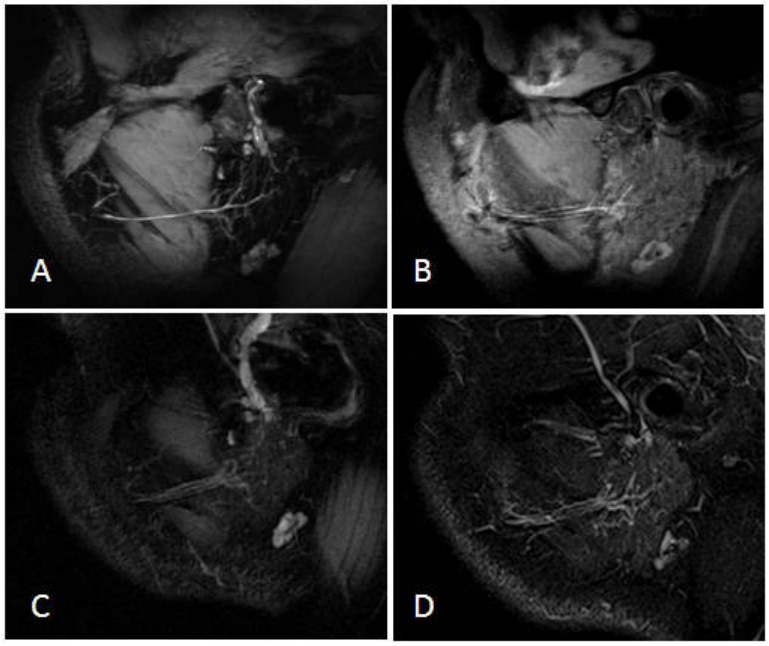

Figure 1: 7T (upper row) and 1.5T (lower row) images of a healthy volunteer. A 6 mm MIP of the 7T MEDIC sequence is shown in (A), which may be compared to the 1.5T counterpart in (C). The duct is also visible in the 7T PD TSE image (B), and at 1.5T best image quality was achieved with the STIR sequence shown in (D).

References:

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