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GEOMETRICAL ANALYSIS OF EXPERIMENTAL ARTERIOVENOUS FISTULA LUMEN IN RATS AND INTER-ANALYST VARIABILITY

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End stage kidney disease (ESKD) is the final stage of chronic kidney disease (CKD) where the kidneys have failed to meet the needs of daily life. As of December 2016, there were 726,331 prevalent cases of ESKD in the United States, and this number continues to rise by 20,000 patients a year [1]. Currently the preferred method of treatment for ESKD patients is hemodialysis through an arteriovenous fistula (AVF) [2]. However, the AVF must fully mature in order to be used in hemodialysis. AVF maturation requires the vein to remodel and to have a sufficiently large lumen diameter and flow rate following AVF creation surgery [2]. AVF maturation failure is strongly correlated to an increase in neointimal hyperplasia, an unfavorable thickening of vessel walls that narrows the lumen diameter and reduces flow rate [3]. It has been reported that up to 60% of newly created AVFs fail to reach maturity and cannot be used for hemodialysis [4]. Nitric oxide (NO) is a vasodilating agent that stimulates the relaxation of arteries and veins [4]. Its promising characteristics could be beneficial to successful AVF maturation. In this study, the effects of exogenous NO on experimental rat AVFs were tested and observed by the geometrical analysis of AVF lumen. Another objective of this study was to investigate the extent of inter-analyst variability among 3-D AVF lumen reconstructions to determine the reliability of the results and provide the basis for creating a robust and reproducible protocol. It was predicted that NO would increase lumen diameter and that there would be minimal inter-analyst variability. Femoral AVFs were created in rats, which then received perivascular gel that released NO; gel without NO was used as a control. Rat AVFs were then subject to MRI scans. This step was performed in our collaborator Dr. Timmy Lee's lab at the University of Alabama at Birmingham. The black blood MRI images of rat AVFs were then used to create 3-D vessel lumen reconstructions in Amira (Themro-Fisher Scientific) by two analysts (myself and a graduate student in the lab). From these reconstructions, lumen centerlines were calculated using VMTK (OROBIX), which provided the coordinates needed to determine the geometrical parameters of interest including lumen area, which was the main premise of this study. We found that the inter-analyst variability was high and hence we were not able to draw any reliable conclusions regarding the effects of NO-releasing gel on AVF maturation. Possible sources of error that may have resulted in the ambiguous results are: (1) no set parameters for how the reconstructions were made and (2) experimental technique of Amira software. Further studies would need to be completed in order to better understand inter-analyst variability and gain more knowledge on how NO affects the luminal diameters of AVFs.

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