AbstractID: 3724 Title: Options for SURLAS design modification due to the impact of ultrasound nonlinear propagation.

Purpose:
To study the impact of acoustic nonlinear propagation on the operation of a Scanning Ultrasound Reflector – Linear Arrays System (SURLAS) and determine possible options to modify its existing design.

Method and Materials:
The SURLAS is a superficial ultrasound hyperthermia system for the delivery of simultaneous (and sequential) thermoradiotherapy. Heat is delivered by dual-frequency scanned planar ultrasound while radiation is delivered with external beam radiation. Compatibility between the SURLAS and a Linac requires an applicator design where ultrasound waves (1) are of higher intensity and (2) travel longer distances than usual. Hence, ultrasound waves, especially from a 4.9 MHz array may be affected by nonlinear propagation (i.e., finite amplitude effects) which causes a dramatic increase in ultrasonic attenuation in the water coupling medium inside the applicator. Ultrasound propagation for the SURLAS applicator was analyzed to identify possible options in design modification to minimize the impact of nonlinear propagation on acoustic output.

Results:
Results are given in terms of limits on maximum power output (MPO), maximum traveling distance (MTD), and maximum frequency (MF) that could be used for hyperthermia delivery. The effects of these parameters on the applicator's design and performance, along with options for adjusting its current design, are discussed.

Conclusion:
A compromise must be reached between MTD and MF for a given required MPO. For example, for a typical chest wall for a frequency of 4.9 MHz, the MTD must be < 11.2 cm. If the current distance of 16 cm is kept, the MF must be < 2.15 MHz. In sum, this work suggests potential solutions for the SURLAS applicator design for specific treatment sites in order to provide sufficient and sustainable heating of tissue during simultaneous thermoradiotherapy.

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