A mobile microscopy and microfluidic platform for sickle cell disease screening

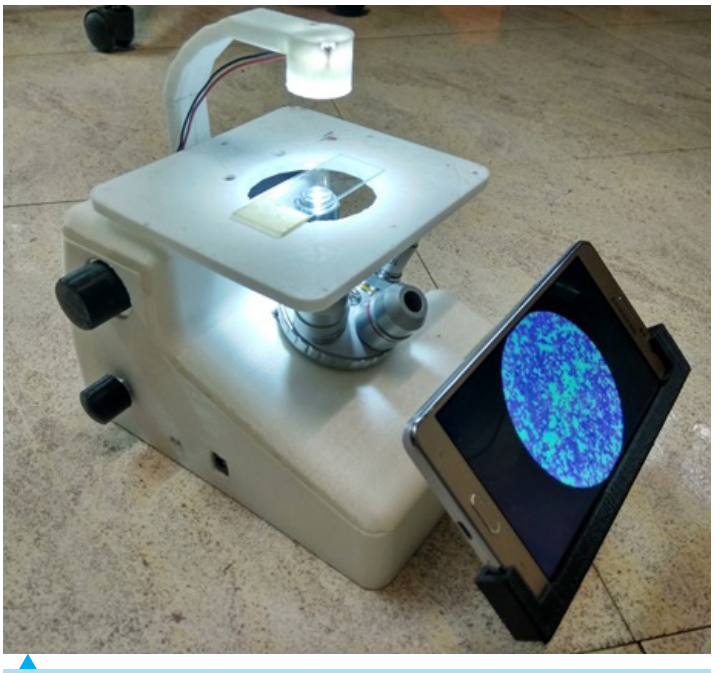

Fig. 1: Mobile microscopy and microfluidic platform developed

Sickle cell disease is an inherited blood disorder that affects the red blood cells (RBCs). A mutation alters the hemoglobin present inside the RBCs. As a result, normally biconcave and deformable RBCs become stiff and sickle-shaped leading to blockage of blood vessels, recurrent pain, and other related complications. Since there is no cure at the moment, patients have to learn different techniques to manage the disease. Detecting sickle cell disease at an early stage, ideally at birth, helps in better management and control.

Our research group has developed an affordable microfluidics and cell phone microscopy-based diagnosis test (Fig. 1) that could distinguish between individuals with sickle cell disease and sickle cell trait. The platform consists of a battery-operated portable microscope and a microfluidic chamber for imaging. The use of the microfluidic chamber ensures that a few drops of blood (e.g. taken from a finger prick) are sufficient to perform the diagnosis in a short time.

An unknown blood sample is divided into two parts and mixed with two different concentrations of a chemical oxygen scavenger. The blood samples are then loaded into two microfluidic chips and kept in a temperature controlled chamber for 30 minutes. After 30 minutes, both the microfluidic chips are imaged under the mobile microscope. Image processing is used to extract different boundary parameters of the cells in the field of view. These boundary parameters are then used to classify blood samples. If the blood sample belongs to a sickle cell disease patient, more than 50% RBCs in

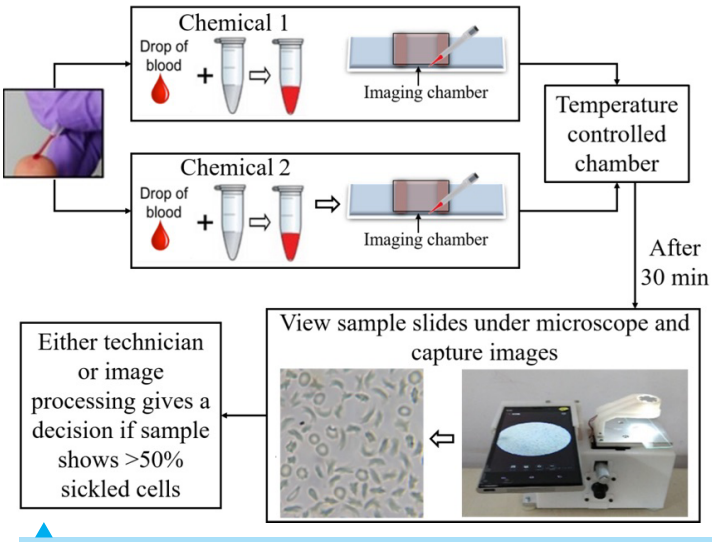

Fig. 2: Schematic of sickle cell disease diagnosis

both samples become sickle shaped. If the sample belongs to an individual with sickle cell trait, RBCs in only one of the chips become sickle shaped. If the sample belongs to a healthy individual, RBCs do not sickle in any of the microfluidic chips. This algorithm can help in immediate identification of an individual with sickle hemoglobin (i.e., trait or disease) and reduce the burden on HPLC systems. This classification scheme relies crucially on the optimised concentrations of the oxygen scavenger initially mixed with blood. Our group is currently working on developing the entire detection protocol in such a way that the healthcare workers can use it in the field to make a confirmed diagnosis.

The mobile microscope (Fig. 2) is small, lightweight, and can be carried to remote locations. It is equipped with multiple objective lenses and a stable XY stage for sample scanning. Images can be acquired in both epi-illumination and trans-illumination modes. The microscope will be commercially available from MedPrime Technologies, a medical devices start-up company incubated at SINE, IIT Bombay after March 2018.

This project was initially funded by a phase 1 Grand Challenges Explorations grant from the Bill and Melinda Gates Foundation through their IKP-GCE program, and later through a translation grant from the Tata Centre for Technology and Design, IIT Bombay. Our group has worked closely with the Valsad Raktadan Kendra, Gujarat and the National Institute of Immunohematology, Mumbai to develop this platform.

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