Biomechanics and Physical Therapy

A Perspective

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What is biomechanics? My response to this question is intended to provide an awareness of the scope of biomechanics and show the reader that biomechanics is an integral part of physical therapy.

BIOMECHANICS DEFINED

At face value, the term biomechanics is made up of two roots, bio and mechanics. Bio means life, living organisms or tissue.[1] Mechanics is physical science that deals with the state of rest or motion of bodies under the action of forces.[2] Therefore, aspects of mechanics having to do with inanimate objects comprising bridges, spacecraft, and automobiles are eliminated from consideration when we merge the terms bio and mechanics. The study of bio or biology includes both plants and animals. Plants are excluded for this presentation because physical therapy has to do primarily with the human portion of the animal world. Admission is happily made, however, that worthwhile concepts and theories can be derived from studies of lower forms of animal life. For the context of this article, biomechanics is the study of animal life systems and tissue combined with the physical science of macro- and micro-bodies under the influence of forces.

Conceptualization of Biomechanics

Biomechanics is broad in nature. This breadth and diversity are demonstrated by the variety of topics associated with biomechanics, such as exercise, biochemistry of exercise, sports, CNS, energetics, and locomotor apparatus. An awareness of the scope of biomechanics is amplified in themes addressed at international symposia on biomechanics.[3-7] Some of these themes are muscle, neuromuscular control, EMG, gait, instrumentation, anthropometry, posture, ergonomics, sports, and fundamentals of movement.[8-10] The biomechanics of joints, soft tissue, blood vessels, tendons, skin, bone, heart, lung, and microcirculation are addressed in other books.[11-14]

Therefore, biomechanics is a factor in the functioning of virtually all biological systems of the body. The study of these biological systems might involve any component of the field of mechanics. The Figure shows the primary biological systems of interest. Mechanics is usually divided into three parts: mechanics of rigid bodies, mechanics of deformable bodies, and mechanics of fluids. The study of the mechanics of the musculoskeletal system is often divided between the investigation of rigid bodies that are stationary (static) or rigid bodies that are in motion (dynamic). Kinematics is the study of the geometry of motion without reference to the cause of the motion. Kinematics deals with position, displacement, velocity, acceleration, and time; these are known as kinematic quantities. Thus kinesiology, the study of motion, is actually the study of kinematics. Kinetics, on the other hand, is the study of the relationship between forces and the resulting motion of bodies on which they act. Some examples demonstrating the range of biomechanical studies are 1) angular displacement of the knee during gait (osseous, soft tissue, and kinematics, 2) hip joint contact force during standing (osseous, soft tissue, and kinetics), 3) palpation of trigger points (nervous and integumentary systems and deformable bodies), 4) fluid transport across capillary membrane (cardiovascular system and kinetics), and 5) nerve conduction velocity along sciatic nerve (peripheral nervous system and kinematics).

PHYSICAL THERAPY AND BIOMECHANICS

The House of Delegates at the Fifty-ninth annual Conference of the American Physical Therapy Association in 1983 adopted a philosophical statement of physical therapy.

> Physical therapy encompasses areas of specialized competence and includes the development of new principles and applications to more effectively meet existing and emerging health needs. Other professional activities that serve the purpose of physical therapy are research, education, consultation, and administration. Physical therapy is a health profession whose primary purpose is the promotion of optimal human health and function through the application of scientific principles to prevent, identify, correct, or alleviate acute or prolonged movement dysfunction.[15]

In the context of this article, movement dysfunction or dysfunction of movement is central. We have already established that movement is kinematics and, therefore, must be considered a mechanical phenomenon. Abnormal movement begs an explanation of the forces or kinetics, which is also kinematics, responsible for the dysfunction. The abnormal body movements (kinematics) may be caused by internal, biologically produced forces (kinetics). For example, body movement may be too slow because of insufficient coronary blood flow, movement may be too fast because a portion of the brain is damaged, or movement may be excessive because edema has reduced the capability of the musculotendinous unit to produce force. Abnormal movement may also result from forces external to the body. Examples are abrupt foot contact with an unexpected elevation in the sidewalk or reduced spinal rotation because of an orthotic device worn about the torso. Biomechanics must be considered an inherent part of physical therapy, which purports the distinctive characteristics of prevention, evaluation, and treatment of movement dysfunction (Figure). In fact, isolating physical therapy from biomechanics appears impossible.

