University of Utah
UNDERGRADUATE RESEARCH JOURNAL

HUMAN ARTERIOVENOUS FISTULA WALL THICKNESS IN THE FIRST SIX MONTHS AFTER CREATION

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Background: Chronic Kidney Disease (CKD) afflicts 15% of adults in the United States, causing more than 726,00 individuals to require renal replacement therapy as CKD worsens and becomes classified as end-stage kidney disease (ESKD) [1]. One such renal replacement therapy is hemodialysis, which requires access to a blood vessel that is characterized by high blood flow rate. This can be acquired by creating an arteriovenous fistula (AVF), where two vessels are anastomosed directly, or by implanting an arteriovenous graft (AVG), which connects the two vessels with a synthetic graft [2]. Studies have shown that the AVF has lower levels of stenosis, thrombosis, and infection than the AVG, leading to the promotion of the AVF as the preferred method of vascular access [3]. In the hemodialysis population, it is estimated that around 25% of hospital admissions are due to access-related issues, totaling over one billion dollars in cost of care [4]. One reason for the high morbidity rate of hemodialysis patients is that once the fistula surgery is performed, it takes three to four months for maturation to take place and many fistulas do not mature [5]. Previously, studies have focused mainly on the AVF lumen enlargement in the AVF maturation process, which allows increases in blood flow through the vessel. However, there is a gap in the knowledge of any correlation between vessel wall thickness and AVF maturation rate. The purpose of this study is to analyze the change in AVF wall thickness, in conjunction with AVF lumen area, throughout the 6 months following AVF creation. It was hypothesized that the vessel wall thickens as the lumen enlarges to promote the integrity of the vessel wall.

Methods: 10 ESKD patients at the University of Utah Hospital with newly-created AVFs were studied. Each patient was subjected to non-contrast agent black-blood magnetic resonance imaging (MRI) scans at 3 time points after the initial surgery. The time points were 1-3 days, 6 weeks, and 6 months. These MRI scans were used to reconstruct 3D models of the vessels using the software Amira (Thermo Fisher Scientific). These 3D models were used to calculate the wall thickness and lumen area for the cross sections perpendicular to the lumen centerline at 20 points, each 1 mm apart from one another, starting at the anastomosis.

Results: The lumen area of each AVF at 3 sequential MRI scans showed that the lumen area increased from 14.26 ± 5.40 mm^2 to 21.91 ± 8.79 mm^2 to 30.62 ± 12.78 mm^2 at each of the three determined time points ($p=0.0005$ by ANOVA for 3 time points). The wall thickness increased from 0.76 ± 0.09 mm to 1.05 ± 0.23 to 1.21 ± 0.18 mm at the three determined time points ($p=0.0001$ by ANOVA for 3 time points). We found that change in lumen area and change in wall thickness display a positive correlation over the first six months after AVF creation ($p=0.0369$).

Conclusion: During the first six months after AVF creation, the vessel wall increases in thickness and is positively correlated with changes to lumen area over the same time period. More rigorous validation of this observation using a larger cohort is necessary.

Funding: NIDDK and UROP support

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