Preliminary studies have shown magnetic resonance-guided, focused-ultrasound (FUS) therapy, to be a feasible method to coagulate neoplastic tissue. However, the sharply-focused ultrasound transducers, commonly used, make treatments very time consuming. Two different methods, increasing acoustic power and use of a defocusing lens, may reduce treatment time by enlarging FUS focus zone. This study quantitatively evaluates these two methods.

A prototype MR guided FUS ablation system and a polystyrene spherical shell lens (GE medical systems, Milwaukee, Wisconsin.) were used in this study. Orthogonal (axial and radial) FUS focus planes were imaged in bovine muscle, at five different acoustic power levels, both with and without a defocusing lens. Images were acquired by a fast gradient echo sequence using a 512x256 matrix, (TE/TR/flip/FOV = 12.6/34 ms/30^0/8 cm) and a 3-inch surface coil. Temperature elevation was calculated from phase difference images and an experimentally determined temperature calibration curve to create temperature elevation contour graphs of the focus.

From these graphs, isotherm areas and maximum temperature elevations were determined and plotted in both axial and radial FUS focus planes as a function of acoustic power level. Without a defocusing lens, the ablative zone can be increased by increasing acoustic power. This approach, however, is limited by high temperatures which increase the risk of uncontrolled cavitation. Use of a defocusing lens increases the full width 1/2 max isotherm size at the focus, but requires a relatively large increase in acoustic power to elevate the temperature of this larger focus into the thermal ablative range.