HOW BIOMECHANICS IS CHANGING WOUND CARE: CURRENT ACHIEVEMENTS AND FUTURE PROSPECTS

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Background

Difficult-to-heal wounds are currently considered among the most important, unsolved and expensive medical burdens. The major chronic wound types are pressure ulcers (PUs, also known as pressure injuries in the US, Canada and Australia), diabetic foot ulcers (DFUs) and venous leg ulcers (VLUs). Each of these wound etiologies involves a considerable mortality risk, for example, PUs cause deaths of 5 per 100,000 people each year at the ages of 65-84, and of 24-30 per 100,000 annually among those older than 84 years [1]. Our research work - extending over twenty years - has explained why quantitative, absolute and generic injury thresholds to predict when PUs, DFUs or VLUs may occur in a certain individual will unfortunately forever remain intangible, despite the vast efforts and resources that have been invested in allegedly discovering such injury thresholds. This perspective talk will explain why seeking such injury thresholds is naive and will always remain the 'search for the holy grail', yet, it will also describe routes for constructive future bioengineering research work needed for better prevention and treatment of PUs, DFUs and VLUs even if currently, there are no simple or straight-forward injury thresholds to predict when a person may suffer a chronic wound.

Biomechanics in wound care research

The roles of biomechanics and mechanobiology in better understanding wound etiologies and improving wound care will be described, in both basic and applied research contexts [2,3]. Biophysical markers for early detection and for targeting prevention will be discussed, given the availability of mechanobiological approaches and methodologies to discover or test feasibility of such biophysical markers towards clinical use, including based on daily subepidermal moisture measurements, infrared thermography imaging, tissue oxygenation readings, high-resolution/contrast skin and wound image processing and hybrid modalities [4-7]. The emerging role of machine learning algorithms in processing the above sensory data will be demonstrated [8]. Some inherent complexities in the prevention and treatment of PUs, DFUs and VLUs will be elucidated, particularly that: (i) Susceptibility to hard-to-heal wounds depends on integrated body system functions which are extremely difficult to predict in individuals, especially in seriously ill patients. (ii) A continuum exists between prevention and treatment of wounds, and clinicians are often required to treat an existing wound while protecting adjacent (peri-wound) tissues from deteriorating at the same time. (iii) Bioengineering can support both prevention and treatment through robotics-aided experimental test systems, computational modeling and mechanobiological assays in cell cultures, which altogether facilitate better understanding of risk factors, injury cascades and (cost-)effective treatments.

Amit Gefen is a Full Professor with the Department of Biomedical Engineering at Tel Aviv University and the Berman Chair in Vascular Bioengineering. The research interests of Prof. Gefen are in studying normal and pathological effects of biomechanical factors on the structure and function of cells, tissues and organs, with emphasis on applications in acute and chronic wound research. To date, Prof. Gefen published more than 300 articles in peer-reviewed international journals and multiple edited books on mechanobiology, cell and tissue biomechanics, with applications that are mostly in wound prevention and treatment. Prof. Gefen is listed among the top 50 most cited biomedical engineering scientists worldwide.

Future directions

Future bioengineering research in wound care is expected to rely heavily on robotics to simulate the different wound etiologies and relevant care environments. Work at the laboratory of the author has already resulted in robotic wound systems simulating PUs, DFUs and VLUs for efficacy research of existing and new wound care technologies and products [9,10]. Robotics are needed because clinical trials in wound prevention and care are becoming extremely expensive and complex to conduct and typically lack statistical power to be able to differentiate between product performance parameters. Likewise, multiphysics computational modeling are being integrated into methodologies for assessing advanced wound dressings, suturing and negative pressure wound therapy systems.

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