Influence of Uterine Artery Blood Flow and Abdominal Aortic Hemodynamics: Implications for Sex Dependent AAA development

Elizabeth Iffrig[1], Pardeep Mittal[2], Gail Peters[2], John Oshinski[1,2], and William Robert Taylor[1,3]

[1]Biomedical Engineering, Georgia Institute of Technology, Atlanta, Georgia, United States, [2]Radiology, Emory University, Georgia, United States, [3]Cardiology, Emory University, Georgia, United States

Purpose Disturbed blood flow is characterized by low wall shear stress and oscillatory flow patterns at the vascular wall and it leads to the development and progression of vascular disease. Oscillatory flow is present in the infrarenal aorta correlating with the location of abdominal aortic aneurysm (AAA) formation. AAA occurs much more commonly in men when compared with women, at a rate of 4-5:1. The mechanism behind this difference is unknown and we are undertaking a project to explore hemodynamic differences between aortic flow in men and women. *In this study, we hypothesized that men and women exhibit differences in oscillatory flow in the infrarenal aorta and that these differences are regulated in part by uterine artery blood flow*

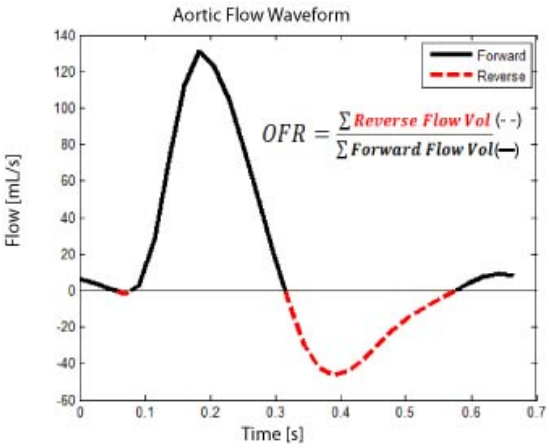

Figure 1. Representative flow versus time waveform in the abdominal aorta. Volumes are calculated by area under the curve.

Methods We included 10 patients who were receiving MRI scans to evaluate treatment for uterine fibroids (highly vascularized tumors of the uterus with low resistance) as well as 7 healthy women and 11 healthy men as controls. We performed gated phase contrast MR to evaluate through plane flow in the abdominal aorta (halfway between the renal arteries and the aortic bifurcation) and in the internal and external iliac arteries. We generated flow versus times curves in the vessels using Segment, and evaluated the Oscillatory Flow Ratio (OFR), ratio of the net reverse flow to the net forward flow over a cardiac cycle (Figure 1). OFR is a surrogate for the presence of disturbed flow and oscillatory wall shear stress.

Results Compared to both healthy women and women with fibroids men had a significantly higher OFR at the level of the abdominal aorta (Figure 2a). In the abdominal aorta, we found that this difference in the OFR was due to a difference only in net reverse flow (Figure 2b). We also observed that healthy women had a higher OFR in the internal iliac artery when compared with women with fibroids. The difference in the oscillatory ratio in the internal iliac artery results from a difference in the reverse blood flow as well.

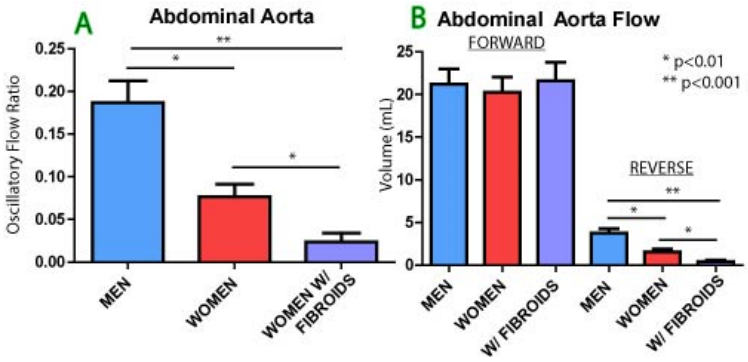

Figure 2. Oscillatory Flow Ratio (OFR) for Men, Women, and Women with fibroids. OFR was significantly greater in men with compared with healthy women and women with fibroids. Additionally, healthy women had a significantly higher OFR when compared with women with fibroids (A). This decrease in OFR from women to women with fibroids is dependent only on a decrease in flow reversal rather than an increase in forward flow (B).

Discussion Men and women exhibit significantly different OFRs in the abdominal aorta. Furthermore, in patients with uterine fibroid where there is a state of reduced vascular resistance in the uterus, OFR is further exacerbated and this is driven by a reduction in flow reversal rather than increased net volume. This finding is consistent with the clinical observation that men experience aortic disease much more frequently than women. In the iliac arteries, we observed a difference only in the internal iliac artery and not in the external suggesting that the structures of the pelvis (i.e. the uterus) contribute to the observed hemodynamics in the aorta.

Conclusion Hemodynamics in the abdominal aorta are influenced by internal iliac artery flow and pelvic floor vascular resistance. Future studies will include scans on women before and after receiving embolization to treat their fibroids and will allow us to make intra patient comparisons and examine the effect of changing peripheral resistance on the aortic oscillatory flow.