THE BIGELOW BOOK PRIZE

This award was established in 1995 by the Cardiovascular Sciences Collaborative Specialization to recognize and honor a pioneer clinician and scientist in the field of cardiovascular sciences. The award will be given in every year that a qualified student is identified and will consist of a book written by Dr. W.G. Bigelow entitled “Mysterious Heparin” and a plaque. Special account will be taken of sustained academic scientific excellence, innovative experimental approaches, original discoveries, and good scientific productivity. Some weight will be given to work that has recognizable clinical relevance, especially that which promises to improve patient care. As much as possible, awardees should exemplify the personal traits of Dr. Bigelow, including drive, curiosity, and scientific integrity.

2021 Bigelow Book Prize Recipient

Brahmdeep S. Saini, PhD Candidate
Institute of Medical Science
Temerty Faculty of Medicine
Supervisor: Dr. Mike Seed

My doctoral research focused on developing cardiovascular MRI methods for assessing placental function in terms of oxygen exchange using a combination of human and sheep imaging studies. I developed an “inputs” and “outputs” approach that included MRI measurements of blood flow and oxygen content in combination with the Fick principle and conservation of mass to determine oxygen transport in the major placental vessels. This work is significant because it yields a comprehensive set of non-invasive measurements: oxygen delivery and consumption of the pregnant uterus, placenta and fetus. Such measurements were otherwise only possible via invasive procedures. The basis of my methodology relies on MRI blood oximetry, which uses magnetic properties of blood (T2) to derive oxygen saturation. T2-oxygen saturation relationship was originally developed in-vitro on human umbilical cord blood and part of my work involved validating MRI oximetry in live sheep fetuses (an accepted model for studying fetal cardiovascular physiology). It allowed me to relate T2 in fetal vessels with invasive measurements of oxygen saturation. The results of sheep fetal validation studies confirmed that the relationship between T2 and oxygen saturation is robust. I applied MRI T2 and the placental function approach on normal pregnant sheep and found that the non-invasive MRI measurements closely resembled existing reference data obtained using invasive techniques. I was then able to apply this method in human fetuses with confidence, thus, establishing a reference range for oxygen saturations in the human fetal circulation. This research proved for the first time that streaming exists in the human fetal circulation, as previously demonstrated in animal models. Streaming is important for allowing well-oxygenated blood to be directed to the metabolically active heart and brain and it may be altered in disease processes. The developed MRI methods were then applied to study the underlying circulatory mechanisms involved in pregnancy conditions that may reduce maternal oxygen delivery to the placenta, compromising fetal health. This included MRI investigation on the impact of maternal exercise, supine positioning and heart disease compared against healthy controls during third trimester. Maternal cardiac function was concurrently assessed using MRI to also study cardiac performance in pregnant women with heart disease. Looking ahead, the developed MRI methods are an important step for improving diagnosis and clinical management of pathologies such as late onset fetal growth restriction, which is notorious for being difficult to detect. Dysfunction in oxygen metabolism may serve as a marker for timely detection.