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26. Measurement of the output of transvaginal probes and correlation with temperature variation in a phantom test

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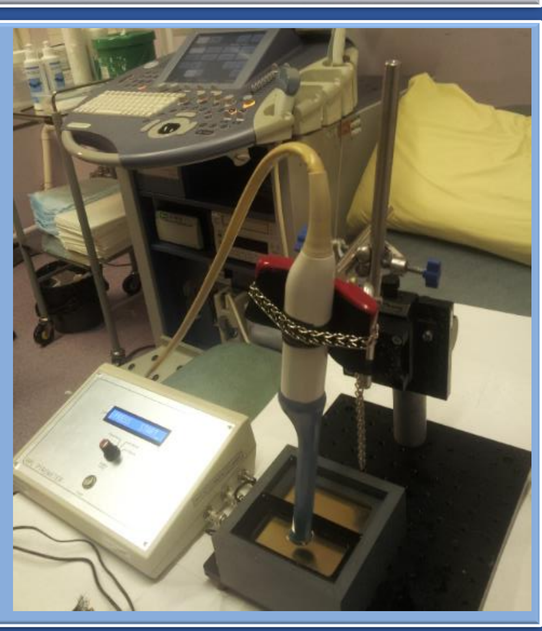
Background

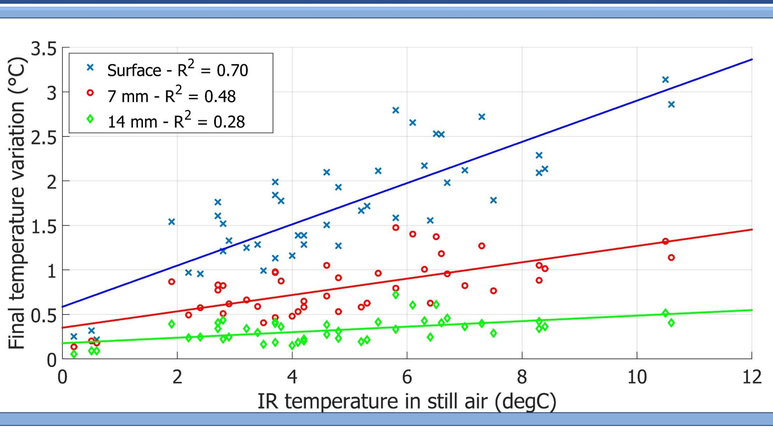
The Thermal Index (TI) is commonly used as an indicator for the assessment of the thermal hazard. TI definition and the methods for its evaluation are reported in the IEC standard 62359 [1]. However, use of TI has been criticized for being too simplistic, not taking into account, for example, the spatial and temporal distribution of heat deposition and transducer self-heating [2]. This latter aspect can be the dominant source of thermal hazard during endocavitary scans.

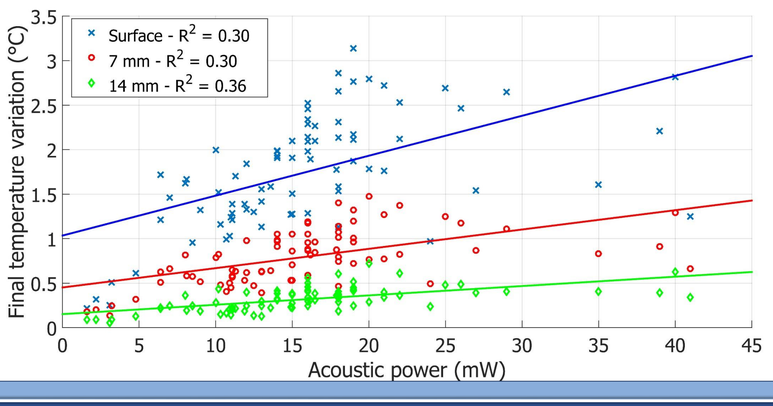
Method

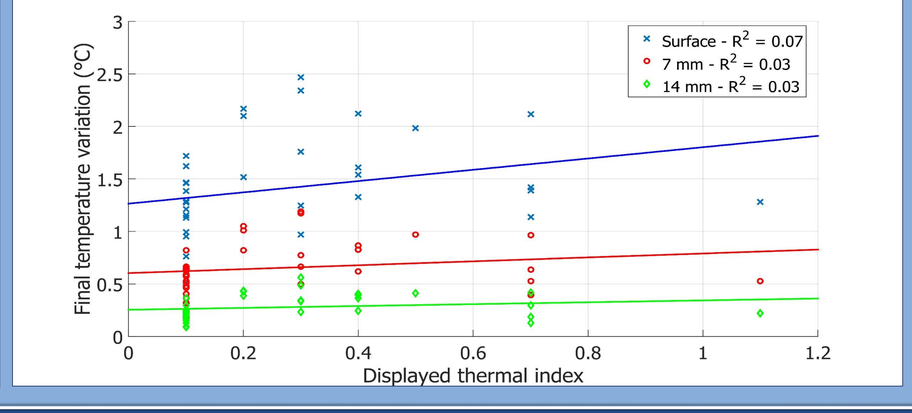
32 different transvaginal probes from 5 manufacturers were tested in 17 hospitals. The surface temperature with the probe operating in air was measured using an infrared camera and the acoustic output power was measured using the NPL Pyrometer. The results were correlated with temperature variation measured in a phantom, reported in a previous work [3].



Results







When B-mode was activated for gynaecology and obstetrics pre-sets, the average temperature rise at equilibrium for the probe in air was 5.5 °C (max 12.5 °C). An average output power of 16.1 mW (max 41 mW) was measured. The results were compared with the temperature after a 15 minutes exposure in the phantom experiments, with the thermocouples at the surface, 7 and 14 mm in tissue. Coefficients of correlation were evaluated for the experiments and for the TI, when available. Goodness of fit decreases with depth using infrared data and increases when output power is used, suggesting that absorption plays a more important role deeper in tissue.

Conclusions

Both probe temperature in air and measured acoustic output power were better predictors than TI for the equilibrium temperature in phantom tests. Moreover, TI tends to underestimate the temperature increase, in particular close to the surface.

Department for Business, Energy & Industrial Strategy

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[1] IEC 62359:2010 Ultrasonics - Field characterization - Test methods for the determination of thermal and mechanical indices related to medical diagnostic ultrasonic fields
[2] Shaw A, Pay NM and Preston RC. Assessment of the likely thermal index values for pulsed Doppler ultrasonic equipment – stages II and III: experimental assessment of scanner/transducer **c**ombinations. NPL REPORT CMAM 12, 1998.
[3] P. Miloro, E. Martin and A. Shaw, “Temperature elevation measured in a tissue-mimicking phantom for transvaginal ultrasound at clinical settings.,” *Ultrasound,* 2016.