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NUMERICAL MODELLING OF STENOSIS DEVELOPMENT IN THE CAROTID ARTERY

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Summary: Stroke is the third-leading cause of death in the developed world, and carotid artery stenosis is one of the leading risk factors for stroke, accounting for about 20 percent of strokes. There are about 152,000 strokes in the UK alone every year where about 1.2 million people live with the after effects.

The carotid arteries are located on each side of the neck and are the blood vessels which supply blood to the large front part of the brain which is where thinking, speech, personality, and sensory and motor functions reside. Each common carotid artery divides in two branches: the internal carotid artery and the external carotid artery. Normal these arteries are smooth; however, over time plaques, made of cholesterol, calcium, destructed cells and fibrous tissue, build up on the walls - a process known as atherosclerosis. Extensive atherosclerosis may cause stenosis (narrowing) of the artery or even complete blockage. In the carotid artery, this typically occurs at the bifurcation where the common carotid artery divided into the internal and external arteries.

Many studies have considered the blood flow, as well as associated parameters such as wall shear stress, in arteries with varying degrees of stenosis; however, this only provides a snap-shot in time and does not give any information on the progression of the disease.

Here we consider a numerical model for stenosis development, based on the haemodynamic properties inside the artery. This enables the development of an understanding of the role of the blood flow in stenosis development, and the two-way interaction between the interaction between the blood flow and the developing stenosis. Blood flow is simulated using the Lattice Boltzmann Method, while the development of the stenosis is governed by the simulated haemodynamic conditions in the wall region. Details of the stenosis growth model will be presented, including details of its development and application. Simulation result will also be presented indicating how the stenosis develops and how the corresponding geometrical changes affects the near wall flow parameters.