Recently, high-powered focused ultrasound (FUS) systems have been introduced in the MRI environment for noninvasive tissue ablation purposes. Accurate MRI temperature mapping of the ablation field is essential for FUS surgery. It is well known that the water proton chemical shift (WPCS) has a linear dependence on temperature elevation. But the calibration of the WPCS temperature coefficient has not been well established. The purpose of this study was to construct a temperature calibration curve for WPCS temperature mapping. This curve provides a very useful guide for quality control in FUS ablation clinical trials.

In the experiment set up, an agar gel phantom was heated to approximately 70^0C and thermally insulated in a Styrofoam container. Thermocouples were inserted into the gel phantom to monitor temperature. A 5-mm thick slice was acquired by a fast gradient echo sequence using a 256x128 matrix, (TE/TR = 6.2/34 ms) and a 5-inch surface coil. The WPCS was calculated from the phase difference images.

Over a six-month period, 17 studies have been conducted. Each study has demonstrated a good linear relationship between phase change and temperature elevation. The average correlation coefficient is 0.9884 ± 0.0148. However, a relatively large variance of WPCS temperature coefficient was observed. The average temperature coefficient is 0.0091 ± 0.0010 ppm/^{0}C. Four of 17 studies were conducted on the same day. The average temperature coefficient of these four studies is 0.0096 ± 0.0001 ppm/^{0}C. The results show that daily calibration could reduce the temperature mapping error from 11% to 1%.