Lung tissue biopsy dissociation device

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Asthma is a disease that affects approximately 1 in 12 people in the U.S. and has an economic cost of about 56 billion dollars each year. Understanding the mechanisms behind the asthmatic response is crucial for the development of new treatments to increase patients' quality of life. Dr. Sameer Mathur, an allergist and immunologist, has interests in eosinophil immunoregulatory activity and conducts asthma research. His lab obtains small lung tissue biopsies from human subjects with asthma. Current devices for tissue dissociation are designed for larger tissue specimens and do not work with the biopsies obtained for Dr. Mathur's lab, hindering their research. To advance his work, Dr. Mathur has tasked the team to develop a smaller scale device that can dissociate biopsy sized tissue (1-2 mm^3).

The current device used, the gentleMACS™ Dissociation Device, does not reliably dissociate the small 1-2 mm^3 tissue biopsy samples that Dr. Mathur receives. Other researchers have tried to overcome this restraint by creating their own dissociation devices. Two important designs that have been used to inspire this team's design include a tumor aggregate dissociator that utilizes shear force in a microfluidic device and a neuron tissue dissociator that uses multi-directional oscillating fluid flow.

The major design goal is to dissociate 10,000 cells from the tissue. To accomplish this, the proposed design consists of 3D printed channels that are narrow in the middle and wide at the ends. After a 45 minute enzymatic (collagenase) digestion, the tissue sample is loaded into one side of the device and a peristaltic pump is used to force fluid over the tissue through the channels which creates shear forces that will separate cells from the ECM. The device was fabricated using a Viper SLA 3D printer at the Morgridge Fab Lab to create high resolution channels within the device. The device is layered with two silicone gaskets and an acrylic lid is placed on top and clamped to create a seal.

We have extensively tested our device with frozen murine lung tissue. The first round of testing validated that cells do not adhere to the surface of the device. The second round of testing demonstrated that cells can be dissociated from the frozen lung tissue. A third round of testing with fresh tissue showed that tissue can be successfully dissociated in this device. Future testing will include the characterization of the cells obtained from dissociation. Fresh human tissue will eventually be used to validate these results.

We have seen successful dissociation with this device with a yield of about 100,000 cells per tissue sample. If we are able to characterize the cells in future testing, we see strong potential for this device to provide a solution to the client's problem. We feel that this device can be useful in multiple fields of research that rely on tissue dissociation as a means of analyzing cells at high resolution. If this device is successful in future testing and we are able to obtain repeatable results, there is potential for the integration of this device with various tissue types.