Title:	Reusable heat-sensitive phantom for precise estimation of thermal profile in hyperthermia application
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Abstract:	PURPOSE: The emergence of thermal modalities has promoted the use of heat-sensitive phantoms for calibration, measurement, and verification purposes. However, development of durable phantoms with high precision ability to represent the temperature distribution remains a challenge. This study aims to introduce a reusable phantom that provides an accurate assessment of the heated region in various thermal modalities. MATERIALS AND METHODS: The phantom contains a thermochromic dye that is transparent blue at room temperature and becomes colourless after exceeding a threshold temperature. In order to determine the threshold temperature of the phantom, spectrophotometry analysis was performed. The various thermal

	(specific heat, thermal conductivity, melting point and latent heat of melting) and acoustic (sound speed, attenuation) properties of this phantom were measured and compared with those of the reference phantom without dye. The application of this phantom for radio-frequency and magnetic resonance guided focused ultrasound modalities was also examined. RESULTS: The spectrophotometry analysis showed a threshold temperature of 50 ± 3 °C for this phantom. The results also demonstrated a 6 °C difference between the onset and ending temperatures of the discolouration process. Moreover, the starting temperature of colouration during cooling was found to be 4 °C lower than the ending temperature of discolouration. The sound speed, attenuation, specific heat, thermal conductivity and melting point of the heat-sensitive phantom were statistically equal to those of the reference phantom; however, the latent heat, and onset temperature of the melting of the heat-sensitive phantom were decreased by addition of the dye. CONCLUSIONS: The developed phantom is applicable for accurate evaluation of temperature variations in various thermal modalities.
Keyword:	MRgFUS; radiofrequency; spectrophotometry thermal gels; tissue equivalency
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