MASTER’S THESIS DEFENSE
Hemodynamics of the Aortic Root upon Transcatheter Aortic Valve Implantation

By
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Abstract:
Since the start of the twenty-first century cardiovascular therapies have seen a shift towards minimally invasive procedures. Heart disease is the leading cause of death in the United States and it manifests itself in many ways. One crucial aspect of heart disease relates to the calcification of the aortic valve and the valvular insufficiencies that this causes. Traditionally patients with these problems would undergo open heart surgery and a bioprosthetic or mechanical heart valve would be implanted to replace the body’s faulty native valve. A large group of patients who suffer from heart disease, especially the elderly, also suffer from other debilitating diseases and their bodies can be too frail to undergo open heart surgery. Transcatheter aortic valve implantation (TAVI) is a minimally invasive procedure that aims to target this population of high risk patients by using a catheter based approach to deliver a replacement valve. TAVI is a relatively new practice, with the first procedure performed in 2002, and there is still much to learn about the effectiveness, durability, and safety of these valves over time. This study presents experimental and simulation work that aims to examine how TAVs may affect the hemodynamics of the aortic root upon non ideal implantation scenarios. The first portion of this paper demonstrates a methodology of accurately characterizing coronary velocity profiles in an ex vivo environment. The experimental set-up allows for the implantation of a TAV into a native aortic root where hemodynamic conditions, including coronary flow, can be observed. The second portion of this research focuses on a series of simulations that demonstrate how changes in deployment constriction and ellipticity alter the flow patterns of an implanted TAV. With more in depth experimental and simulation studies it is hoped that this research can further the design and development of future TAVs.