BLOOD FLOW DYNAMICS IN MICROVESSEL BIFURCATIONS

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Thesis submitted is fulfilled of requirement
for the award of degree of
Bachelor of Mechanical Engineering

Faculty of mechanical engineering
UNIVERSITY MALAYSIA PAHANG

November 2009

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project and in my opinion, this project is adequate in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering.

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STUDENT'S DECLARATION

I hereby declare that the work in this project is my own except for quotations and summaries which have been duly acknowledged. The project has not been accepted for any degree and is not concurrently submitted for award of other degree.

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Dedicated to my parents

ACKNOWLEDGEMENTS

I am grateful and would like to express my sincere gratitude to my supervisor Mr Mohamad Mazwan Bin Mahat for his germinal ideas, invaluable guidance, continuous encouragement and constant support in making this research possible. He has always impressed me with his outstanding professional conduct, his strong conviction for science, and his belief that a degree program is only a start of a life-long learning experience. I appreciate his consistent support from the first day I applied to graduate program to these concluding moments. I am truly grateful for his progressive vision about my training in science, his tolerance of my naïve mistakes, and his commitment to my future career. I also sincerely thanks for the time spent proof reading and correcting my many mistakes.

My sincere thanks go to all my labmates and members of the staff of the Mechanical Engineering Department, UMP, who helped me in many ways and made my stay at UMP pleasant and unforgettable. Many special thanks go to member in my group research with the same supervisor for their excellent co-operation, inspirations and supports during this study.

I acknowledge my sincere indebtedness and gratitude to my parents for their love, dream and sacrifice throughout my life. I am also grateful to my fiance for her sacrifice, patience, and understanding that were inevitable to make this work possible. I cannot find the appropriate words that could properly describe my appreciation for their devotion, support and faith in my ability to attain my goals. Special thanks should be given to my committee members. I would like to acknowledge their comments and suggestions, which was crucial for the successful completion of this study.

ABSTRACT

This thesis deals with the blood flow behaviour in the microvessel bifurcation using variety of blood parameters. There are two situations for the analysis which normal mircovessel and abnormal microvessel bifurcations. The objectives of this thesis are to investigate the effect of bifurcation on blood flow distributions and predict flow abnormalities due to blood properties. The thesis describes the finite volume technique to predict the abnormalities and identify the effect of the bifurcation. The structural three-dimensional solid modeling of normal and abnormal blood vessel were developed using the computer-aided drawing software. The strategy of validation of finite volume model was developed. The finite volume analysis was then performed using COSMOS Flow in Solidwork software. From the result,it is observed that bifurcation give an effect to the blood flow behavior.For normal and abnormal case, using the different pressure for same diameter of blood vessel bifurcation, the pressure result shown an increment when blood flow into the bifurcation. It is same when analyze using different velocity for same diameter, the value will decrease when it goes to the bifurcation. For analysis using different diameter of blood vessel bifurcation, the effect of bifurcation will clearly seen. Pressure and velocity will be proportional in values of analysis refer to the equation of fluid dynamics. Peak velocity of the normal and abnormal also showed different values. Normal microvessel bifurcation has a higher value of peak velocity than abnormal microvessel bifurcation. Reynolds Number also get an effect when the diameter of the blood vessel increase. Finally, the correlations obtained from this numerical result could be used to investigate the pressure and velocity distribution around the diseased segment.

ABSTRAK

Tesis ini membentangkan tentang sifat darah pada salur darah yang bercabang dua menggunakan parameter darah yang berbeza.Terdapat dua situasi di dalam analisis ini iaitu salur darah bercabang normal dan juga salur darah bercabang tidak normal.Objektif tesis ini ialah untuk mengenalpasti kesan salur darah bercabang kepada pergerakan darah dan untuk menjangka pergerakan darah tidak normal berdasarkan sifat darah itu sendiri.Tesis ini membincangkan penilaian kebolehtahanan untuk menjangka sesuatu tidak normal dalam salur darah dan kesan cabang pada pergerakan serta sifat darah.Permodelan struktur tiga dimensi untuk salur darah normal dan tidak normal dibangunkan dengan perisian lukisan bantuan komputer.Strategi pengesahan model kelantangan terhingga dibangunkan.Analisis kelantangan terhingga dijalankan dengan COSMOS di dalam perisian Solidwork.Keputusan yang diperolehi daripada analisis ialah cabang pada salur darah memberi kesan kepada pergerakan dan sifat darah.Bagi kes salur darah normal dan tidak normal menggunakan tekanan yang berbeza tetapi diameter sama,nilai tekanan menunjukkan peningkatan apabila darah melalui cabang.Ia juga sama apabila analisis kelajuan darah berbeza pada diameter yang sama,ia menunjukkan penurunan apabila sampai ke salur darah yang bercabang.Bagi analisis untuk diameter salur darah yang berbeza,kesan disebabkan salur darah bercabang dapat kelihatan dengan jelas.Tekanan dan kelajuan adalah bertentangan antara satu sama lain merujuk kepada persamaan dalam dinamik berdalir.Kelajuan tertinggi darah turut memberi nilai yang berbeza dalam kes salur darah normal dan tidak normal.Salur darah normal mempunyai nilai kelajuan tertinggi lebih daripada salur darah tidak normal.Nombor Reynold juga menunjukkan kesan apabila diameter salur darah berubah.Perkaitan diperolehi daripada kajian ini boleh dimanfaatkan untuk lanjutan taburan tekanan dan kelajuan bagi darah disekitar tempat yang sakit.

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u_i : velocity in the *i*-th direction

P : pressure

f_i : body force

μ_i : viscosity

δ_{ij} : Kronocker delta

ρ : density

υ : mean velocity

D : diameter

∂t : partial differential of time

∂p : partial differential of pressure

R : radius

L : length

α : alpha

A : area

V : volume

LIST OF ABBREVIATIONS

MCA : Middle cerebral artery

CFD : Computational Fluid Dynamics

CAD : Computer Aided Design

FEM : Finite Element Method

CT : Computer-assisted tomography

CAE : Computer Aided Engineering

CSS : Computational Solid Stress

FEA : Finite Element Analysis

PDE : Partial Differential Equation