Wall Shear Stress and its Causality in Cerebral Aneurysm Development

In a recent case-control study by Zimny et al. (2021), the development of unruptured cerebral artery aneurysm can be reasonably traced to the combined factor of high wall shear stress and wall shear stress gradient. In addition, regions of bifurcation apices with such factor of significant wall shear stress are critical in aneurysm formation. A consideration of directional and spatial changes in opposition against the inertia and seamless hemodynamic blood flow in approaching the juncture of bifurcation apex that increase interaction of contact forces between arterial walls and blood volume may aid in further discussion of causality. On the other hand, arterial diameter or radii is also a contributing factor based on the observation of smaller vessels in female patients at bifurcation points that lead to high wall shear stress due to greater concentration of force within a more compact space from increased blood flow velocity (Lindekleiv et al., 2010). A probable explanation for the increased tendency of aneurysm development in such regions could also look into the opposing reactive mechanism of vessel walls to expand their surface area and volume in order to counter, accommodate, and redistribute the increased amount of force velocity from instances of more aggressive blood flow and hemodynamic contact, even of a transient nature that builds up over time. This suggests that an interplay of blood flow and fluid force mechanics and the physical characteristics of arterial curvature has a dynamic role to play in the localization of cerebral aneurysm formation.

References

Lindekleiv HM, Valen-Sendstad K, Morgan MK, Mardal KA, Faulder K, Magnus JH, Romner B, Ingebrigtsen T. Sex differences in intracranial arterial bifurcations. *Gend. Med.* 2010;7(2):149-55.

Zimny M, Kawlewska E, Hebda A, Wolański W, Ładziński P, Kaspera W. Wall shear stress gradient is independently associated with middle cerebral artery aneurysm development: a case-control CFD patient-specific study based on 77 patients. *BMC Neurol.* 2021;21(1):1-10.