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) production1. The velocity gradient near the arterial wall is called the wall shear rate. WSS is calculated approximately on the basis of Poiseuille's law.3 In in vitro and in animal experiments, shear stress T is often derived from the measured flow q , the lumen radius r and the medium viscosity η according to the equation (1): (1) τ=(4 η"q")/(πr^3) When all values are entered in SI units (i.e., η in Pa*s, q in m3/s, and r in m), the resulting τ will be in units of Pa = 10 dynes/cm
Why do we measure it?	Wall shear stress is a potentially important factor of atherogenesis, rupture of atherosclerotic plaques[4] and non-atherosclerotic intimal thickening. Therefore, methods of estimation of the distribution of WSS in the arterial system are of clinical relevance. Wall shear stress is a potentially important factor of atherogenesis, rupture of atherosclerotic plaques4 and non-atherosclerotic intimal thickening. Therefore, methods of estimation of the distribution of WSS in the arterial system are of clinical relevance.
How can it be measured?	In clinical studies, shear rate is favored over shear stress because of the invasive nature of measuring blood viscosity. Assuming that blood viscosity does not differ between subjects and groups, shear rate (Ƴ) may be estimated from the measured blood flow velocity (v) and the internal diameter of the artery (d) according to the equation (2): (2) γ=(8v_mean)/d where v_mean is the mean flow velocity of the blood or by equation (3) (3) γ=(4v_peak)/d where v_peak is the peak flow velocity measured in the middle of the arterial lumen.

	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?	Measurement of WSS is mainly established in physiological and clinical research. Although analysis of WSS measured by computational fluid dynamics in multi-slice computed tomography angiography (CTCA) has shown some evidence that regions of low or significantly increased WSS in coronary arteries are associated with adverse cardiovascular events, additional studies are needed to identify the predictive strength of WSS in cardiology. 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.
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