This study utilized computational fluid dynamics on a patient specific radio-cephalic fistula under hemodialysis treatment to determine the dynamics of access recirculation and identify the presence of disturbed flow" Fulker et al (2017).

Abstract:

Arteriovenous fistulae are the preferred choice of vascular access in hemodialysis patients, however complications such as stenosis can lead to access failure or recirculation, which reduces dialysis efficiency. This study utilized computational fluid dynamics on a patient specific radio-cephalic fistula under hemodialysis treatment to determine the dynamics of access recirculation and identify the presence of disturbed flow.

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Metrics of transverse wall shear stress and oscillatory shear index were used to characterize the disturbed flow acting on the blood vessel wall, whilst a power spectral density analysis was used to calculate the any turbulence within the access. Results showed that turbulence is generated at the anastomosis and continues through the swing segment. The arterial needle dampens the flow as blood is extracted to the dialyzer, whilst the venous needle reintroduces turbulence due to the presence of jet flows. Adverse shear stresses are present throughout the vascular access and coincide with these complex flow fields. The position of the needles had no effect in minimizing these forces. However, improved blood extraction may occur when the arterial needle is placed further from the anastomosis, minimizing the effects of residual turbulent structures generated at the anastomosis. Furthermore, the arterial and venous needle may be placed in close proximity to each other without increasing the risk of access recirculation, in a healthy mature fistula, due to the relatively stable blood flow in this region. This may negate the need for a long cannulation segment and aid clinicians in optimizing needle placement for hemodialysis.

Reference:

Fulker, D., Ene-Iordache, B. and Barber, T.J. (2017) High Resolution Computational Fluid Dynamic Simulation of Haemodialysis Cannulation in a Patient Specific Arteriovenous Fistula. Journal of Biomechanical Engineering. October 28th. .

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