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WALL SHEAR STRESS

What is it?	The wall shear stress (WSS) of the artery is defined as the tangential force per unit area exerted by the flowing blood on the surface of the artery. The magnitude of the WSS is proportional to the velocity gradient near the artery wall, i.e., how fast the flow velocity of the blood increases perpendicularly towards the centre of the artery with distance from the artery wall. Low WSS values are associated with low local blood flow velocities, which in turn are associated with long fluid residence times near the wall and low nitric oxide (NO) production. The velocity gradient near the arterial wall is called the wall shear rate (WSR). WSS can be calculated by the computation of the local gradient of velocity or approximated on the basis of Poiseuille's law WSS depends on the dynamic viscosity of blood (μ) and on the WSR according to: $$WSS = \mu WSR = \mu \frac{du}{dr}$$ where WSS is measured in N/m^2, μ in poise (1 poise = 1(dyne·s)/cm^2) and *du/dr* is the blood velocity gradient in 1/s.
Why do we measure it?	Wall shear stress is an established factor of atherogenesis, rupture of atherosclerotic plaques, intimal thickening and arterial remodelling. Therefore, methods for the computation of WSS in the arterial system are of clinical relevance.
How can it be measured	Magnetic Resonance Imaging (MRI) is a non-invasive technique providing flow data from which WSS can be calculated. WSS can be assessed also by non-invasive Doppler ultrasound in superficial vessels e.g., the carotid arteries. Intravascular ultrasound can also be used, but the probe can affect flow conditions. In some clinical studies, shear rate is favoured over shear stress because of the difficulty of measuring blood viscosity. Assuming that blood viscosity does not differ between subjects and groups, shear rate (WSR) may be estimated from the measured blood flow velocity (v) and the internal diameter of the artery (d) Since until today the shear rate is not calculated according to a uniform formula, it is necessary in any case to describe the calculation of the shear rate.
Where is it measured?	Ultrasound-based measurement of WSS in superficial arteries, e.g., the carotid artery, is possible with high regional and temporal resolution. However, a solid link to clinical practice and use in clinical routine is still lacking. In flow-mediated dilatation (FMD) of the brachial artery, it is recommended to measure WSS as an important stimulus and determinant of FMD. Although study results on the association of WSS with FMD are partly contradictory, the measurement and calculation of WSS within

	these studies needs to be described in order to harmonize measurements, better interpret results and improve the clinical applicability of WSS within FMD measurement. WSS can be measured by MRI to assess the impact of the blood flow at the aortic wall which may lead to dilatation of the aorta or development of aortic aneurysm.
References	Napoli et al. 2006. DOI: 10.1016/j.niox.2006.03.011 Katritsis et al. 2007. DOI: 10.1016/j.pcad.2006.11.001 Reneman et al. 2006. DOI: 10.1159/000091648 Glagov et al. 1993. Front Med Biol Eng. 5(1):37-43. DOI not available Parker et al. 2009. DOI: 10.1152/japplphysiol.91302.2009 Thijssen et al. 2019. DOI: 10.1093/eurheartj/ehz350 Gijsen et al. 2019. DOI: 10.1093/eurheartj/ehz551 Brands et al. 1995. DOI: 10.1016/s0301-5629(94)00111-1 Guala et al. 2022. DOI: 10.1016/j.jcmg.2021.09.023

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