Volume 1, Number 1: 1-2, April 2003
Editorial

International Journal of
Vascular Biomedical Engineering

Evolving Concept by the Engineer on the Circulatory Arrest of Arterial System - Hemodynamic Aspect

Byung-Boong Lee, M.D.¶

Sungkyunkwan University School of Medicine & Samsung Medical Center

Once the circulation system should stop functioning with various causes, its fall-out effect to the system will always depend heavily on the acuteness of the event regardless of its etiology. Besides, the location and degree of this circulatory blockage will also play major role at the same time especially to the initial response, and the capacity of natural compensation through the detour route bypassing the blockage area will become another important factor affecting to the outcome of this circulatory insults together with the resilience of tissue response to this compromised circulation. Though there are many different conditions to affect the eventual outcome of this circulatory insults in positive way, the nature unfortunately does not always have adequate preparation to this status, especially to the "acute" nature of the impact to the arterial circulatory system in particular. The relief of this acute blockage of arterial system is often required either by mechanical removal (e.g. thrombectomy with/without endarterectomy; embolectomy) or by thrombolytic therapy to melt the blood clot as the source of acute blockage. However, most of thrombotic blockage has an organic cause to require permanent procedure to eradicate this cause of acute blockage subsequently either by the surgical bypass or by the percutaneous interventional procedure (e.g. angioplasty and/or stent insertion).

If this acute insults to the arterial system should have occurred following the long process of slow progression of the blockage phenomenon (e.g. atherosclerotic arterial occlusive disease), the nature has often good chance to compensate this process with natural adjustment with the change of vessel condition (e.g. diameter of the lumen) itself as well as naturally developing collateral (bypass) system though mostly failed eventually. When this natural compensation should fail to meet the mandate condition for the normal quality of life, there is another fair chance to improve this shortage on the circulation by surgical and/or endovascular (interventional) means this time with remarkable success in limited period especially when the patient should reduce various risk factors like smoking, diabetes mellitus hypertension, hypercholesterolemia, obesity, and sedentary life style, etc. to accelerate the natural progress of the disease process (e.g. atherosclerosis).

All these strategies to confront acute and/or chronic blockage of the arterial system with reasonable success have been heavily depending on the new critical contribution by the biomedical engineer in this particular field through their quiet but steady progress to provide mechanical and theoretical solutions with new technology based on advanced hemodynamic concept of this arterial circulatory system. Rapid accumulation of the substantial new information on hemodynamics for the last three decades has given the proper momentum to the vascular surgeon to expand their role to reduce the risk of once unavoidable amputation of

¶ 50 Ilwon-dong, Kangnam-ku, Seoul, 135-710, Korea
E-mail : bblee@smc.samsung.co.kr

the limbs substantially following the acute and chronic blockage of the arterial system of lower extremity with various newly designed bypass graft. Bypass surgery to compensate the lower extremity ischemia also has made substantial improvement by the proper implementation of new additional hemodynamic information (e.g. compliance mismatch along the anastomosis) through the various modification of surgical techniques including bypass anastomosis.

The risk of stroke was also substantially reduced by the timely removal of blockage along the carotid artery as preventive measurement of the stroke with advanced technology based on unique hemodynamic information of carotid artery the engineering partner established for the clinician. This new hemodynamic knowledge on carotid artery was finally able to explain the odd distribution of atheromatous plaque along the outer wall of carotid sinus due to the low shear stress site development opposite to the flow divider at carotid bifurcation area. This hemodynamic information was able to provide critical guideline for the proper management of carotid blockage problem together with new information of plaque analysis based on further advanced technology (e.g. MR and/or US tests) giving more accurate information for the proper selection of optimum type of the treatment at the optimum time as preventive measurement of stroke. All these critical advances on the clinical management of carotid artery occlusive disease would have not been possible without this timely contribution by the engineer based on this new hemodynamic concept.

Furthermore, various prosthetic vascular grafts, newly designed with new implementation of physiologic characteristics of natural vessel to this man-made condition, gave substantial compensation of inherent disadvantage of the graft as artificial vessel, textile or non-textile, to substitute natural vessel.

The biomedical knowledge we have accumulated for decades through the clinical and experimental trial and error have made tremendous contribution in this field with no doubt but it is still far too short to give adequate answer to solve many critical problems mostly related to the engineering issues to improve the results of clinical management of acute and chronic blockage of arterial system, especially with this bypass surgery utilizing prosthetic graft in terms of long-term patency rate comparing to the autogenous vein graft as arterial substitute. If this vein graft which is far better than the prosthetic graft, can not meet all the requirement as the arterial substitute, it certainly is not surprising to have more problems with this man-made vessel we are now heavily depending on for the clinical management.

Therefore, it seems to be the right time for us to review this particular problem related to the prosthetic graft, for example, from the scratch once again to formulate new strategy based on newly accumulated clinical and engineering knowledge. We should not lose this right momentum to organize this joint efforts among clinicians and engineers which we earned on right time lately through this unique Society. Let us start from the small topic like prosthetic graft for the arterial blockage, for example, to see how much we can share our knowledge in this particular field of circulatory disorder and tap the unknown potential from each other and then we will have unlimited progress through our synergistic efforts, fulfilling our aim of the Society.

References:

1. Perry MO (edit): Acute Ischemia and its sequelae. In Rutherford R et al (edit): Vascular Surgery (4th edit) W.B. Saunders Co. Philadelphia, 1995, pp 641-736.
2. Kempczinski RF (edit): Management of chronic Ischemia of the lower extremities. In Rutherford R et al (edit): Vascular Surgery (4th edit) W.B. Saunders Co. Philadelphia, 1995, pp741-903.
3. Moore WS (edit): Management of extracranial cerebrovascular disease. In Rutherford R et al (edit): Vascular Surgery (4th edit) W.B. Saunders Co. Philadelphia, 1995, 1456-1660.