A PRELIMINARY STUDY ON THE BEHAVIOUR OF BLOOD FLOW OVER AN ATHEROMATOUS PLAQUE AND IN AN ANEURYSM

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Formation of blood clots inside the vessels (thrombosis) has been recognized as one medical problem with grave consequences. Two sites in arteries where there is a significantly higher probability of formation of a thrombus (a blood clot) are, over an atheromatous plaque, and, inside an aneurysmal sack. An atheromatous plaque forms due to the deposition and accumulation of cholesterol on the inside of the vessel wall. On the other hand, an aneurysm is a local bulging out of a blood vessel due to that part of the vessel wall getting weakened. Accordingly, a preliminary study was carried out to further examine the role of the flow behaviour associated with the above situations on the high probability of formation of thrombosis at such places, as indicated by several previous investigations.

Two dimensional physical model studies of flow over an atheromatous plaque and in an aneurysm were carried out in a flow visualization apparatus at the Fluids Laboratory of the University of Peradeniya. Models to simulate the flow in an aneurysm, and the flow in an atheromatous plaque were cut on 10 mm thick perspex sheets using a computer controlled machine. For each case, three different sizes of aneurysmal sack and atheromatous plaque were modelled representing different amounts of blockage of the blood vessel. Observations were taken by sketching the path of seeding particles added to the flow for a range of flow velocities; deposition of seeding particles was noted too. Short video clips were also made using a video camera to get more information about the flow pattern in each case.

The model results indicated that a larger eddy that forms inside the aneurysmal sack brings seeding particles into it form the main-stream. Consequently, in the prototype situation, we may expect, platelets in the blood to fall out of the main-stream and get deposited in the aneurysm, which is the first step in the formation of a thrombosis. It must, however, be emphasized that the similarity of the seeding particles to the platelets has not been quantified. Also, the flow 'trapped' in the aneurysm due to the lee-vortex probably contributes to a build up of activated clotting factors near the platelet deposition. In this way, it appears that the flow behaviour near an aneurysm helps bring most of the blood clotting factors together, thereby creating an environment favourable for the formation of a blood clot.

The model results further showed that the flow separation and subsequent vortex formation on the downstream slope of the atheromatous plaque help deposit seeding particles on the vessel wall and on the plaque. So, perhaps, platelets in blood could fall out of the main-stream in this manner and get deposited in the vicinity of the plaque. As in the previous case, the presence of platelets in contact with the plaque and vessel wall around it could lead to a high probability of blood clot formation if other factors necessary for the same are also present.

It must be added that the models examined in the preliminary study reported here should be taken as simplified representations of the actual prototype situation.