Results: With the test data, we achieved a mean-square error of 0.0355 between the averaged score using all 30 1-min. segments and the average SSARI value for the full 30 min. Furthermore, moreover, DNN scores had 1/10 the variability of the averaged SSARI values.

Conclusions: The DNN can distinguish between intact AR and impaired AR (e.g. via calcium channel blockade or renal mass reduction or both), just as does SSARI as we have reported. The DNN, however, provides equivalent accuracy in doing this with only 1/10 the data length. Further refinement of this methodology will allow us to leverage its use in the clinical setting as DNN will inform AR impairment and susceptibility to hypertensive renal injury in patients with CKD.

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SA-PO015

Difference in Early Hemodynamics Between Arteriovenous Fistulas and Grafts in Porcine Models

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Background: The formation of neointimal hyperplasia (NIH) leads to shortened patency rates for long-term hemodialysis vascular accesses – the arteriovenous fistula (AVF) and the arteriovenous graft (AVG). NIH is more severe in AVG than AVF in patients, but the reasons are not yet completely understood, though it may be multifactorial. Bioflow parameters (e.g., wall shear stress (WSS)) are linked to NIH formation. Here we investigated and compared hemodynamics and NIH in porcine AVF and AVG models. We hypothesized that a higher WSS value leads to less NIH formation and better vascular access outcomes. Therefore, we compared early flow hemodynamics to late NIH formation.

Methods: Carotid-jugular fistulas and grafts were created in young pigs (n=3 each). They were scanned by magnetic resonance imaging (MRI) 1 week after surgery. Black-blood and three-contrast velocity MRI scans were used to calculate cross-sectional area (CSA) and perform computational fluid dynamics to analyze hemodynamic parameters, including flow rate, velocity, WSS, and oscillatory shear index (OSI). Since NIH formation occurs near the venous anastomosis, we focused on the proximal venous segments closer to the anastomosis. Early hemodynamics were obtained at week 1. NIH was visualized at weeks 4-6 by histology.

Results: The venous CSA in the AVFs (mean±SD, 14.87±7.38 mm²) and the AVGs (19.58±6.33 mm²) were similar (p=0.06) at week 1. However, the AVF venous flow rate (532.2±40.7 l/min), velocity (177±20.02 cm/s), and WSS (196.68±91.12 dyn/cm²) were significantly larger than the AVG (346.49±127.92 mL/min, 31.80±15.65 cm/s, 73.59±51.53 dyn/cm²) (p=0.01 – 0.02) at week 1. OSI in the AVF and AVG were similar (0.03±0.029 vs. 0.027±0.03 rotation/s, p=0.07). Histology showed that the AVF had more NIH than the AVG at weeks 4-6.

Conclusions: Our results reveal differences between the AVF and AVG in early hemodynamics and late NIH formation. Specifically, AVFs had less NIH than AVGs in our porcine models, similar to human. Our results suggest that higher WSS values in AVF may prevent NIH formation and lead to better vascular access outcomes. Future research can consider hemodynamic parameters at later time points, in other regions of the vessel (i.e. the arterial anastomosis), and fluid-structure interactions.

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SA-PO016

Differential Hemodynamics Between Arteriovenous Fistulas With or Without Intervention Before Successful Use

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Background: A significant number of arteriovenous fistulas (AVFs) fail to mature for dialysis. Although interventions promote maturation, functional primary patency loss is higher for AVFs with interventions (assisted maturation) than AVFs without interventions (unassisted maturation). Blood flow-associated hemodynamics are proposed to affect AVF remodeling. However, the optimal hemodynamic parameters for unassisted maturation are unclear.

Methods: Patients (n=6) underwent magnetic resonance imaging (MRI) at 1 day, 6 weeks, and 6 months after AVF creation surgery. Before successful use for hemodialysis, 3 AVFs required intervention and 3 did not. MRI of the AVFs were used to calculate lumen cross-sectional area (CSA) and perform computational fluid dynamics to analyze hemodynamics, i.e. velocity, wall shear stress (WSS), and vorticity.

Results: The no-intervention group and intervention group had similar pre-surgery vein diameters and 1-day post-surgery venous CSA. The no-intervention group had significantly larger 1-day venous diameter (0.97±0.67 mm; mean±SD), WSS (333±336 dyne/cm²) and vorticity (179±1290 l/s) than the intervention group (diameter=0.23±0.10 mm/s; WSS=49±40 dyn/cm²; vorticity=493±122 l/s/P<0.05). At 6 months, the no-intervention group had significantly larger venous CSA (43.5±27.4 mm²) than the intervention group (15.1±6.2 mm²)/P<0.05. No intervention AVF arteries followed the same trend.

Conclusions: Lumen area and hemodynamic parameters differ between intervention and non-intervention AVF groups. Larger venous velocity, WSS, and vorticity immediately after AVF creation surgery may be important for later lumen enlargement and AVF maturation.

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SA-PO017

Formulating Customizable Extracellular Matrix Scaffolds From Decellularized Mouse Kidneys

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Background: Current cell culture methods are not adequate for recapitulating the physiology of mature, differentiated kidney cells in vivo. Podocytes plated on plastic tissue culture dishes differ from podocytes within the glomerulus due to their lack of foot processes or slit diaphragms, making human podocytopathies difficult to accurately study in this system. Several researchers have shown that growing podocytes in 2D culture systems that better resemble their native environment, the glomerular basement membrane, can help promote their differentiation. Rather than using expensive commercially available products, here we formulate a cell culture matrix derived from decellularized mouse kidneys. By removing the cellular content from mouse kidneys while leaving the extracellular matrix intact, we create a customizable, non-immunogenic scaffold for cell growth in-house.

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Underline represents presenting author.

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