EFFECTS OF SPORTS ACTIVITY ON BLOOD FLOW IN ARTERY AND AORTA OF A HUMAN

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This paper deals with a comparative study of blood flow variables. The properties of blood flow of the thoracic aorta and pulmonary artery of a male subject engaged in sporting activity (body acceleration), have been investigated. By utilising a mathematical solution, the distributions of the velocity, flow rate and wall shear, have been obtained. The results of the study demonstrated that (the specific type of) sporting activity reduces the duration of negative velocity. It was found that a lower heart pulse frequency provides a better blood flow rate which in turn, results in less harm to vascular walls.

KEY WORDS: sports, blood flow properties, velocity of blood, flow rate of blood, wall shear of blood, theoretical solutions

INTRODUCTION: There are many situations in which the human body is subjected to body acceleration. Some examples of these vibrations or body acceleration are as follows: travel in road vehicles, in aeroplanes, in speed boats and fast body movements resulting from sports activity such as gymnastics, playing tennis, aerobics, etc. Many researchers Clayberg (1970), Arntzenius, Koops, Rodigo, Elsbach, & Brummelent (1970), Arntzenius, Laird, Nooredrgraaf, Verdouw, & Huisman (1972), Sud, & Sekhon (1985) and Chaturani, & Wassf Isaac (1995) have studied the properties of blood flow under situations requiring body acceleration. Pedley (1990) considered the pressure gradient in the pulmonary artery of a human. Abdalla Wassf Isaac (1996) has made a mathematical model, providing examples for blood variables {velocity u_z, flow rate Q, wall shear τ_w, fluid acceleration F, etc.}, and has compared the results of the blood flow properties, with and without body acceleration. After considerable effort, using a pressure gradient in the aorta of a human, described by Milnor (1989), Abdalla wassf Isaac (1996) has been able to obtain a mathematical model. In the present study, an exact analytical solution and a comparison of blood flow variables with and without sports activity have been obtained.

EFFECTS OF SPORTS ACTIVITY:

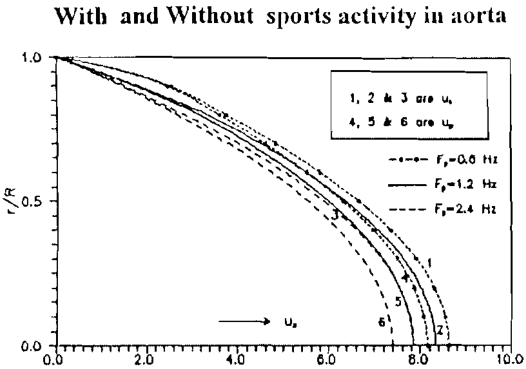

Figure 1 - Velocity (u_z – r) variation with pressure gradient frequency F_p ($t=t_o$ + 0.265 sec, F_b = 1.2 Hz, φ = 0.0 and R = 1.17 cm) and a comparison of u_z (G_z = 0.1G) with up (G_z=G=0.0).

i- Velocity of blood (u_z): The velocity of blood in artery and aorta in human is an important factor in terms of human physiology. In a previous study, Abdalla wassf Isaac (1996) described the velocity of blood in an artery. This study showed a comparison of velocity $\{(u_z - r), (u_z - t)\}$ with and without body acceleration (related to sporting activity). It has been observed that, the velocity in the case of exertion through exercise (or body acceleration) is greater than the velocity recorded without body acceleration. Conversely, it may be noticed that for r/R=0, the velocity is always positive with time when playing games (or under body forces) as shown also in Figure 1, 2 and 3.

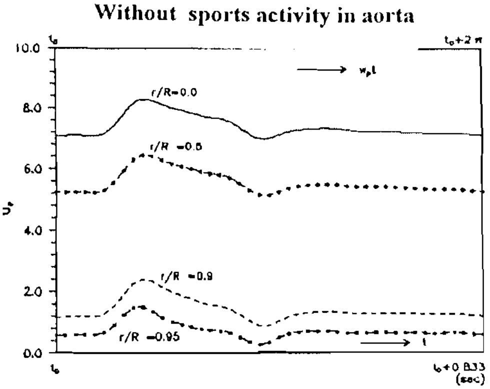

Figure 2 - Variation of velocity – time (u_p – t) profiles with radial distance (F_p = 1.2 Hz and R = 1.17 cm).

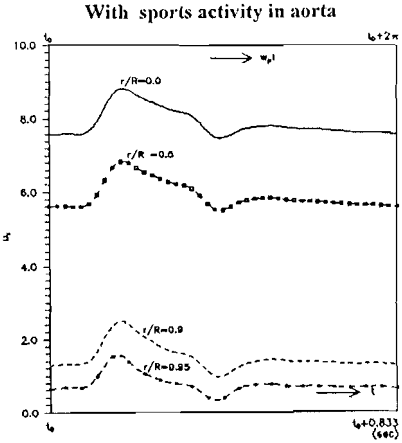

Figure 3 – Variation of velocity – time (u_z – t) profiles with radial distance (φ = 0.0, R = 1.17 cm, G_z = 0.1G and F_b = F_p = 1.2 Hz).

ii – Flow rate (Q): The flow rate of blood does not change, whether engaged in sporting activity or without body acceleration, at the same frequency as shown in Figure 4 and 5. However, the low heart pulse frequency provides a greater blood flow rate as seen in Figure 4.

