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Abstract

A microfluidic-based sensor with a built-in probe for conformal mechanical measurements of different anatomical sites at the exterior surface of human Pectus Carinatum (PC) costal cartilage

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Abstract:

This study aims to measure the viscoelastic properties of different anatomical sites at the exterior surface of human Pectus Carinatum (PC) costal cartilage (CC) tissues via a microfluidic-based sensor, and determine whether the viscoelastic properties show a link with the anatomic sites and the cartilage length. Five CC segments from the 7th ~ 10th ribs are obtained from a 15yr-old PC patient. Using a testing protocol of multiple indentation-relaxation steps, four anatomical sites: anterior/posterior surfaces and superior/inferior borders are measured at locations of 6mm apart along the length of each CC segment. The instant indentation modulus and normalized relaxation amount are derived from the recorded viscoelastic response to quantify the elasticity and viscosity at each measured site of the CC segments, respectively. These CC segments are found to be stiffer and less viscous than healthy porcine CC. The normalized relaxation amount reveals a decreasing trend with the indentation depth in the range of 80μm~240μm, but becomes stabilized in the indentation range of 240μm~480μm for all the CC segments. Overall, the anterior surface is stiffer than the posterior surface, which is opposite to porcine CC and is possibly due to different gravitational forces acting on them. For all the CC segments, the instant indentation modulus and normalized relaxation amount both reveal a considerable, random variation among the four anatomical sites at the same location. However, the average instant indentation modulus and average normalized relaxation amount from the four sites at the same location both do not change much along the cartilage length, indicating that the rest anatomical sites might adjust to accommodate the change at one anatomical site. Only one of the segments show a decreasing trend of instant indentation modulus along the cartilage length and exhibits mild variation in elasticity and viscosity among the four sites and along the cartilage length.

Biography:

Jiayue Shen received her Ph.D. degree from Old Dominion University, Department of Aerospace and Mechanical Engineering in 2018. During the same year, she joined the College of Engineering, SUNY Polytechnic Institute as an Assistant Professor. Her research interests focus on flexible electrodes, microfluidic-based sensors, soft robots and related applications. She has published more than 16 journal papers and conference proceedings and has been serving as reviewers for various journals and international conferences. Additionally, she has been serving as a conference committee member of 2019 2nd International Conference on Smart Sensing and Intelligent System as well.

Recent Publications:

1. Jiayue Shen, Michael Stacey, and Z. Hao (2018). A Distributed-deflection Sensor with a Built-in Probe for Conformal Mechanical Measurements of Costal Cartilage at Its Exterior Surface. IEEE Sensors Journal 18(2):822-829.

2. Dan Wang, Jiayue Shen, Lanju Mei, Shizhi Qian, Jiang Li and Zhili Hao (2017). Performance Investigation of a Wearable Distributed-Deflection Sensor in Arterial Pulse Waveform Measurement. IEEE Sensors Journal 17(13):3994-4004.

3. Jiayue Shen, Wenting Gu, Xavier-lewis Palmer, and Zhili Hao (2015). Synchronized Heterogeneous Indentation Behavior of Viscoelastic Materials Upon Macroscopic Compression via a Distributed-Deflection Sensor. IEEE Sensors Journal 15: 6524-6533.

4. Wenting Gu, Jiayue Shen, Yichao Yang, and Zhili Hao (2015). Dynamic characterization of a polymer-based microfluidic device for distributed-load detection. Sensors and Actuators A: Physical 222:102-113.

5. Jiayue Shen, Peng Cheng, Wenting Gu, and Zhili Hao (2013). Stress relaxation measurement of viscoelastic materials using a polymer-based microfluidic device. Sensors and Actuators A: Physical 203: 119-130.

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