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BIOMECHANICS AS A TOOL FOR STUDY OF CARDIOVASCULAR DISEASE
WILL WE PREDICT CARDIOVASCULAR DISEASE WITH ENGINEERING PRECISION?

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INTRODUCTION

With the impending completion of the human genome sequence, biology will join the ranks of physics, mathematics, and chemistry as an exact basic science. This fact will be reflected in the choice of the curriculum for many academic disciplines, but especially for Bioengineering. Bioengineering, and specifically Biomechanics, will integrate these disciplines and serve as the platform for expanding analysis as well as creation and design of new approaches in Biology and Medicine. Not only is mechanics determined by biology but also biology is controlled by mechanics. Thus, biomechanics is becoming an integral part of medical research. One of the most interesting aspects of biomechanics is its application to problems related to disease (1).

BIOMECHANICS IN SHOCK

I will illustrate this for the specific case of biomechanics applied to the cardiovascular system. Cardiovascular biomechanics already serves to analyze many problems in the circulation, from drug delivery, viral vector transport in gene therapy, mechanotransduction, gene expression, blood flow in arteriosclerosis, heart failure, to organ microcirculation. The need for biomechanics is especially evident in the case of one of the most serious problems in the circulation, physiological shock. Shock leads to a major failure of the circulation, accompanied by a plethora of organ dysfunctions, cessation of microvascular flow and even death within a short time. It is one of the most difficult conditions to manage in a patient and there is a rich medical literature with numerous ideas and suggestions. What then does Biomechanics have to offer to understand this problem? Biomechanics serves to identify key events in this condition from a physical point of view (2). The role of blood cells and microvascular flow, activation accompanied by a change of biomechanical cell properties, its impact on the flow and transport of cells in the microcirculation, nutrient transport and organ function. I will show that biomechanics serves to even identify a key trigger mechanism that causes cell activation in shock (3,4).

A BIOMECHANICS OUTLOOK

Biomechanical models are of major help in unraveling such challenging diseases. They bridge molecular events with the mechanics of cells, the microcirculation and organ function. No single model is adequate and our challenge is to formulate models that identify the essential events. Without mechanical models we have no entry to a cohesive picture of shock. Therein lies a future for Biomechanics.

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