# SINGLE BREATH-HOLD HIGH SPATIAL RESOLUTION ABDOMINAL IMAGING AND T2* MAPPING AT 7.0 T

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## Introduction

Abdominal imaging examinations constitute a growing fraction of clinical MRI exams. A typical abdominal exam, for example for screening of the liver, consists of $T_2$-weighted studies with and without fat saturation, and $T_1$-weighted gradient echo studies prior to and following administration of contrast media. Since ultrahigh field magnetic resonance imaging becomes more widespread, a range of applications established in the clinical scenario at 1.5 T and 3.0 T is emerging at 7.0 T. Arguably, abdominal MR imaging at 7.0 T earns the moniker of "advanced MR techniques" since some of the inherent advantages of ultrahigh-field MRI are offset by practical impediments associated with magnetic field inhomogeneities, off-resonance artifacts, dielectric effects, RF non-uniformities, localized tissue heating and RF power deposition constraints. The intrinsic sensitivity advantage at 7T can be put to use to increase the temporal resolution to reduce the impact of respiratory and peristaltic motion, or to drive the spatial resolution into the sub-millimeter range. For these reasons, this pilot study examines the feasibility of abdominal imaging at 7T using an eight element transceiver coil array.

## Methods

A self-designed eight-channel surface coil array was used in conjunction with a single-breath-hold 2D FLASH sequence on a 7T whole body MR system (Magnetom, Siemens Medical Solutions, Erlangen, Germany) to produce in-phase and out-of-phase images of the liver and the gallbladder. An interface box containing transmit/receive switches, preamplifiers and a 1:8 RF power splitter interconnected the coil array with the scanner. Relative $B_1$-maps were acquired in vivo to enable transmit phase optimization for the individual channels prior to collect in vivo data from a healthy volunteer. The protocol was: TE (in-phase/out-of-phase)=2.04/2.55ms, TR=7.6ms; Voxel size = (0.4x0.4x2) mm³; 5 averages; nominal flip angle: 35°; Acquisition time: approx. 20s. For T2* mapping of the liver a set of images was acquired with TE ranging from TE=2.04 ms to TE=9.18 ms. Mono-exponential fitting using nonlinear least squares optimization implemented by Trust-Region algorithm was applied for pixel-by-pixel $T_2$* quantification.

## Results

$T_1$-contrast weighted images delivered high details of subtle liver structures as shown in Figure 1 (in phase)and Figure 2 (out-of-phase) without the need of contrast agent application. Besides great vessels, capillaries in the dimension of half a millimeter of diameter were clearly identifiable. The gallbladder imaging resulted in an anatomic image shown in Figure 3 with a sub-millimeter in plane resolution which is superior to that commonly achieved at the kindred 1.5T and 3.0T counterparts. Despite the current non-uniformity of the RF field distribution, our results suggest that high spatial resolution anatomic details can be considered to be beneficial in a clinical setting. Admittedly, this requires further developments in the areas of $B_1$ mapping and $B_1$ shimming tailored to each patient's size and geometry. Unlike $B_1$ field distribution, $B_0$ uniformity was found to be clinically acceptable as indicated by the $T_2$* map shown in Figure 4. $T_2$* was found to be approximately 8 ms for the parenchyma and approximately 45 ms for the large liver vessels.

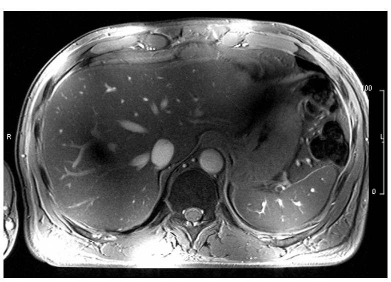

**Figure 1:** $T_1$ weighted liver images in-phase (left), using a voxel size of (0.4x0.4x2.0) mm³.

**Figure 2:** $T_1$ weighted liver images out-of-phase and a voxel size of (0.4x0.4x2.0) mm³.

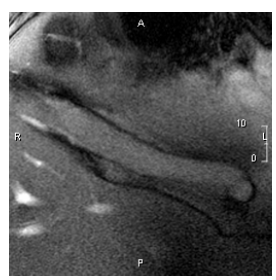

**Figure 3:** $T_1$ weighted image of the gallbladder using a voxel size of (0.3x0.3x4.0) mm³

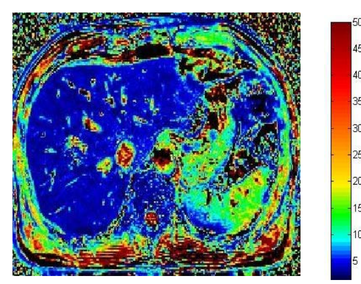


**Figure 4:** Abdominal $T_2$* color map showing a rather uniform T2* distribution in the liver.

## Conclusion

Ultra high field MRI (7T) owns a high potential of depicting sub-millimeter anatomic abdominal structures, such as the gallbladder wall and subtle liver vessels. As transmit array hardware becomes more readily available, 7T imaging may be expected to transition into an enabling technique for routine body imaging. However, further clinical studies have to be conducted to validate the diagnostic capability of 7T liver imaging versus established abdominal imaging protocols used in day-to-day clinical routine at 1.5 T or 3.0 T.