Atherosclerosis is a chronic inflammatory disease of arteries that develops preferentially at branches and bends that are exposed to disturbed blood flow. It is seen as a highly intricate disease with cycles of progressive endothelial insult, arterial inflammation, altered hemodynamics, and vascular remodelling, leading to plaque formation, progression, and rupture.

Vascular function is modified by flow, in part, via the generation of mechanical forces that alter multiple physiological processes in endothelial cells. Hemodynamic shear stress is crucial for endothelial homeostasis – and an expression of a particular endothelial phenotype – under normal physiological conditions.

Atheroma develops in areas of low endothelial shear stress (ESS). The high ESS seems to protect against atheroma formation, and the intimal accumulation of lipid and other atherogenic material may be related to ESS. Endothelial cells transduce the fluid shear stress into biochemical signals that regulate many pathways: intracellular enzyme activity, gene transcription, protein and micro-RNA synthesis, and release of bioactive mediators, which can adjust the endothelial cell structure and function, the surrounding cellular environment, and the balance between inhibition and promotion of atherosclerotic processes.

In brief, ESS is an important determinant of endothelial function and phenotype. Physiologic ESS induces endothelial quiescence and an atheroprotective gene expression profile, while low ESS motivates an atherogenic phenotype. The functional regulation of the endothelium by local hemodynamic SS provides a model for understanding the focal propensity of atherosclerosis and may help guide future biomarkers and therapeutic strategies.