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“Central Blood Pressure Waveform Monitoring by Conformal Ultrasonic Devices”

Abstract: Monitoring of central blood pressure (CBP) waveform from deeply embedded vessels, such as the carotid artery and jugular vein, has significant clinical values due to their proximity to the heart. The CBP waveform has a direct relationship with the cardiovascular status such as the atrial, ventricular, and valvar activities on both left and right sides. The most accurate method for measuring CBP, namely cannulation, is too invasive to allow frequent measurements, even though it is crucial for many conditions related to all-cause cardiovascular mortality prediction. Existing non-invasive solutions, including photoplethysmography (PPG) and tonometry, have significant challenges to provide accurate and reliable measurements on blood vessels that are deep underneath the skin. Here, we demonstrate a skin-integrated conformal ultrasonic device that overcomes all these limitations by combined strategies of material design and advanced microfabrication. This conformal probe has an ultrathin profile (240 μm in thickness), a high reversible stretchability (60%), and a comparable axial resolution (400 μm) with commercial transducers. This study demonstrates the first conformal electronics capable of launching ultrasonic waves that penetrate into deep biological tissues (>4 cm) in a gel-free manner, and acquiring accurate CBP waveforms at deeply embedded arterial and venous sites to monitor cardiovascular events. Also, this is the first conformal device that enables observing the prominent pressure amplification caused by progressive increase in vessel stiffness along the arterial tree, by comparing the captured peripheral blood pressure (PBP) with the CBP waveforms. Additionally, this device allows correlating the blood pressure (BP) waveforms at different locations of the body with a simultaneous electrocardiogram (ECG) to evaluate arterial stiffness along conduit arteries. Collectively, this opens up extensive opportunities for continuous and accurate deep tissue diagnosis and prognosis using non-invasive wearable electronics.

Biosketch: Mr. Chonghe Wang obtained his B.E. in Structural Engineering from Harbin Institute of Technology, China, in 2016, where he focused on ultrasonic non-destructive evaluation algorithms. He is currently a graduate student researcher in the department of NanoEngineering at the University of California, San Diego, under the supervision of Prof. Sheng Xu, where he developed ultrasonic technology based skin-integrated wearable electronics for hemodynamic monitoring. His first author research manuscript was submitted and under revision by *Nature biomedical engineering* (2nd round of revision). Other co-first author works were published/ accepted in *Science Advances* (research article) and *Advanced Materials* (Invited review article). His research interest includes soft bio-electronics and translational medical devices.