Purpose:
Prior 13C MR imaging studies of hyperpolarized (HP) [1-13C]pyruvate and 13C urea in the TRAMP murine model of prostate cancer have demonstrated the ability to monitor changes in metabolism and perfusion. Radiation therapy represents a common treatment of prostate cancer that could clinically benefit from an early assessment of therapeutic efficacy. The goal of this work was to investigate serial changes in perfusion (HP urea) and HP pyruvate metabolism in TRAMP tumors following exposure to increasing doses of radiation therapy in order to better understand the potential clinical value of HP 13C MR for predicting prostate cancer radiation therapy.

Methods:
Three TRAMP tumors (mean tumor size = 4.3 ± 1 cc) were exposed to varying doses of radiation by placing a single radioactive seed source using a Nucletron microSelectron-HDR applicator on the surface of the tumor for ~10 min. dwell periods. This resulted in doses of 14 Gy (close to the seed) to 5 Gy (deeper within the tumor ). MR imaging studies were acquired serially at baseline, 1 day, 4 days and 8 days following therapy using a 14T, 600WB micro-imaging spectrometer.

Results:
There are visually clear dose dependent changes in the lactate/pyruvate ratio over time. HP urea and total HP carbon significantly decreased in tumor regions receiving both high ($p < 0.01$; and 0.05, respectively) and intermediate doses ($p< 0.01$, for both) by 1 day after treatment. Whereas HP urea initially increased in the low dose regions and then decreased. For all three doses, the lactate/pyruvate ratios significantly decreased ($p < 0.01$ for all doses) by 8 days following treatment.

Conclusions:
Significant, dose-dependent decreases in perfusion and pyruvate-to-lactate flux were observed after radiation therapy. Ongoing serial radiation studies of TRAMP tumors are investigating the relationship between perfusion and metabolic changes and therapeutic efficacy.