KEY PUBLICATIONS

Ultrasound QA

References

A Comparative Study on a Novel Quality Assessment Protocol Based on Image Analysis Methods for Color Doppler Ultrasound Diagnostic Systems

Fiori G, Pica A, Sciuto SA, Marinozzi F, Bini F, Scorza A. A Comparative Study on a Novel Quality Assessment Protocol Based on Image Analysis Methods for Color Doppler Ultrasound Diagnostic Systems. *Sensors*. 2022; 22(24):9868. https://doi.org/10.3390/s22249868

- Utilizes the Doppler 403TM flow phantom as the basis for developing a worldwide standard for Doppler Equipment Testing.
- "The reference test device is constituted by a horizontal and diagonal vessel of known and constant cross-sectional area filled with blood-mimicking fluid. The flow rate can be adjusted to provide constant or pulsatile flows in the range of 1.7–12.5 mL·s−1."
- "Each QC parameter investigated in this study and described in the following subsection was tested at three distinct flow rate regimes (low QL, medium QM, and high QH) set on the Doppler phantom."
- "Since Color Doppler is among the most used and widespread Doppler techniques in diagnostic imaging, the need for an internationally accepted quality standard for Doppler equipment is deemed important."

Summary: "This study demonstrates how the Doppler 403 Phantom provides the stability, acoustic realism, and geometric precision required for rigorous Doppler QA. Serving as the foundational reference in a validated assessment protocol, the Doppler 403 enables reproducible measurements across systems and institutions – making it an essential tool for physicists responsible for acceptance testing, routine QA, and Doppler performance standardization."

Correlation-based Doppler-angle estimation with plane-wave excitation

Lok U-W, Lin F-Y, Yeh C-L, Li P-C. Correlation-based Doppler-angle estimation with plane-wave excitation. *Informatics in Medicine Unlocked*. 2020;19:100315. doi:10.1016/j.imu.2020.100315

- Mini-Doppler 1430, Gammex, Middleton, WI, USA.
- "Conventional Doppler imaging does not provide angle information, which makes it difficult to obtain flow information, especially for lateral flows. A correlation-based transit-time approach has been developed for estimating the Doppler angle under the framework of a focused-beam architecture, which has a fast computation capability."
- "The effect of the number of ensembles was assessed with the flow rate in the phantom set as 24 cm/s, while the effect of flow rate was assessed using flow rates of 15, 24, 31, and 39 cm/s."

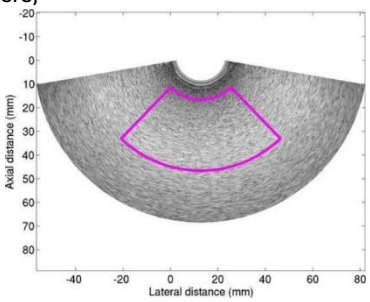
- "Simulations with constant flows were conducted to demonstrate the feasibility of the proposed methods. In addition, flow-phantom experiments with different numbers of ensembles and flow rates were used to demonstrate the feasibility of the proposed method, as well as determine the computation times for each estimation approach using MATLAB."

Summary: "By leveraging the Mini-Doppler 1430 Phantom in a peer-reviewed evaluation of plane-wave Doppler angle estimation, this study shows that a compact, tissue-mimicking flow phantom can serve as a reliable, reproducible benchmark — enabling quantitative performance assessment and standardization of Doppler workflows."

A Phantom-based Assessment of Repeatability and Reproducibility of Transvaginal Quantitative Ultrasound

Chen S, McFarlin BL, Meagher BT, et al. A Phantom-Based Assessment of Repeatability and Reproducibility of Transvaginal Quantitative Ultrasound. *IEEE Trans Ultrason Ferroelectr Freq Control*. 2019;66(9):1413-1421. doi:10.1109/TUFFC.2019.2921925

- Uses custom Zerdine ultrasound phantom for transvaginal quantitative ultrasound analysis.
- "The total R&R variabilities for AC and logBSC are small (AC: 0.042 ~ 0.065 dB/cm-MHz; logBSC: 0.50 ~ 0.68 dB), indicating high measurement precision."
- "The AC and logBSC biomarkers measured on transvaginal QUS phantoms using the reference phantom method are repeatable, and reproducible between sonographers, transducers, and probe covers."
- "Using phantoms removes biological variability, enabling objective evaluation of imaging system performance."



Summary: "Zerdine® Ultrasound Phantoms deliver the stability and acoustic precision needed for repeatable, reliable quantitative ultrasound. Validated in peer-reviewed studies, Zerdine provides a consistent, tissue-mimicking standard that helps medical physicists optimize protocols, ensure system performance, and confidently compare results across scanners and sites."