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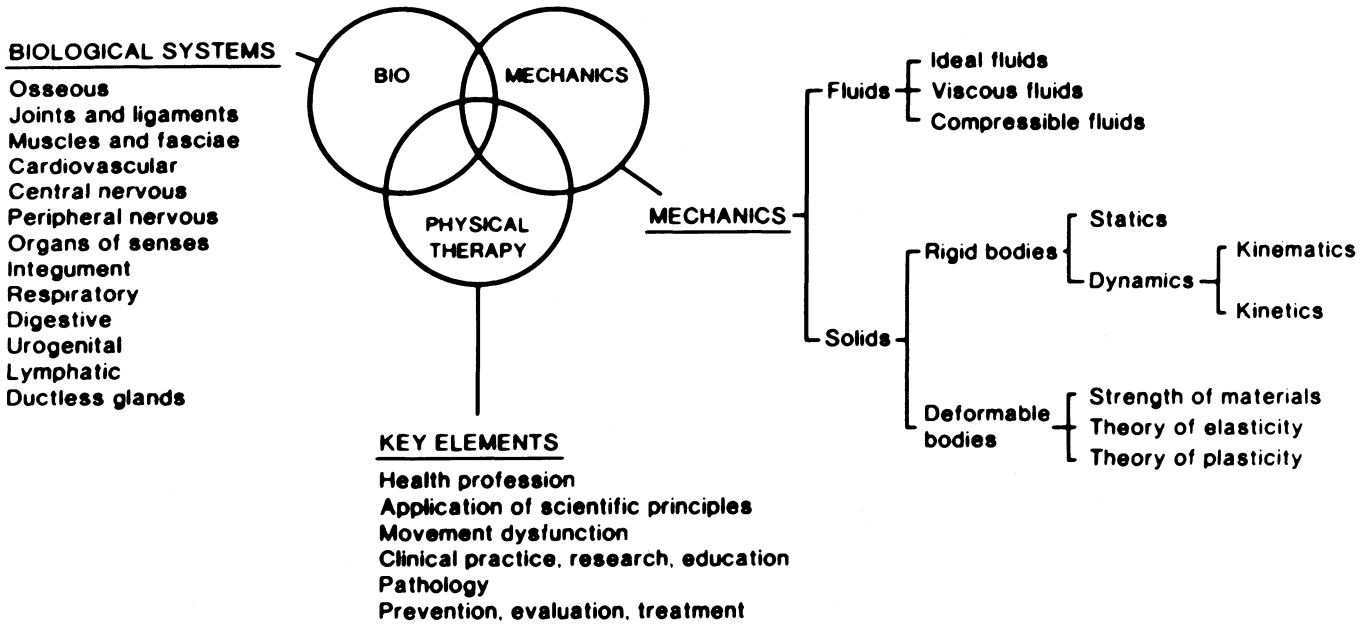

Figure. Illustration of overlap between biomechanics and physical therapy.

Several books have been written on biomechanics. They address skeletal injury, diseased hips, lameness in horses, and pathological locomotion[16–19]; physical therapists have written two books on biomechanics.[20–21] The text by Winter includes explanations of both kinematics and kinetics.[22]

In physical therapists' quest to become more independent or interdependent with other disciplines, they are obliged to practice clinically and educate with a solid understanding of biomechanics. Furthermore, physical therapists need to make scholarly contributions in the areas of biomechanics and creatively apply biomechanical principles in their clinical practice. How else can movement dysfunction be considered a distinctive characteristic of physical therapy? Physical therapy biomechanics is a fertile area with open-ended opportunities and challenges.

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