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The objective measurement of tissue pathological state by medical imaging plays an increasing role in clinical practice. The ultrasound imaging modality offers dedicated solutions based on image-derived quantitative measurements for evaluating a variety of diseases in cardiology, radiology and oncology. Our presentation will show three solutions developed by Toshiba for quantifying myocardial contractility, liver fibrosis and tumor perfusion, respectively.

The first part of the presentation will demonstrate a solution for quantification of left ventricular contractility, which is an important clinical indicator of the cardiac function. To quantity regional motion abnormalities, a 3D wall motion tracking technique was implemented in an analysis software application. The technique tracks the speckle pattern, frame-by-frame, over a cardiac cycle to calculate a field of motion vectors in 3D. This field is then processed to measure clinical parameters, such as strain values in different directions (longitudinal, circumferential and radial) and volumetric values (left ventricle ejection fraction).

The second part of the presentation will demonstrate a solution for evaluating liver fibrosis. Tissue characterization consists in differentiating subtle changes in ultrasound speckle patterns, indicative of the tissue microstructures, which remain non perceptible to human visual inspection. The solution, named Acoustic Structure Quantification (ASQ), was developed to quantify the homogeneity of the speckle pattern using the probability function (PDF) of the echo amplitude in a region of interest. The PDF is estimated using a modified chi-square distribution. The peak value of that distribution was found to be a promising quantitative parameter to distinguish fibrotic tissue from normal tissue in liver.

The last part of the presentation will describe a solution for quantifying perfusion using dynamic contrast enhanced ultrasound (D-CEUS). The technique utilizes an intravenous injection of microbubble contrast agent, which supports ultrasound imaging of macro-vascularization. The D-CEUS technique is a promising application for monitoring tumor response to cancer therapies. Our approach uses a mathematical function to model the contrast uptake (or time-intensity-curve) in a region of interest outlining a tumor. From that function, quantitative parameters are derived that are indicative of blood flow dynamics, which vary during the course of the therapy.