QUALITY ASSURANCE PROCEDURES FOR SUPERFICIAL HYPERTHERMIA EQUIPMENT IN AMSTERDAM

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Introduction

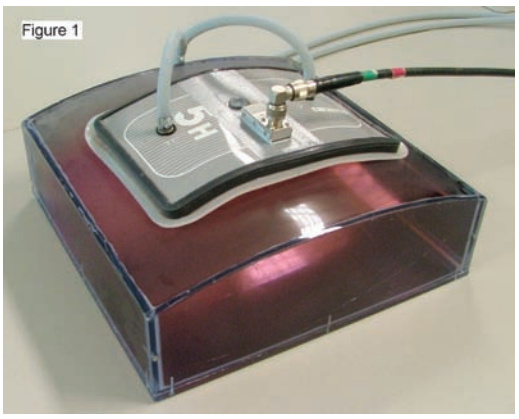
Quality assurance (QA) is essential for reliable clinical application of hyperthermia, and involves both guidelines for treatment delivery and test procedures to check the system operation. Purpose: This paper reports on the development of QA procedures to characterise the performance and stability of our superficial Contact Flexible Microstrip Applicators (CFMA), elaborating on existing ESHO QA guidelines.

Methods

Superficial hyperthermia is given using CFMA applicators with five different sizes (ranging from 5x14 cm to 13x24 cm) operating at 434 MHz and is used for treatment of superficial tumours (melanoma, breast carcinoma). Three aspects of the Specific Absorption Rate (SAR) distribution of the CFMA applicators are tested in various phantom models:

1) *Effective Field Size (EFS)* is the area contained by the 50% SAR contour measured at a depth of 10 mm, this is a measure for the tumour coverage.
2) *Penetration Depth (PD)*: the distance below 10 mm at which the SAR is reduced to 50% of its value at 10 mm depth.
3) *Efficiency*, quantified by the amount of power effectively absorbed in the phantom in relation to the input power.

Two types of QA procedures were developed: The first acceptance requires extensive measurements, periodical repeat tests can be limited to simpler measurements. Action is taken when large deviations are detected.



EFS: The initial test was performed by measuring the E-field distribution 10 mm below the surface in a rectangular tissue equivalent phantom. The repeat test is performed by obtaining the SAR distribution 10 mm below the surface in three different tissue equivalent phantoms, each with a surface with different curvature, measuring the temperature rise after a short power pulse with a thermocouple sheet (fig 1).

PD: The initial test was performed by measuring the E-field distribution in the transversal midplane of a rectangular tissue equivalent phantom. The repeat test simply uses the EFS repeat test to monitor the stability of the PD.

Efficiency was established calorimetrically in both the acceptance and repeat test, by measuring the temperature rise in a well isolated volume of saline after a 10 min power on period, and converting this to the effective output power.

Results

Acceptance and repeat tests are straightforward and easy to conduct. EFS ranges between 60 cm² and 300 cm² for different antennas, with little difference between straight and curved surfaces. Efficiency ranged between 70% and 85%, depending on applicator type.

Conclusion

The AMC superficial QA procedures are easy to perform and provide an accurate impression of the performance and stability of the CFMA applicators used in the AMC. The approach is also applicable for superficial hyperthermia equipment in general.