Off-pump Left Ventricular Apical to Descending Aortic Conduits in Adults with Aortic Stenosis: Postoperative Cardiodynamic Evaluation with Cardiac MRI

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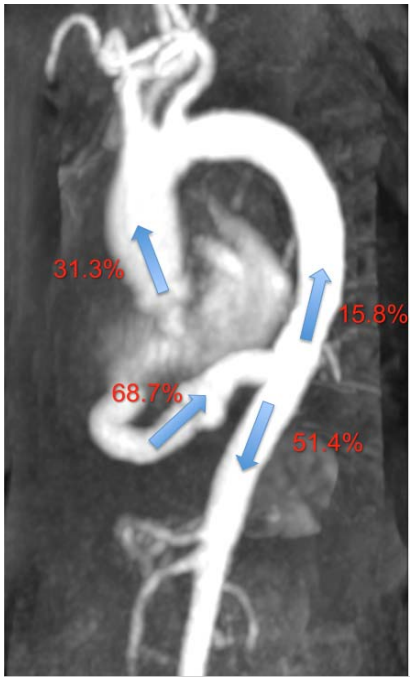
BACKGROUND: Off-pump apico-aortic conduit (AAC) surgery is an alternative to aortic valve replacement in select adult patients with a highly calcified aortic root. The AAC is placed in the apex of the left ventricle (LV) and connects to the descending thoracic aorta. The changes in blood flow resulting from the AAC have not been well defined. Specifically, the amount of flow which supplies the aortic arch vessels through retrograde flow in the descending aorta compared to flow through the native aortic valve after surgery is not known. Therefore, the objective of this study is to evaluate the postoperative hemodynamics in patients with AAC using PCMR.

METHODS: A retrospective review of 10 patients undergoing AAC in 2009- 2010 from a single center was performed. Postoperative cardiac MRI exams were performed on a Philips 1.5T Achieva system. The exam acquired short-axis cine-images of the LV, contrast-enhanced magnetic resonance angiography (MRA), and phase-contrast MR (PCMR) encoded in the through-plane direction at five locations: the ascending aorta above the native aortic valve, the conduit near the insertion into the descending aorta, the descending aorta below the conduit insertion, and the descending aorta above the conduit insertion. The data was processed on an offline workstation using FLOW software (AZL, Lieden, the Netherlands), and flow values as a fraction of cardiac output (CO) were determined for each PCMR measurement location.



RESULTS: Mean age of the patients was 75,5 +/-6,9 years and 5/10 patients were male. All patients tolerated the MR exams well. Conduit flow was 68,7 +/-13,6 % of total cardiac output (CO) and flow through the native aortic valve was 31,3 +/-13,6 % of CO. In the descending aorta, 15,8 +/- 9,9 % of CO that travelled retrograde (cranial-direction) from the conduit to supply vessels of the arch. 51,4 +/-12,2 % of CO was directed caudally from the conduit down the descending aorta. Figure 1 shows a schematic of the flow division superimposed on a MIP from the MRA.

DISSCUSSON: AAC surgery results in a significant change in the blood flow patterns in the aorta. In the subjects examined in this study twice as much flow was directed out of the conduit compared to the native aortic vale, presumably due to the lower flow resistance of this pathway. In addition, 31% of the conduit flow was directed retrograde in the descending aorta to help supply the vessel of the aortic arch. There was also significant skewing of the velocity profiles in the descending aorta away from the conduit due to the momentum of the conduit fluid in the descending aorta.

CONCLUSION: ACC surgery results significant alteration of the unusual blood flow distribution in the descending aorta. The majority (68,7%) of cardiac output passed through the conduit. The majority of the conduit flow was toward the caudal direction, but 31 percent of the conduit flow was directed cranially up the descending aorta. Further study of the hemodynamics of the AAC may lead to improved surgical design of the conduit or help identify possible complications of the new flow patterns.

Figure 1. An MIP of the MRA with arrows and cardiac output percentages showing the flow division and flow directions in the 10 patients.