# High-Resolution Hyperpolarized C-13 Spectroscopic Imaging of the TRAMP Mouse at 3T

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**Introduction:**

The TRAMP mouse is an established and well-studied murine model of prostate cancer (1). In order to study cellular bioenergetics in this model, high resolution, *in vivo* MR spectroscopic imaging (MRSI) studies with non-proton nuclei such as $^{13}C$ would be required but prior studies have been limited due to the low natural abundance of C-13 and its low sensitivity compared to proton. With the recent development of a method to retain dynamic nuclear polarization (DNP) in solution, such data may be acquired by injecting a hyperpolarized C-13 agent, as shown in a previous studies in rat models (2-3). In addition, this technique may also enable the acquisition of MRS data with a very high temporal resolution (in the order of seconds), and tissue specific metabolic changes may be observable. This study was designed to investigate the feasibility of acquiring high spatial resolution $^{13}C$ MRSI data in normal and transgenic mice using hyperpolarized $^{13}C$-labeled pyruvate.

**Method:**

The studies were performed on a GE EXCITE 3T scanner (GE Healthcare Technologies, Waukeshaw, WI) using a custom built dual-tuned proton-carbon T/R coil. High resolution $^{1}H$ MR images were acquired in sagittal, axial and coronal views using T2-weighted fast spin echo sequence (FSE) with a 6 cm FOV, 128 x 128 matrix, 1.5 mm slice thickness with no inter-slice spacing and TE=102 ms / TR=4 s. Dynamic hyperpolarized $^{13}C$ spectroscopic imaging was performed 15 seconds after the injection of 3ml of a solution of hyperpolarized $^{13}C_1$-pyruvate into the tail vain of the anesthetized mouse. MRSI data were acquired in a 10 mm axial slice covering the mouse prostate with FOV of 40mm x 40mm and an 8 x 8 encoding matrix. Nominal spatial resolution for the MRSI data was 0.25cc. Total acquisition time was 16s (TR = 250ms, 5000Hz/512pts filter) Flip angle was set at 10 degree for each excitation. Data analysis was performed offline using custom software developed in our research group.

**Results:**

High-resolution MR images showed the mouse prostate in all three planes (Fig. 1-2). Elevated lactate that had been converted form hyperpolarized C13 pyruvate was observed in the cancerous prostate in the TRAMP mouse (Fig. 2).

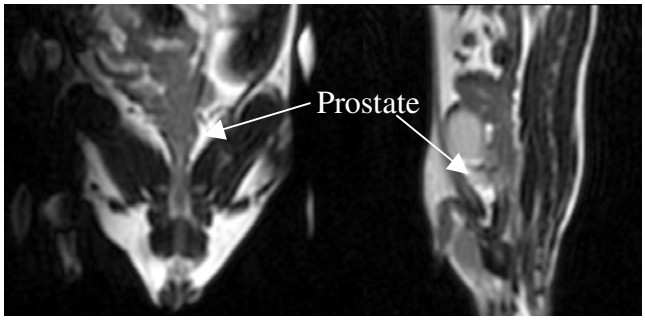


**Figure 1**. High-resolution T2-weighted FSE images acquired in a TRAMP mouse in coronal (left) and sagittal plane (right). Prostate of the mouse is clearly observable.

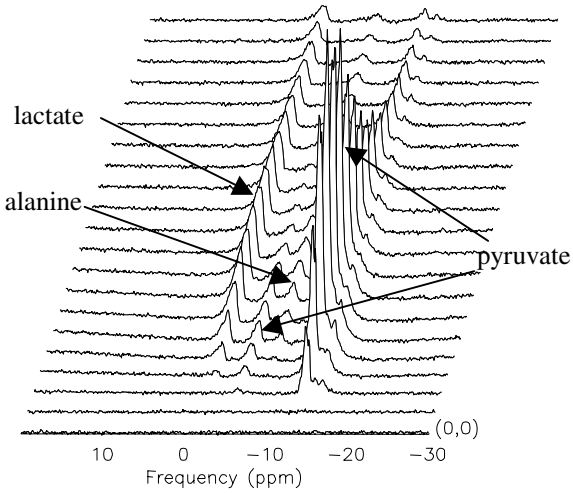


**Figure 3.** Non-localized time resolved spectra acquired in a normal mouse with temporal resolution of 3s. Note the conversion of the hyperpolarized $^{13}C$ pyruvate to lactate and alanine that was observed in real time.

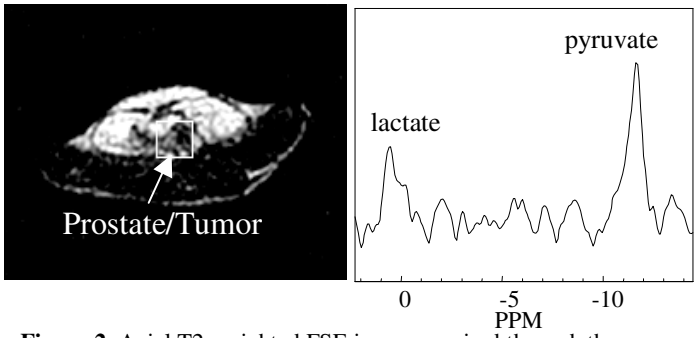


**Figure 2**. Axial T2-weighted FSE image acquired through the cancerous prostate of the TRAMP mouse. MRSI data acquired in a TRAMP mouse prostate tumor demonstrated elevated lactate converted from hyperpolarized C13 pyruvate.

**Discussion:**

This study demonstrated the feasibility of using hyperpolarized $^{13}C$ pyruvate to acquire high resolution MRSI data in normal and transgenic mice on a clinical 3T MR scanner. The results of this study indicate the potential to use the DNP C-13 technique to assess metabolism in cancer nodules and benign tissue in transgenic mice *in vivo*.

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**References：**

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