Microfluidic Generation of Alginate Beads to Quantify Intra-Tumoral Compressive Stress

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Abstract

Cancer progression is highlighted by the emergence of aberrant mechanical features in the tumor microenvironment that present pathological signals to drive tumor malignancy. Alterations to extrinsic signals such as tumor ECM stiffness and composition have been well described; however, the development of solid stresses *within* the tumor and its effect on tumor evolution is poorly understood. Recent reports have suggested that intra-tumoral stress guides cancer cell escape from tumors, highlighting an emergent mechanobiological driver of cancer progression; however, these aspects are difficult to investigate with standard *in vitro* tools and requires the development of advanced biophysical tools. To address this, we have developed a microfluidic platform that generates deformable alginate microbeads that are able to quantify compressive stresses generated within a growing glioblastoma (GBM) tumorsphere. PDMS microfluidic devices were fabricated via SU-8 mold with channels ranging from 10µm-40 µm in diameter. Fluorescently labeled sodium alginate underwent a cross-linking reaction within the device to generate monodisperse beads proportional to the channel size. Physical characterization of microbeads included the following: ImageJ particle analysis to calculate average diameter and atomic force microscopy to calculate elastic modulus. Microbeads were subsequently embedded into GBM tumorspheres, and their deformation was tracked longitudinally. Stress distributions are extracted via 2D axisymmetric finite element-based models.

Biography of Presenter:

Zachary P. Fowler is a current graduate student at the University of Louisville in the Department of Bioengineering. He received his B.S. in Bioengineering in 2022 and is a member of the Biomedical Engineering Society (BMES). He has worked as a biomedical researcher for over two years, gaining experience in microfluidics, ultrastructural analysis, tissue decellularization, fluorescent microscopy, scanning electron microscopy, and ultrasonic scattering and has presented his work at national conferences including BMES 2022. He has worked for campus housing as a resident assistant as well as a medical scribe in the Norton Hospital system, and currently works as a graduate assistant in the Department of Engineering Fundamentals.