Review of Progress in Research and Plans for Future Research

Dr. Amit Gefen

The primary area of my research is *Musculoskeletal Biomechanics*, with a particular emphasis on relations between mechanical loading, functional adaptation, mechanical properties, damage and injury of hard and soft tissues in the musculoskeletal system. The overall goal of my research work is to determine the mechanical influences on bone and soft tissue physiology and pathology, and thus, provide new means for body protection and injury prevention, enhance medical diagnostics and treatments, and improve design of implants. In the last 10 years, I addressed the nature of tissue responses to mechanical loads and the onset of damage and injury in tissues using an integrated biomechanical approach employing analytical models, numerical models, animal models and human studies.

Presently, I am a tenured Senior Lecturer in the Department of Biomedical Engineering of the Faculty of Engineering at Tel Aviv University, and am heading the Musculoskeletal Biomechanics research group.

***Progress in research since the Dan David Scholarship was awarded* (2002)**

During the recent 3 years, my research interests and activities were focused on the following topics:

- Research into the biomechanics of musculoskeletal injuries and into the biomechanics of the development and progression of degenerative musculoskeletal conditions, such as bone loss, overuse damage in bone, pressure ulcers and injuries/muscle atrophy in the diabetic foot.
- Research to develop patient-specific, real-time dynamic biomechanical models of the human body (based on a patient's muscle, bone, and joint anatomies from various imaging modalities) that can be readily constructed on personal computers, for application to body protection and injury prevention (e.g. detection of critical mechanical stresses causing bedsores, pressure ulcers in residual limbs of amputees, diabetic foot ulcers, or stress fractures).
- Studies of computer-aided-assessment of bone quality and computer-aided treatment planning in orthopaedics using biomechanical models that account for the short-term mechanical response of bone and its long-term adaptation behavior.
- Research to better understand the pathophysiology of stress-induced bone resorption following insertion of orthopaedic implants, and development of mechanisms/interventions to overcome this problem.

The Dan David Scholarship substantially supported these research activities. Three specific studies were conducted with the aid of the Dan David Scholarship, and the Dan David Foundation is acknowledged accordingly in each of the following papers:

- Gefen, A., Gefen, N., Zhu, Q., Raghupathi, R. and Margulies, S.S. Age-Dependent Canges in Material Properties of the Brain and Braincase of the Rat. *Journal of Neurotrauma*, **20**: 1163-1177, 2003.

- Gefen, A. and Seliktar, R. Comparison of the Trabecular Architecture and the Isostatic Stress Flow in the Human Calcaneus. *Medical Engineering & Physics,* **26:** 119-129, 2004.

- Gefen, A. and Margulies, S.S. Are In Vivo and In Situ Brain Tissues Mechanically Similar? *Journal of Biomechanics*,**37**: 1339-1352, 2004.

Copies of these papers are available in PDF format in the web-site of my laboratory, at www.eng.tau.ac.il/~msbm under "Publications".

Plans for future research

Corresponding with the general research goals above, my plan for the upcoming four years is to conduct studies to characterize mechanical factors in the onset of pressure ulcers and diabetic foot ulcers, and develop novel protective means for minimizing the prevalence of these maladies. I am also planning to analyze damage and adaptation phenomena in trabecular bone toward development of enhanced clinical tools for evaluation of patient-specific bone quality, for applications of surgical and pharmaceutical treatment planning e.g. in osteoporosis, and for evaluating the risk of an individual to suffer a fracture.

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