Optimisation of ultrasound equipment using a phantom as part of an-Annual Quality Assurance (QA) Program.

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Introduction

The UHL Ultrasound Physics annual Quality Assurance (QA) Programme performs a complete set of tests using a test phantom to check for deterioration of equipment performance. However, this testing does not optimise scanner pre-sets for clinical applications. Here we present an alternative QA approach, where an ultrasound phantom was used to characterise the performance of ultrasound probes used for vascular applications to optimise pre-set scanning settings. This enables practitioners to achieve the best resolution achieved by their equipment and provides measurements quantifying the uncertainty of measurement parameters.

Method

Several GE Logic E9 ultrasound machines (n=4) with their probes (Model: L9, C1-6, ML6-5, L8-18i) were individually tested. Settings, including pre-set application, gain, focus, TGC and probe working frequency, were optimised to achieve the best quality image. Resolution testing was undertaken by the UHL Medical Physics staff, with pre-set optimization aiming to visualise the best axial and lateral resolution, based on consensus from 3 AVS clinical vascular scientists scanning an ultrasound tissue-mimicking ultrasound phantom (CIRS Multi-Purpose Multi-Tissue Ultrasound Phantom Model 040GSE) (Fig.1). Testing was performed under normal ultrasound room conditions with dimmed lighting and reference images saved to PACS. Caliper accuracy was routinely checked, and annual QA was performed with specific attention to the most detailed measurements performed clinically (for temporal artery imaging using a L8-18 hockey-stick probe).

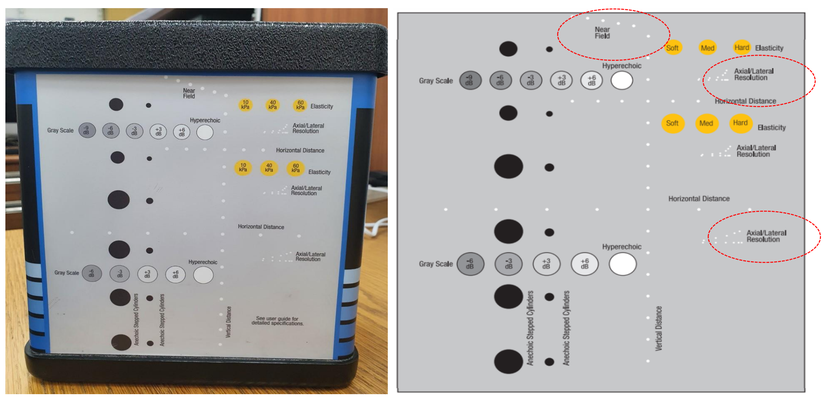

Figure 1. A CIRS Multi-Purpose Multi-Tissue Ultrasound Phantom was used to optimise ultrasound equipment for vascular applications.

Results

Optimised settings for each GE Logic E9 ultrasound machine and probes were recorded and saved as pre-sets for routine clinical use. Recording the specific axial and lateral resolutions at these settings, enabled the resolution achieved at each pre-set to be quantified. This ensures that clinically significant small measurements fall within an achievable resolution range (Fig.2).

Probe	Ultrasound Pre-Set	Axial resolution	Lateral resolution	Depth of measurement
L9	LEA	0.25 mm 0.5 mm	1 mm 1 mm	3 cm 6.5 cm
ML6-15	LEV	0.25 cm 0.25 cm	0.5 cm 0.25 cm	3cm 6.5 cm
C1-6	EVAR	1 mm 1 mm	2 mm 3 mm	6.5 cm 10.5cm
L8-18i	Temp A	0.25 mm	0.5 mm	3 cm

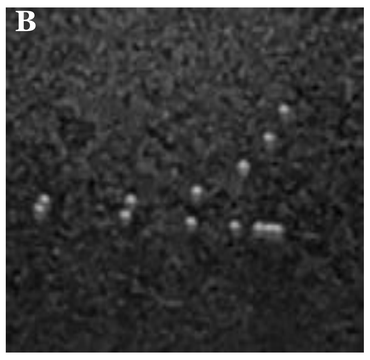

Figure 2 Table with axial and lateral resolution results obtained after optimisation of settings for individual probes for a GE Logic E9 scanner (A). Image of axial and lateral resolution results obtained for an LE8-18 I transducer (B).

For reporting caliper measurements, the unit of measurement (and number of decimal places reported) needs to take into account the resolution of the probe with correct rounding up or down of readings. The standard deviation of measurements (calculated from UHL's annual probe QA for calipers) was smaller than the reported unit of measurement. Therefore, it was not significant to affect accuracy when using standard rounding up or down techniques (Fig.3).

Scan Measurement Pre-Set	Probe	Caliper Units	MOU Standard Deviation
Temporal Arteries	L8-18	0.00 mm	±0.1 mm
Leg Vein	L6-15	0.0 mm	±0.4 mm
Leg Vein	L9	0.0 mm	±0.2 mm
Carotid	L9	0.0 cm	±0.02 cm
Leg Arterial	L9	0.0 cm	±0.02 cm
EVAR / AAA	C1-6	0.0 cm	±0.02 cm

Figure 3 Results of Measurement of Uncertainty (MOU) for caliper accuracy.

Optimisation of ultrasound equipment as part of the annual QA program performed by the Medical Physics Department contributed to the Leicester Vascular Studies Unit receiving Improving Quality in Physiological Services (IQIPS) accreditation (Fig.4).

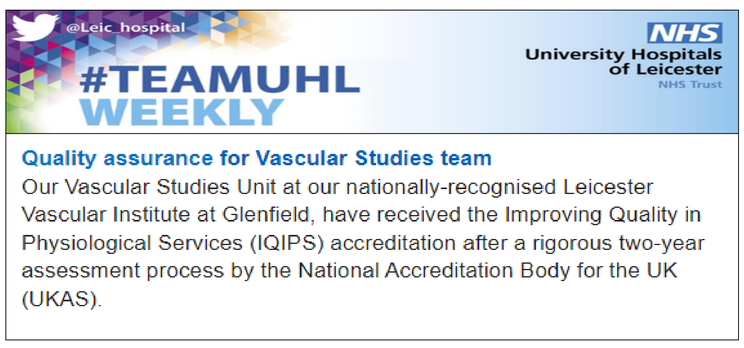

Figure 4 Improving Quality in Physiological Services (IQIPS) accreditation received by the UHL Vascular Studies Unit.

Conclusions

An ultrasound phantom can be a useful tool for helping to achieve the best performance of the ultrasound system and ensure that units in clinical measurements are achievable, with a known value for the uncertainty of measurement, therefore improving the quality of diagnostic services provided to patients.

ACKNOWLEDGEMENT

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References:

1. Multi-Purpose, Multi-Tissue Ultrasound Phantom, Model 040GSE. User Guide. CIRS