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Three-dimensional Computational Simulation and In-vitro Experiments for Assessing Radiocephalic Wrist Arteriovenous Fistulas
RYUNGEUN SONG, Sungkyunkwan University, SUN CHEOL PARK, HYUN KYU KIM, Uijeongbu St' Mary's Hospital, JINKEE LEE, Sungkyunkwan University — A radio-cephalic arteriovenous fistula (RC-AVF) is the best choice for achieving vascular access (VA) for hemodialysis, but this AVF has high rates of early failure depending on the vessel condition. The high wall shear stress (WSS) contributes to VA failures due to plaque rupture, thrombosis, etc. Thus, we have used a low-Re k-ε turbulence based CFD model combined with an in-vitro experimental approach to evaluate the WSS distribution and to minimize its effects under several conditions. The properties considered in this study were non-Newtonian flow characteristics, complete cardiac pulse cycle, and distention of blood vessels. The computational domain was designed for arteriovenous end-to-side anastomosis based on anastomosis angles of 45, 90, and 135. For experiment the digital domains were converted into 3D artificial RC-AVF via poly(dimethylsiloxame) (PDMS) and 3D printing technology. The micro-particle image velocimetry (μ-PIV) was used to measure the velocity field within the artificial blood vessel. The results showed that the largest anastomosis angle (135) resulted in lower WSS, which would help reduce AVF failures. This research would provide the future possibility of using the proposed method to reduce in-vivo AVF failure for various conditions in each patient.

Jinkee lee
Sungkyunkwan University

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