

MATHEMATICAL MODELING OF BLOOD FLOW THROUGH AN
ECCENTRIC CATHETERIZED ARTERY

SIMA SARV AHRABI

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To my beloved Father and Mother

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ABSTRACT

The mathematical model of blood flow through a catheterized stenosed artery is considered. A catheter is a tube, which is used in medicine for patients who are bedridden and whose blood pressure needs to be measured and monitored continuously. An example is the use of catheter during X-ray angiography or coronary balloon angioplasty in cardiac patients. Inserting a catheter in an artery will alter some characteristics of blood flow. This project investigates the effect on blood flow characteristics such as the velocity, the wall shear stress, the resistance impedance and the streamlines when a catheter is inserted into a stenosed artery. The catheter and the artery are assumed to be in a co-axial and eccentric position while blood is assumed to be Newtonian. The governing Navier-Stokes equations are solved analytically using perturbation method. The results show that a catheter placed in an eccentric position does alter the blood flow characteristics such that the axial velocity and the wall shear stress distribution are higher while the resistance impedance values are lower compared to their values in an artery where the catheter is concentrically placed. It is also found that under the same situation, the position of trapping moves closer to the wall of the stenosis while the size of the trapped bolus increases.

ABSTRAK

Pemodelan matematik bagi aliran darah apabila kateter dimasukkan ke dalam arteri berstenosis dipertimbangkan. Kateter adalah suatu tiub yang digunakan dalam perubatan bagi pesakit yang memerlukan tekanan darah mereka diukur dan dipantau secara berterusan. Contohnya, kateter digunakan semasa prosidur *X-ray angiografi* atau *belon angioplasti* untuk pesakit jantung. Apabila kateter dimasukkan ke dalam arteri, ciri-ciri aliran darah akan berubah. Projek ini mengkaji kesan kateter terhadap ciri-ciri aliran darah seperti halaju, tekanan ricih dinding, rintangan impedan dan garis arus apabila kateter dimasukkan pada kedudukan sepaksi *eksentrik*, manakala darah diandaikan sebagai bendalir Newtonan. Persamaan menakluk Navier-Stokes diselesaikan secara analisis menggunakan kaedah usikan. Hasil kajian menunjukkan bahawa halaju sepaksi dan tekanan ricih dinding adalah lebih tinggi sementara nilai rintangan impedan adalah lebih rendah berbanding dengan ciri-ciri aliran pada arteri di mana kateter diletakkan secara *konsentrik*. Kajian juga mendapati pada situasi serupa, kedudukan *trapping* makin hampir dengan dinding stenosis sementara saiz bolus *trapping* bertambah.