

THE POTENTIAL OF HIGH RESOLUTION MR IMAGING AT 3 AND 7 TESLA FOR TREATMENT GUIDANCE OF EARLY GLOTTIC CARCINOMA.

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Target audience Researchers interested in the added value of high resolution imaging of small tumors. Head and neck physicians.

Purpose In this study we assess the feasibility and clinical value of MR imaging at 3 and 7 Tesla for early glottic carcinoma. Laryngeal cancer is the most common cancer in the head and neck region. About 67% of laryngeal tumors are glottic. As they cause symptoms of hoarseness in an early stage, these tumors are usually identified when still small (T1 stage). The main treatment modalities are laser surgery and radiotherapy. For T1a glottic cancer, both types of treatment have comparable cure rates, but differ in functional outcome (e.g. voice quality), cost effectiveness etc. Several studies that addressed the comparison of the treatment types were inconclusive [1]. A critical factor is the lack of information on the exact tumor extent and location. Mostly, laryngoscopy is used to stage and locate the tumor; however, it visualizes only superficial structures. Imaging is generally not performed since most imaging modalities are unable to detect these small glottic tumors. To image them, high resolution (<1 mm³) is required. Here we study if MRI at 3T and 7T can achieve this resolution with diagnostic quality. Moreover, we study if the gain in SNR at 7T increases diagnostic quality.

Methods The experiments were performed with nine healthy volunteers (5 male, 4 female, age 24–47, BMI 19.5–25.8) and two patients (male, ages 68 and 69) with glottic tumors. All volunteers and patients were scanned at 3T (Achieva 3TX, Philips Medical Systems, Best, Netherlands) and at 7T (Philips Healthcare, Cleveland, OH, USA). They were fixed to a flat base plate by an immobilization mask (Fig. 1). At 3T, the transmit field was delivered by the body coil and a two-element flexible surface receive coil was used. At 7T, local transmit solutions were applied, similar to those described in [2, 3], employing two dipole antennas folded around a D₂O-filled pillow (Fig.1) and two 15-channel receive arrays. On both platforms similar multi-slice (MS) T2W and T1W TSE sequences were acquired. On the 3T system additional 3D TSE sequences were acquired, optimized for 3T. For one patient the standard radiotherapy protocol was used on 3T to permit radiotherapy treatment planning. Sequence details are in Fig. 2. In patients, the T1W scans were performed without and with Gadolinium.



Fig. 1. Setup for 7T MRI.

Results In Figs. 3 & 4 images of a healthy volunteer are shown. The imaging of volunteers showed reproducible quality, however motion affected the quality of the images of two volunteers. Comparing the T2W MS sequences (Fig. 3) indicates that the 7T images show more structures around the larynx (such as the epithelial layer and paraglottic fat) which are less apparent on the 3T MS scan due to noise. The 3D 3T sequence performs better than the MS 3T sequence, but is still noisier than the 7T MS sequence and shows less anatomical detail. For the T1W images (Fig. 4) without Gadolinium the 3T scans show more contrast. Fig. 5 shows images of a patient who was staged with a T2 tumor based on laryngoscopy. On 3T, the standard (lower resolution) radiotherapy protocol was used. The tumor can be identified in the 3T T2W scan. The interpretation of the 7T T2W scan is hampered by patient motion. However, the T1W 7T scan clearly shows anterior commissure involvement, not seen during laryngoscopy and on the 3T scans. Fig. 6 shows images of a patient who was staged with a T1a tumor. The 3T and 7T scans show similar results, the 7T scans have less contrast (for T2W due to smaller TE) but superior anatomical detail. Both 3T and 7T scans show extensive involvement of the right vocal cord, therefore it was decided to treat this patient with radiotherapy instead of laser surgery.

Discussion When subject motion was minimal, good high resolution images could be obtained at both 3T and 7T. The 7T setup provided more detailed anatomical information, but 7T imaging is not necessary to obtain a resolution < 1 mm³. Two patients were scanned using high resolution protocols. In both cases new information was obtained by MR imaging that led to increased knowledge of tumor position and extent.

Conclusion We have shown that it is feasible to perform high resolution imaging of small glottic tumors both on 3T and 7T after optimization of the setup and protocol. High resolution imaging of patients gave additional information compared to laryngoscopy. We expect that this will have implications on staging and treatment decisions.

References [1] Abdurehim et al. Head and Neck 34(8): 1179-89, 2012. [2] Koning et al. MRM in press, 2012. [3] Bluemink et al. Proc Intl Soc Mag Reson Med 20 #1055, 2012.

Seq.	Field	Seq.	TSE	TR(ms)	TE(ms)	Voxel size(mm ³)	FA(°)	RA(°)	NSA	Sense
1	3T	3D	TSE (145)	4027	336	0.5 x 0.5 x 1	90	25-160	2	1.7
2	3T	MS	TSE (11)	3000	68	0.5 x 0.5 x 1	90	80	2	1
3	7T	MS	TSE (11)	3000	68	0.5 x 0.5 x 1	90	80	2	1
4	3T	MS	TSE (145)	2248	208	1 x 1 x 2	90	25-160	2	2
5	3T	3D	TSE (145)	300	20	1 x 1 x 1	90	40	2	1.1
6	3T	MS	TSE (3)	500	20	0.6 x 0.6 x 2	90	180	2	1
7	7T	MS	TSE (3)	500	20	0.6 x 0.6 x 2	90	180	2	1

Fig. 2. Sequence parameters. FA: flip angle. RA: refocusing angle.

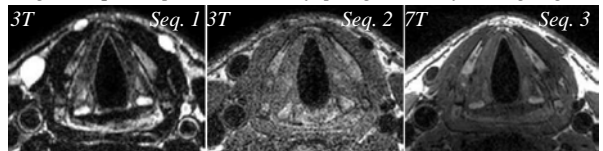


Fig. 3. T2W images of healthy volunteer. Sequences 1, 2, and 3.

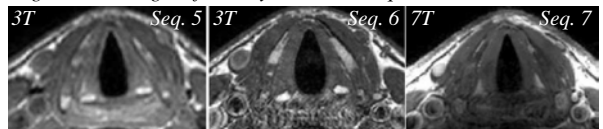


Fig. 4. T1W images of a healthy volunteer. Sequences 5, 6, and 7.

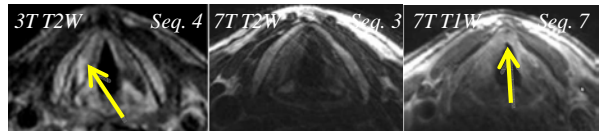


Fig. 5. T2 glottic patient. 3T T2W, 7T T2W and 7T T1W

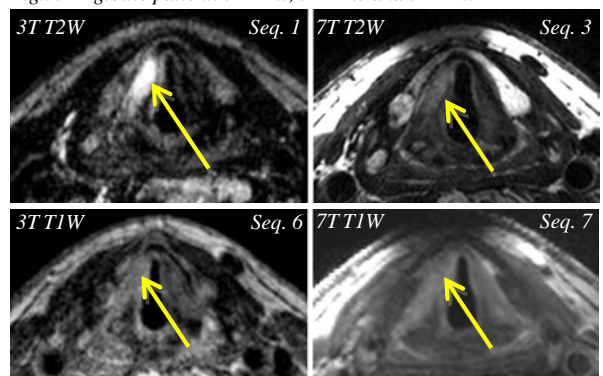


Fig. 6. T1a glottic patient. Top: T2W. Bottom: T1W post contrast.