Cardiovascular Diagnostics of Coronary Dysfunction

Rupak K. Banerjee, PE, PhD, Fellow ASME
Professor of Mechanical and Biomedical Engineering
University of Cincinnati, Cincinnati, OH

Date: April 4, 2014
Time: 12:20 - 1:15 pm
Venue: Baldwin Hall 544

ABSTRACT
Coronary blood circulation is influenced by patho-physiological resistances such as epicardial stenosis and microvascular dysfunction. Delineation of the severity of these resistances is important for clinical decision-making during coronary intervention. In current clinical practice, pressure-based diagnostic parameter, Fractional Flow Reserve (FFR; the ratio of distal to aortic pressures at hyperemia) and flow-based parameter, Coronary Flow Reserve (CFR; the ratio of hyperemic to basal flows) are used for evaluation of epicardial stenosis. However, the use of FFR and CFR remains limited as evaluation of microcirculatory status with these parameters is difficult and continues to stay in developmental stage. Clinical indices that can simultaneously distinguish between the status of epicardial stenosis and microvascular dysfunction have not yet been established.

Supported by in vivo and in vitro experimental and numerical studies, new and alternative cardiovascular diagnostic parameters: pressure drop coefficient (CDP) and lesion flow coefficient (LFC), which are developed from fundamental fluid dynamics principles for delineating the epicardial stenosis from microvascular dysfunction, are currently under investigation in a clinical setting. In human subjects with mild to severe stenosis under normal and abnormal microcirculations, CDP, a functional parameter, is obtained using simultaneous intracoronary measurements of pressure drop and flow. Similarly, LFC, a combined functional and anatomical index is determined using pressure drop, flow and percent area stenosis (%AS) measurements. The CDP correlated well with FFR and CFR in combination. Similarly, the LFC correlated well with FFR, CFR and %AS in combination. Both of these parameters are found to have distinct cut-off values for distinguishing the concomitant epicardial stenosis from microvascular disease. In collaboration with the Division of Cardiology, this line of investigation is currently being pursued as part of a larger and continuing interest in improving cardiovascular diagnostics in heart patients.
BIOSKETCH
Dr. Rupak Banerjee is a Professor of Mechanical (primary) and Biomedical (secondary) Engineering Departments at the University of Cincinnati (UC). He joined UC in 2002 following an appointment of 2 years at the Kettering University (formerly, General Motors Institute). Preceding this appointment, Dr. Banerjee was a staff scientist for the Drug Delivery and Kinetic Resources group in the Division of Bioengineering and Physical Sciences at NIH, a computational fluid dynamics (CFD) applications specialist for 4 years in the Biomedical Industry Team at Fluent, Inc., and a research engineer for over 3 years with the Fluid and Heat Transfer Analysis Group at Raytheon. Dr. Banerjee received his PhD (1992) in Mechanical Engineering at Drexel University; MS (1987) in Applied Mechanics at Indian IIT, New Delhi; MS (1984) in Biological Sciences & BS (1984) in Mechanical Engineering at BITS, Pilani, India.

Dr. Banerjee’s research and teaching interests include analytical and numerical analysis with experimental study of biological systems. His expertise in experimental and numerical techniques, including CFD, involves solving transient or steady state physiologic and patho-physiologic flows, mass and heat transfer problems coupled with pharmacokinetics. His primary research areas include: 1) cardiovascular hemodynamics, in particular, guide-wire diagnostics of diseased coronary arteries, funded by Merit Review (a R01 under Veterans Affairs [VA] system) grant and AHA grants; arterio-venous fistula funded by the NIH and VA; and stent-graft design funded by Cleveland Clinic Foundation; 2) characterization of thermal ablation using high intensity focused ultrasound [HIFU] and radiofrequency [RF], funded by NSF; 3) NASA funded research on oxygen transport in biological systems under microgravity; and 4) tumor and ocular drug delivery funded by Ophthalmology department of UC. He has published ~100 journal and book publications, over 135 peer-reviewed conference articles and has 3 patents. He was elected a Fellow of ASME and Chair of the Biotransport committee of the Bioengineering Division and the Heat and MassTransfer in Biotechnology (K-17) committee of the ASME Heat Transfer Division.