

Mechanics of Material/Cell/Tissue Interactions in vitro

Malgorzata Lewandowska-Szumiel

Department of Biophysics and Human Physiology, Medical University of Warsaw, Chalubinskiego 5, 02-004 Warsaw, Poland

INTRODUCTION: Our knowledge of the mechanical interactions between cells/tissues and materials is far from complete. However, it seems likely that an improved understanding will facilitate successful clinical intervention at all levels: repair, reconstruction and replacement.

This is the case especially with load-bearing tissues, and this lecture will focus mainly on bone tissue as an example. Artificial materials are playing a growing role in bone repair. This is due first to the fundamentally good and broad tolerance of bone cells and tissue towards many materials including a wide variety of metals, ceramics and polymers. This has led to new possibilities in bone reconstruction/regeneration, including so-called tissue engineered products, in which scaffold materials are enriched with living host cells.

Studies both reported by others in the literature and from our group in Warsaw will be presented. They will relate to three main topics:

METHODS: The difficulties to fully understand material/cell/tissue mechanical interactions are in great part a consequence of problems with finding adequate experimental systems. Thanks to recent developments in cell culture in vitro techniques, there are new and interesting possibilities. Some methods and resultant data will be shown, which indicate that elastic deformation of metallic implants may play a role in bone regeneration in contact with them, due to its influence on the osteogenic cell differentiation. Also, methods and results for exploring the role of other mechanical factors, such as shear stress will be briefly discussed in relation to their effect on the osteogenic potential of bone cells, which, in turn, is responsible for osteoconduction in vivo.

CONSEQUENCES: Relatively new findings suggest that attached cells are probably able to “feel” the supporting surface, i.e. their viability and function seems to be dependent, for example, on the surface stiffness of the support materials. Although this general concept is neither fully established nor understood, there are a growing number of reports, which describe such phenomena, including studies in our laboratory. The potential role of these observations in directing efforts to identify and develop new

biomaterials - including new scaffolds for tissue engineered products - will be discussed.

MECHANISMS: What are the means by which bone cells respond to mechanical stimulation? Recent scientific reports concerning bone cell mechanoreceptors will be presented.

The lecture is intended to not just cover scientific methods and phenomena. It is also intended to suggest the practical consequences of an improved understanding of the mechanics of material/cell/tissue interactions for further development of implant products and clinical treatment methods.