Effect of Temporal Variation of Wall Shear Stress on the Remodeling of Arteriovenous Fistulae.

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Introduction: Non-maturation of arteriovenous fistulae (AVF) is in many ways the “Achilles Heel” of hemodialysis. The surgical configuration of the AVF and the subsequent wall shear stress (WSS) are believed to be key players in the remodeling of the AVF. **Purpose:** This study aimed to investigate the temporal effect of WSS on the maturation of AVFs created in two different configurations. **Methods:** AVFs were created between the femoral artery and vein of three pigs in a curved (n=3) and straight (n=3) configuration. Reconstructed geometry of the AVF obtained from CT-scans and flow data from Doppler ultrasound were utilized to numerically evaluate WSS at 2D (D: days), 7D, and 28D post-surgery. Time dependent WSS-area data was regressed using random effects model: Area = $\beta_0 + \beta_1$time + $\beta_2\Delta$WSS/Δtime, where β_i and Δ were the regression coefficients and the gradient, respectively. A p-value < 0.05 indicated statistical significance. **Results:** For the curved AVF, the slope of temporal gradient of WSS (-0.019) had a statistically significant effect ($p = 0.022$) on the dilation of the vein, while it is not significant for the maturation of the straight AVF ($p = 0.53$). Also, time has a positive effect ($\beta_1 = 0.337$) on the maturation of the curved AVF ($p < 0.05$), while it has a negative effect ($\beta_1 = -0.071$) for the straight AVF ($p < 0.05$). **Conclusion:** Our results document a temporal linkage between an increase in diameter and a decrease in WSS in the curved AVFs, with an opposite interaction in the straight AVFs. Creation of an AVF in a surgical configuration which results in a favorable linkage between WSS and diameter could result in a significant improvement in AVF patency rates.

	Straight Fistula		Curved Fistula	
	regression coefficients	p-value	regression coefficients	p-value
β_0	0.498	0.041	-0.166	0.041
β_1	**-0.071**	<.0001	**0.337**	<.0001
β_2	-0.025	**0.53***	**-0.019**	**0.022**