Microscopic time-harmonic elastography in correlation with biophysical properties of liver tumors in vivo

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Theme: Mechanics/tissue structure

During the second BIOQIC cohort, we developed a new imaging modality for measuring soft tissue stiffness at the micrometer scale. This optical-based time-harmonic elastography (OTE) measures field components of harmonic deflections by optical flow methods and converts them into stiffness maps using exactly the same inversion algorithms developed for magnetic resonance elastography (MRE). As a result, stiffness values measured with OTE are directly comparable to those measured with MRE, bridging orders of magnitude of length scales (µm pixel size for OTE while mm pixel size for MRE) as well as dynamic ranges (20 to 60 Hz for in vivo MRE while up to 6000 Hz for OTE). Figure 1 shows a representative elastogram of a zebrafish larva generated with OTE based on harmonic frequencies in the range between 900 and 2400 Hz and reconstructed using a multifrequency inversion method of MRE. We plan to translate this technique into clinical applications for resected tissue samples from liver metastases and primary tumors. We hypothesize that cancer cell viability after chemotherapy is significantly correlated with tissue biomechanical properties. If true, one could quantify the therapeutic success of cancer treatment based on changes in mechanical properties of biopsy specimens directly comparable to in vivo MRE before surgery. This will pave the way for the clinical use of OTE as a quantitative ex vivo method along with MRE as a non-invasive imaging tool for evaluating treatment success in liver metastases and tumors.

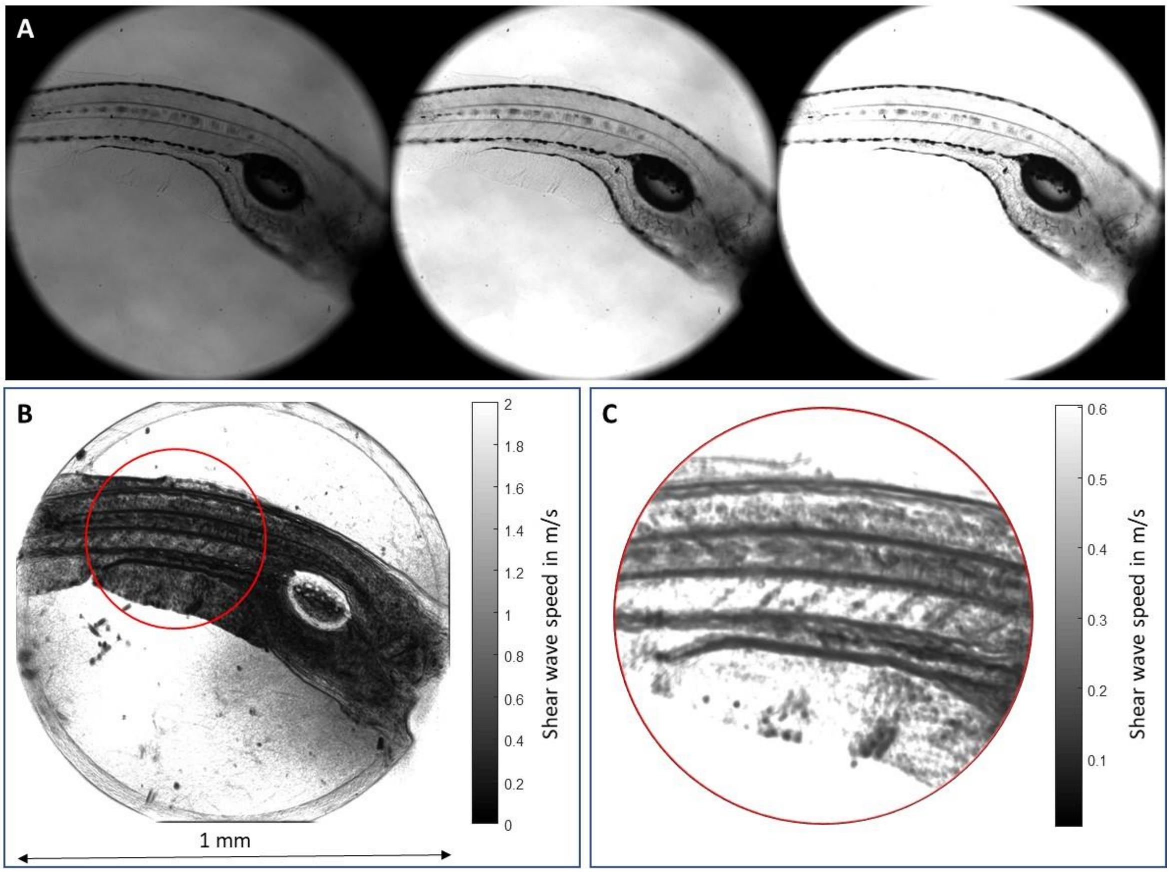

Figure 1: OTE in a zebrafish larvae. A: snapshot optical microscopy images at three different exposure times which are later combined to a HDR image. B: Shear wave speed map (elastogram) of the fish shown in A. C: zoom in of details of stiffness from the area demarcated by the red ring in A.

Please contact Ingolf Sack (ingolf.sack@charite.de) for any further questions on this project.