New ultrasound device may add in detecting risk for heart attack, stroke

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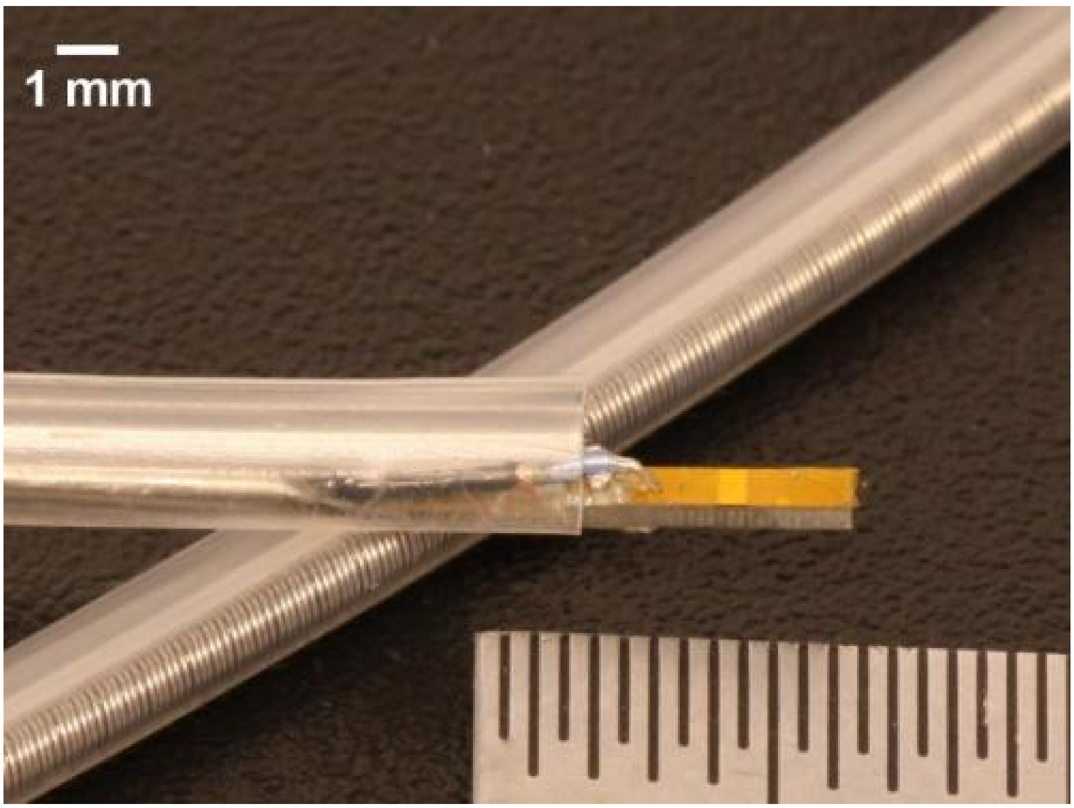

Researchers from North Carolina State University and the University of North Carolina at Chapel Hill have developed an ultrasound device to help identify arterial plaque that is at high risk of breaking off and causing heart attack or stroke. Credit: Xiaoning Jiang, North Carolina State University

Researchers from North Carolina State University and the University of North Carolina at Chapel Hill have developed a new ultrasound device that could help identify arterial plaque that is at high risk of breaking off and causing heart attack or stroke.

At issue is the plaque that builds up in arteries as we age. Some types of plaque are deemed "vulnerable," meaning that they are more likely to detach from the artery wall and cause heart attack or stroke.

"Existing state-of-the-art technologies are capable of determining if plaque is present in the arteries, but can't tell whether it's vulnerable. And that makes it difficult to assess a patient's risk," says Dr. Paul Dayton, co-author of a paper on the new device and professor in the joint biomedical engineering department at NC State and Chapel Hill. "Our goal was to develop something that could effectively identify which plaques are vulnerable."

There are two ultrasound techniques that can help identify vulnerable plaques, but both depend on the use of contrast agents called "microbubbles."

The first technique is to identify "vasa vasorum" in arteries. These are clusters of small blood vessels that often infiltrate arterial plaque, and which are considered indicators that a plaque is vulnerable. When microbubbles are injected into an artery, they follow the flow of the blood. If vasa vasorum are present, the microbubbles will flow through these blood vessels as well, effectively highlighting them on ultrasound images.

The second technique is called molecular imaging, and relies on the use of "targeted" microbubbles. These microbubbles attach themselves to specific molecules that are more likely to be found in vulnerable plaques, making the plaques stand out on ultrasound images.

"The problem is that existing intravascular ultrasound technology does not do a very good job in detecting contrast agents," says Dr. Xiaoning Jiang, an NC State associate professor of mechanical and aerospace engineering, an adjunct professor of biomedical engineering and co-author of the paper.

"So we've developed a dual-frequency intravascular ultrasound transducer which transmits and receives acoustic signals," Jiang says. "Operating on two frequencies allows us to do everything the existing intravascular ultrasound devices can do, but also makes it much easier for us to detect the contrast agents – or microbubbles – used for molecular imaging and vasa vasorum detection."

The prototype device has performed well in laboratory testing, but the researchers say they are continuing to optimize the technology. They hope to launch pre-clinical studies in the near future.

More information: "A preliminary engineering design of intravascular dual-frequency transducers for contrast enhanced acoustic angiography and molecular imaging", Jianguo Ma and Xiaoning Jiang, North Carolina State University; Heath Martin and Paul A. Dayton, North Carolina State University and the University of North Carolina at Chapel Hill, Published: May 2014, *IEEE Transactions on Ultrasonics, Ferroelectrics, and Frequency Control*.

Abstract
Current intravascular ultrasound (IVUS) probes are not optimized for contrast detection due to their design for high-frequency fundamental mode imaging. However, data from transcutaneous contrast imaging suggests the possibility of utilizing contrast ultrasound for molecular imaging or vasa vasorum assessment to further elucidate atherosclerotic plaque deposition. This paper presents the design, fabrication, and characterization of a small aperture (0.6 x 3 mm2), IVUS probe optimized for high-frequency contrast imaging. The design utilizes a

dual-frequency (6.5 MHz/30 MHz) transducer arrangement for exciting microbubbles at low frequencies (near their resonance) and detecting their broadband harmonics at high frequencies, minimizing detected tissue backscatter. The prototype probe is able to generate nonlinear microbubble response with more than 1.2 MPa of rarefractional pressure (mechanical index: 0.48) at 6.5 MHz, and also able to detect microbubble response with a broadband receiving element (center frequency: 30 MHz, -6 dB fractional bandwidth: 58.6%). Nonlinear super-harmonics from microbubbles flowing through a 200 ?m diameter micro-tube were clearly detected with a signal-to-noise ratio higher than 12 dB. The preliminary phantom imaging at the fundamental frequency (30 MHz) and dual frequency super-harmonic imaging results suggest the promise of small aperture, dual-frequency IVUS transducers for contrast enhanced IVUS imaging.

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