Repeatability of shear wave elastography in liver fibrosis phantoms – Evaluation of five different systems

Mulabecirovic A, Mjelle AB, Gilja OH, Vesterhus M, Havre RF. Repeatability of shear wave elastography in liver fibrosis phantoms-Evaluation of five different systems. *PLoS One*. 2018;13(1):e0189671. Published 2018 Jan 2. doi:10.1371/journal.pone.0189671

- Uses the Model 039 Shear Wave Liver Fibrosis Phantoms: "all systems used in this study provided high repeatability in quantitative measurements in a liver fibrosis phantom and excellent inter- and intra-observer correlations."
- "All four liver fibrosis phantoms could be differentiated by quantitative elastography, by all platforms ($p < 0.001$)."

- "Excellent intra- and interobserver agreement (interclass correlation 0.981–1.000 and intraclass correlation 0.987–1.000)."

- "Coefficient of variation in the range 0.00–0.21 for all four phantoms, equivalent to low variance and high repeatability."

Summary: "The Model 039 Shear Wave Liver Fibrosis Phantom provides a certified, tissue-mimicking elasticity standard with multiple stiffness levels that enables reproducible shear-wave speed measurements. As demonstrated in peer-reviewed repeatability studies, Model 039 offers the stability and realism required for dependable elastography QA, longitudinal monitoring, and cross-system standardization."

A Comparative Study on the Influence of Probe Placement on Quality Assurance Measurements in B-mode Ultrasound by Means of Ultrasound Phantoms

Scorza A, Conforto S, D'Anna C, Sciuto SA. A Comparative Study on the Influence of Probe Placement on Quality Assurance Measurements in B-mode Ultrasound by Means of Ultrasound Phantoms. *Open Biomed Eng J*. 2015;9:164-178. Published 2015 Jul 31. doi:10.2174/1874120701509010164

- Two Point Spread Function (PSF) Phantoms models are used for image quality assessment of a real time B-mode scanner, GAMMEX 405 GSX LE (phantom A) and GAMMEX 1425A (Phantom B).

- [The assessment] "confirms some predictions based on general working principles of diagnostic ultrasound systems: (a) measurements strongly depend on settings as well on phantoms features, probes and parameters investigated; (b) relative uncertainty due to probe manipulation on spatial resolution can be very high, i.e. from 10 to more than 30 percent; (c) Field of View settings must be taken into account for measurement reproducibility as well as Dynamic Range compression and phantom attenuation."

- "For the convex array transducer, the differences between tests in horizontal distance can be attributed to phantom tissue mimicking material and mostly to FoV settings, because it influences mm to pixel ratio (i.e. scale factor) and the distortion of imaged nylon wires sections."

- "For both convex and linear arrays the differences among test results seem to depend significantly on phantom tissue mimicking material, Dynamic Range and Field of View settings. Phantom attenuation is related to pin target visibility over the background speckle, that influences uncertainty in parameter measurement, i.e. distance accuracy, spatial resolution."

Summary: "By combining the 405 GSX LE and 1425A phantoms, this study demonstrates a comprehensive, reproducible QA methodology — one that captures both grayscale spatial/contrast fidelity and flow/target-based image performance. This dual-phantom approach enables quantification of imaging variations due to probe placement, ensuring that ultrasound systems deliver consistent, high-quality images regardless of operator or scan conditions."

Comparison of ultrasound quality assurance phantom measurements from matched and mixed scanner-transducer combinations

Tradup, D.J., Hangiandreou, N.J. and Taubel, J.P. (2003), Comparison of ultrasound quality assurance phantom measurements from matched and mixed scanner-transducer combinations. Journal of Applied Clinical Medical Physics, 4: 239-247. https://doi.org/10.1120/jacmp.v4i3.2521

- Compares results of common QA tests made using matched and mixed ultrasound scanner-transducer combinations, utilizing the Model 405GS LE, Gammex RMI, Middleton, WI. Ten matched and ten mixed ultrasound scanner-transducer combinations.

- "Our basic QA phantom tests include a visual evaluation of image uniformity and quantitative evaluations of vertical distance accuracy, horizontal distance accuracy, and maximum depth of penetration. The complete set of QA tests is performed for each multifrequency transducer using two different frequencies every six months."

- "Considering all of the match and the mix data for all three measurements, and all transducers and frequencies, we conclude that the mix and match data are very comparable."

Summary: "The 405GS Ultrasound Phantom delivers the tissue realism, spatial and depth-target accuracy, and phantom-stability required for standardized B-mode QA. Peer-reviewed data show that QA metrics derived from this phantom remain consistent and statistically comparable even when transducer-scanner pairings vary — enabling flexible, efficient, and reliable QA across diverse scanner–transducer pools."