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Pilot studies using an ESHO quality assurance phantom for phased-array deep hyperthermia devices

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Introduction
Phantoms for quality assurance (QA) of deep hyperthermia therapy (DHT) devices are not commercially available. In this work, we suggest an easy to build phantom to perform commissioning and regular QA on the performance of DHT phased-array devices.
Methods
The phantom container consists of a 64cm long polyurethane tube with an external diameter of 25cm and a wall thickness of 8 mm, where both ends are sealed with discs. Inside the tube, 3D-printed structures hold 13 catheters spaced by 3 cm and distributed in a cross shape.The central catheter is extended to cover the full length of the container. The phantom is filled with a tissue-equivalent gel. After placing the phantom in the BSD-2000 3D Sigma Eye applicator (Pyrexar Medical, Salt Lake City, USA), a power pulse of 1000W for 10 minutes at 100MHz is applied, with equal amplitudes and phase settings to target the center of the phantom. Temperature is recorded inside the catheters using thermistors provided with the BSD-2000 3D system. A scanning method with a 5mm step is performed for the longitudinal axis measurement. From the longitudinal data, the position of the center and the extension (full width at half maximum, FWHM) of the heated volume is determined.
Results
A maximum temperature rise of $\Delta T=7.6℃$ was measured at the center of the phantom after the 10 minutes power pulse. Along the longitudinal axis, a high-resolution profile is achieved over a length of 60cm. From the longitudinal data the position of the center and the extension (full width at half maximum –FWHM = 32.5cm) of the heated volume can be determined. In the vertical and horizontal directions, only the position of the center is clearly defined by fitting a polynomial curve.
Conclusions
The proposed phantom allows the commissioning of new devices and regular QA measurements for DHT phased-array systems. Fast temperature rise measurements can be used to determine the FWHM in the longitudinal direction and the center of the heating focus in all three spatial directions.

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