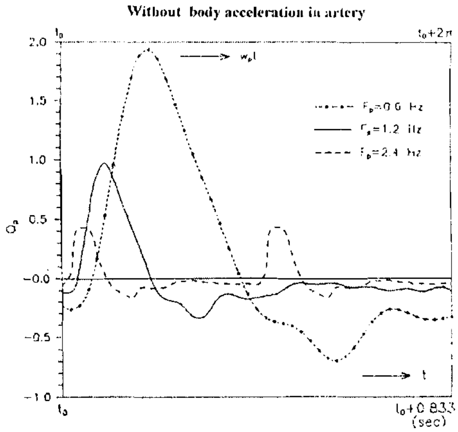

Figure 4(a) - Variation of flow rate Q_p profiles with pressure gradient frequency F_p in main pulmonary artery of a human (R =1.35 cm, ϕ = 0).

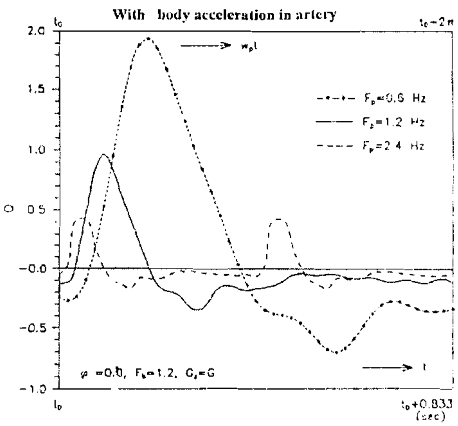

Figure 4(b) - Variation of flow rate Q profiles with pressure gradient frequency F_p in main pulmonary artery of a human (R = 1.35 cm, ϕ = 0).

iii – Wall shear (τ_W): The magnitude of wall shear with sporting activity (or body acceleration) is greater than that without playing games (or body acceleration) as shown in Figure 6. The increase in the wall shear magnitude may give rise to shear injury of the arterial wall and change in the shape of wall cells. Consequently, an increase in wall shear may cause specific wall muscle fatigue, leading to a loss of viscoelasticity of the arterial wall.

With sports activity in aorta

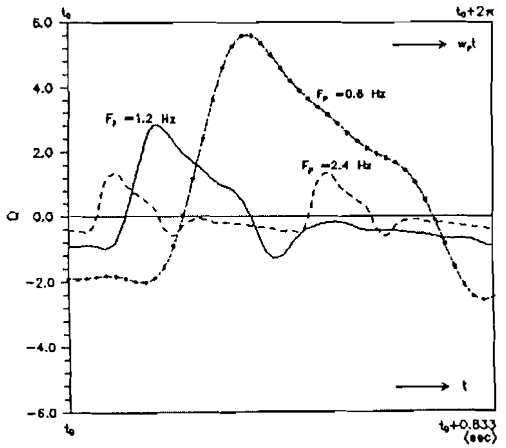

Figure 5 – Blood flow rate Q variation with pressure gradient frequency F_p (φ F_b = 1.2 Hz, R = 1.17 cm and G_z = 0.1G).

With sports activity in aorta

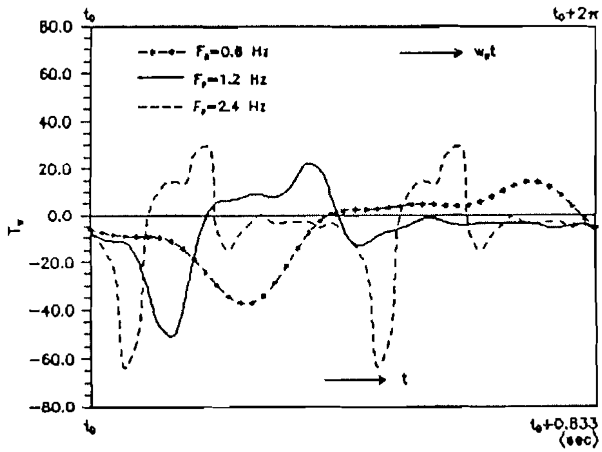

Figure 6 – Wall shear variation with pressure gradient frequency F_p (φ = 0.0, F_b = 1.2 Hz, R = 1.17 cm and G_z = 0.1G).

CONCLUSIONS: In this paper, the blood flow with sports activity (or under body acceleration) has been considered. A comparison of velocity of blood, flow rate and wall shear with and without sports activity (or under body acceleration) has been made. The comparison of profiles may play an important role in future studies of blood flow, particularly taking into consideration specific body acceleration related to sports activity.

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Acknowledgements

This work is supported by the Egyptian Ministry of Higher Education, Egyptian Government, through Physics and Mathematics Engineering Department; Faculty of Engineering (Port - Said), Suez Canal University.