Boosting SNR with an internal antenna and external antennas in the human cervix uteri in TSE at 7T.

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Target audience

Clinicians who are interested in imaging the female inner pelvic region and physicists and clinicians interested in the benefits of internal antennas.

Purpose

For cervical cancer it is important to obtain images from the (para)cervical region with a very high resolution. Especially the T_2–weighted images are clinically needed for determining tumour extension into the parametria (i.e. connective tissue surrounding the cervix). Establishing parametrial involvement is crucial for both prognostic estimates, as well as the treatment decision between radical surgery and (chemo)radiation. Since resolution and contrast-to-noise ratio at lower fields is suboptimal, we propose to boost the signal-to-noise ratio (SNR) not only by obtaining MRI at 7T, but also by applying an internal antenna.

Methods

Seven external fractionated dipole antennas [1] for transmit and receive were combined with a single endorectally placed antenna [2], used for receive only on the Philips 7T whole body system. B_1 shimming was applied on the region of the cervix. Separate signal and noise measurements were obtained with and without the internal antenna functioning as an extra receiver. SNR maps (Fig.1) were obtained to measure the added value of the internal antenna over the external antennas alone. The SNR difference was calculated using the mean signal over the area of interest divided by the standard deviation of the noise scan from that same area, using the same coil weighting factors [3]. Turbo spin echo (TSE) images were obtained to visualize the cervix and plan an oblique high resolution TSE scan (T_E = 70 ms, T_R = 10 s, resolution = 0.75 x 1 mm^2) perpendicular to the cervical canal.

Results

The outlined coil setup enabled T_2-weighted visualization of the entire female pelvis (Fig.2). Using the internal antenna as a extra receiver, we gain a factor of 3.2 SNR on average in cervical region (delineated in Fig.1). This means that we can trade the SNR for imaging at a (clinically desired) higher spatial resolution. Sagittal TSE images (Fig.2) are obtained to determine the location of the cervix. Note the details of the vagina due to the high spatial resolution and contrast. The slice of the TSE perpendicular to the cervix (Fig.3) gives a high resolute image of the cervix and the parametria. Note that besides the parametria, various other anatomical structures in the (para)cervical region, which are also important in cervical cancer staging, are clearly visible. These detailed structures with different T_2 contrasts have never been observed before.

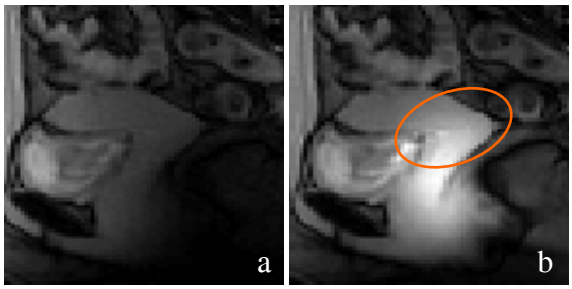

Fig. 1. The signal images from the SNR measurements without (a) and with (b) the internal antenna. In orange the region is shown where the SNR was determined. It is clear that the internal antenna contributes in a great manner to the SNR. Scan duration = 53.7 s; T_R = 15ms; T_E = 1.49ms; resolution = 2x2 mm^2.

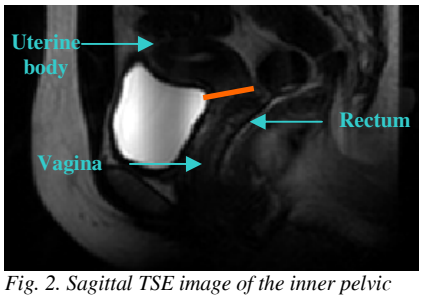

Fig. 2. Sagittal TSE image of the inner pelvic region of a healthy volunteer) The orange line corresponds to the location of the cervix and corresponds to the oblique slice in Fig. 3. Scan duration = 60 s; T_R = 12 s; T_E = 209ms; resolution = 1.6x1 mm^2.

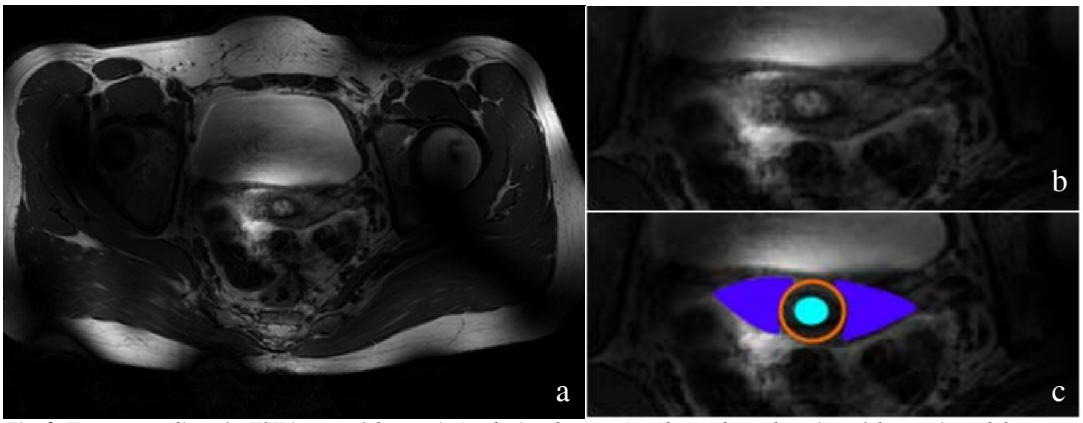

Fig. 3. Transverse slice of a TSE image of the cervix (c: depicted orange) and an enlarged section of the cervix and the different structures which can be visualized due to the increased SNR. The parametria (c: purple) and the cervical canal/endocervical mucosal lining (c: blue) are also visible. Scan duration=380 s; T_R = 10 s; T_E = 70 ms; resolution = 0.75x1 mm^2.

Conclusion and discussion

We are able to obtain T_2-weigthed images of the whole pelvic region and obtain a homogeneous B_1 field in the cervical region, while boosting the SNR by using an internal antenna. Due to the high resolution which was obtained, all relevant (para)cervical structures were distinguisable. These multiple structures are essential during cervical cancer staging and the assessment of parametrial involvement.

References

[1] Raaijmakers et al. ISMRM 2013: 6577. [2] Kroeze et al. ISMRM 2012: 0539. [3] Haacke EM, Brown R.W., Thompson M.R., Venkatesan R. *Magnetic resonance imaging*. 1999:332-337.