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Three-Dimensional Quantification of Angiotensin II-Induced Abdominal Aortic Aneurysms Using High-Frequency Ultrasound

Student researcher: Amelia Adelsperger, Junior

Abdominal aortic aneurysms (AAAs) are localized pathological vessel dilations and are the thirteenth leading cause of death in the United States. While AAA expansion in patients traditionally is assessed with 2-D ultrasound by measuring transverse diameters, recent advancements in ultrasound techniques now make it feasible to quantify AAA volumes noninvasively. High-frequency ultrasound (typically up to 40 MHz) is ideal for rodent imaging when investigating experimental aneurysms. The purpose of this study was to use 3-D ultrasound to measure aneurysm progression in the apolipoprotein-E-deficient ($apoE^{-/-}$)/angiotensin II (Ang II) mouse model that creates suprarenal dissecting aneurysms. High-frequency ultrasound (40 MHz, Vevo2100, VisualSonics) was used to collect images from C57BL/6 $apoE^{-/-}$ mice infused with Ang II from subcutaneously implanted osmotic mini pumps (1,000 ng/kg/min) for 28 days (n = 6). We could clearly visualize, segment, and quantify 3-D volumes of AAAs and visualize the dissection between medial and adventitial layers. Total AAA volume increased steadily at an average rate of 0.51 ± 0.32 mm^3/day (mean ± SE) between days 3 and 14 after aneurysm formation. This is similar to the increase in false lumen expansion (0.42 ± 0.30 mm^3/day), but higher than the true lumen expansion that remained relatively constant over 14 days (0.09 ± 0.06 mm^3/day); the false lumen being the diseased region of expansion that contains lipids, inflammatory cells, and blood clots. These data suggest that 3-D ultrasound can be used to measure aneurysm volumes in mice and may have utility in evaluating the efficacy of potential therapeutic agents.

Research advisor Craig Goergen writes, "This project using ultrasound to study abdominal aortic aneurysms is important as it improves our understanding of disease progression in a commonly used mouse model. These animals currently are being used to develop therapies that will slow aneurysm growth and prevent vessel rupture. Furthermore, the same techniques these students used here could be used in human patients to quantify expansion rates and predict rupture potential. Ultimately, we hope to help develop nonsurgical treatments to help aneurysm patients."

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