

In vivo ^1H MRS of Gallbladder Bile using an Optimized 8-Channel Phased Array at 3T: Towards Improved Diagnosis of Hepatopancreatobiliary Diseases

S. Mohajeri^{1,2}, T. Bezabeh¹, S. B. King¹, O. B. Ijare¹, G. Y. Minuk³, J. Lipschitz⁴, and I. C. Smith¹

¹National Research Council Institute for Biomedical Research, Winnipeg, Manitoba, Canada, ²Human Anatomy and Cell Science, University of Manitoba, Winnipeg, Manitoba, Canada, ³Hepatology, University of Manitoba, Winnipeg, Manitoba, Canada, ⁴Surgery, University of Manitoba, Winnipeg, Manitoba, Canada

INTRODUCTION: Bile is a biofluid synthesized in the liver and stored in the gallbladder. It facilitates the emulsification, digestion, and absorption of lipids. Study of bile composition is valuable in the diagnosis of various hepatopancreatobiliary diseases. *In vitro* ^1H MRS studies performed on bile samples collected during endoscopic retrograde cholangiopancreatography (ERCP) have shown diagnostic value in detecting hepatopancreatobiliary disorders [1, 2]. However, given the invasive nature of ERCP, there is a great interest in performing such analysis *in vivo*. The study performed by Prescott et al. using a 1.5T MRI scanner was the first to show the possibility of obtaining ^1H MR spectra of human gallbladder (GB) bile *in vivo*. However, the published *in vivo* spectra were of low quality and not able to detect individual bile components except for phospholipids [3]. This could be due to the low magnetic field strength (1.5T), use of spin echoes with longer delays, lipid contamination and/or respiratory motion effects [3]. A more recent study performed by Kunnecke et al. on the bile composition in cynomolgus monkeys using a 4.7T and a home-built surface coil in transmit/receive mode has shown promising results [4]. However, a 4.7T scanner is not routine in clinical human studies. Moreover, safety issues should be considered when using transmit home-built coils in humans. Therefore, to address these issues, we present our initial efforts to obtain good quality spectra from pigs (with similar bile duct system as that of humans) using a 3T Siemens scanner and a home-built receive array coil.

MATERIALS AND METHODS: The experiments were performed on anesthetized pigs using a Siemens 3T Magnetom Trio clinical scanner. A comparison was made between a Siemens flexible body array coil and our home-built 8-channel surface receive array coil (approved for human use). Our array was optimized for the depth of interest for GB which is typically 5 cm from the surface of the body (mean anterior distance from skin to GB [5]). We performed single voxel spectroscopy using the Siemens PRESS sequence on pig GB bile to obtain *in vivo* ^1H MR spectrum. The voxel size was $15 \times 15 \times 15 \text{ mm}^3$. The use of a respiratory gated sequence helped us to decrease respiration motion artifacts. The PRESS acquisition parameters were: TE = 30 ms, TR = 2000 ms, bandwidth = 2000 Hz and NS = 64. The MRS spectral quality and signal to noise ratio (SNR) were compared for the two coils.

RESULTS & DISCUSSION: Figure 1 shows the *in vivo* ^1H MR spectra of pig GB bile obtained using the Siemens flexible body coil (left plot) and our 8-channel surface receive array (right plot). From Fig. 1, we can see a huge improvement in SNR (4 - 5 fold) using our surface coil. By such improvement in the spectral quality, we are able to detect metabolites that would have been otherwise difficult to detect. Specifically, we can detect signals from lipids, phosphatidylcholine and even glycine- and taurine-conjugated bile acids in the downfield region (7.8 - 8.1 ppm) as two distinct separate peaks. The localized ^1H MRS of GB bile obtained *in vivo* by Kunnecke et al. using a custom-built surface coil in transmit/receive mode had also provided high-resolution spectra, allowing the identification and quantification of glycine- and taurine-conjugated bile acids and phospholipids [4]. However, the magnetic field strength of 4.7T is not available in clinical settings and the transmit/receive coil should be evaluated carefully regarding safety issues or must be replaced by a much safer receive array coil. In order for this to be of any clinical use at the present time, comparable spectra have to be obtained at 3T and preferably with the use of a receive array coil. We have achieved this goal by using our home-built receive array coil. Moreover, comparison of our coil with a commercial Siemens flexible body coil yielded significant improvement in SNR that could greatly enhance the diagnostic quality of the spectra.

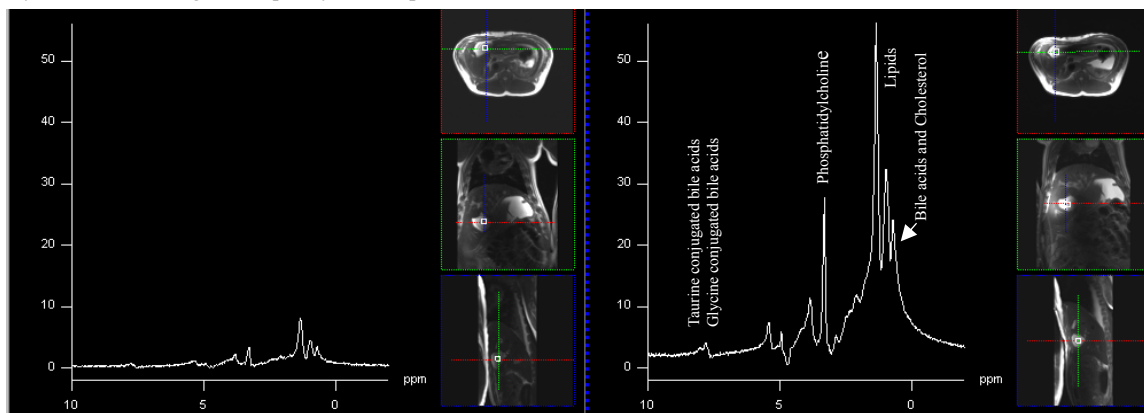


Figure 1. *In vivo* ^1H MRS acquired from pig gallbladder bile using Siemens flexible body array (left) and Home-built 8-channel receive array (right)

CONCLUSION: Detection of bile composition *in vivo* can be helpful in the non-invasive diagnosis of various hepatopancreatobiliary disorders. Our preliminary results on pigs show that the use of an optimized array coil can improve SNR significantly, potentially yielding spectra of good diagnostic quality from human bile in clinical settings. The recruitment for such a study is underway.

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