HIGH RESOLUTION VOCAL CORD IMAGING - COMPARISON BETWEEN 3T AND 7T.

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Introduction Accurate diagnosis of extension of laryngeal tumors requires high quality imaging. This is especially important in small glottic tumors (Tis, T1a and T1b) that may be treated either with laser excision surgery or with radiotherapy (RT). Larger glottic tumors and supra- and subglottic tumors are mostly treated by RT or surgery. Laryngoscopy is useful in determining the mucosal extent. Imaging is able to show deep extent of tumor; i.e. invasion of surrounding tissues. For tumors of the vocal cords in particular, the choice and extent of laser excision surgery or radiotherapy depends on whether the tumor is restricted to the epithelial layer (Tis), or invades the underlying vocalis muscle. At present, on CT and MR (1.5T and 3T) it is very difficult to visualize the epithelial lining of the vocal cords. In this work we explore the possibilities of 7T MR imaging of the larynx, especially the lining of the vocal cords. Since the lining has a thickness in the order of 1 mm, high resolution is required. Moreover, to avoid partial volume effects and to be able to image small tumors, the slice thickness should be small. This requires high SNR, which can be achieved at 7T. We compare the 7T images with 3T results.

Materials and methods The experiments were performed with a healthy volunteer on a 7T MR scanner (Philips Healthcare, Cleveland, OH, USA) and a 3T MR scanner (Achieva TX, Philips Medical Systems, Best, The Netherlands). Images were acquired with an immobilization mask to permit radiation treatment planning, but the mask was not required for good image quality. The volunteer was fixed to a flat base plate with a five-point head-and-shoulder immobilization mask (Posicast PR5; Sinmed, Reeuwijk, The Netherlands). At 3T the body coil was used for transmit and a two-element flexible surface coil was used for receive, corresponding to [1]. At 7T the setup was similar to [2], employing two 15-channel local receive arrays (*figure 1b*) and two dipole antennas (*figure 1a*) folded around a deuterium (D_2O)-filled pillow (*figure 1c*). The receive arrays were placed on top of the mask at the position of the larynx. The pillow with the antennas was placed over the receive arrays (*figure 1d*). As a result of the immobilization mask, the volunteer experienced no pressure of the pillow on the throat. For B_0-shimming at 3T a volume shim procedure was adopted, whereas at 7T image-based shimming [3] (2^{nd} order) was performed. Multi-slice T2W turbo spin-echo sequences were used to image the vocal cords (turbo factor 11, TR = 3000 ms, in-plane resolution of 0.5×0.5 mm^2, NSA = 2, Sense = 1, WFS = 1.2 pixel, TE and slice thickness indicated in *figure 2*). The acquisition times for the 3T and 7T scans were equal (3m18s). The FOV acquired in the FH direction was smaller at 7T due to higher SAR (less slices could fit in a stack). The slice gap was set equal to the slice thickness.

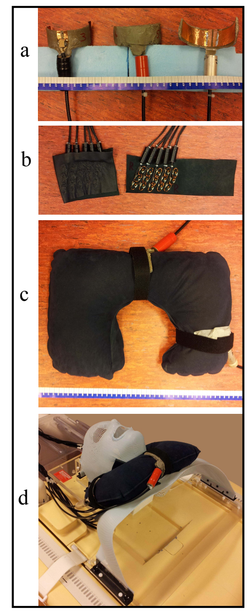

Figure 1 : Setup with immobilization mask.
a) Transmit antennas.
b) Receive arrays.
c) D_2O-filled pillow with transmit antennas.
d) Receive and transmit components placed over the immobilization mask.

Results *Figure 2* shows various 3T and 7T images. To obtain similar contrast in 3T and 7T images, the echo time at 3T had to be longer (TE = 100 ms at 3T versus TE = 68 ms at 7T). Both on 3T and on 7T the epithelial lining of the vocal cords could be seen. However, for the 3T images with a slice thickness of 1 mm the SNR was too low, resulting in noisy images. As a result a larger slice thickness was needed, leading to more partial volume effects. Although the 7T images suffered from some motion artifacts, the lining of the vocal cord and the line of the paraglottic fat could clearly be seen, even though the slice thickness was only 1 mm. The motion artifacts were most pronounced in AP direction due to breathing and could be reduced by choosing the phase encode direction RL.

Conclusion and discussion Anatomical details such as the epithelial layer and the paraglottic fat were more distinct on the 7T images than on 3T images. For a slice thickness of 1 mm only the 7T images had sufficient SNR, the 3T images were too noisy to show the anatomical details. The possibility to acquire such thin slices at 7T could help to substantially reduce partial volume effects. The gain in SNR at 7T had two causes: 1) higher field strength and 2) better receive coils. Although at 7T more time would needed to perform B_0 and B_1 shimming, for patients where the tumor extent is unclear, 7T imaging may provide useful additional information for laser excision surgery or radiation treatment planning.

References

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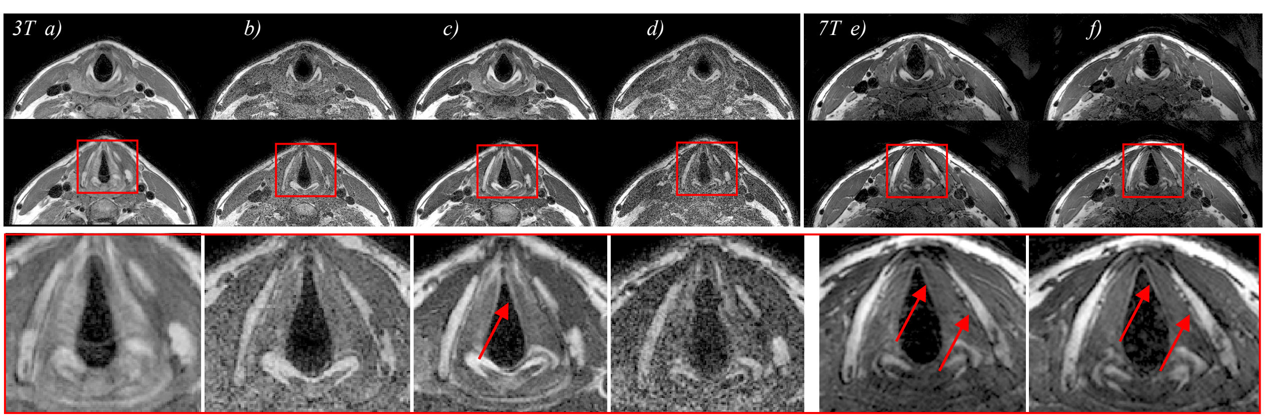

Figure 2: Larynx and vocal cords at 3T and 7T (multi-slice TSE, TR=3000 ms, 0.5× 0.5 mm^2, NSA=2, turbo factor=11). a) 3T, TE=68 ms, slice thickness=3 mm. b) 3T, TE=68 ms, slice thickness=1 mm. c) 3T, TE=100 ms, slice thickness =3 mm. d) 3T, TE=100 ms, slice thickness=1 mm. e) 7T, TE=68 ms, slice thickness=1 mm, phase encode in AP direction. f) 7T, same as e), but phase encode in RL direction (less motion artifacts). The arrows indicate the epithelial layer and the paraglottic fat.