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Advanced synchrotron radiation tomography in regenerative medicine: A 3D exploration into the intimate interactions between tissues, cells and biomaterials

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The evaluation of engineered tissues is usually performed by light microscopy on one or more histological sections. This conventional analysis provides only bi-dimensional (2D) information with the consequent risk that the selected sections do not properly represent the entire biopsies. In recent years there has been an increasing interest in a novel approach to evaluate different engineered tissues by means of synchrotron micro-tomography (SCT). Using SCT, tissue regeneration subsequent to grafting hosting sites with different types of biomaterials (with or without stem cells seeding) was recently explored. SCT was shown to be fundamental to explore the dynamic and spatial distribution of regenerative phenomena, also in complex anatomic structures. Traditionally, absorption imaging with SCT is conducted with almost no distance between sample and detector. Homogeneous materials with a low attenuation coefficient (like collagen, unmineralized extracellular matrix, vessels, nerves, etc.) or heterogeneous materials with a narrow range of attenuation coefficients (like the case of heterologous bone scaffolds or graded mineralized bone) produce insufficient contrast for absorption imaging. For such materials, the imaging quality can be enhanced through the use of phase contrast tomography (PCT), often achieved with an increased distance between sample and detector (propagation-based imaging). In the present lecture, the most recent breakthroughs in regenerative medicine will be shown, demonstrating the unique capabilities of the SCT in offering not only an advanced characterization of different biomaterials (to understand the mechanism of their biological behavior as tissue substitute) but also to investigate the growth kinetics of regenerated tissues in different environments.

Biography

Alessandra Giuliani is Permanent Researcher and Aggregate Professor in Physics Applied to Cultural Heritage, Environment, Biology and Medicine at the Polytechnic University of Marche, Clinical Science Department. Within the Physics Group, she coordinates the research in Physics Applied to Biomaterials, Tissue Engineering and Regenerative Medicine. The purpose of her research is to study, using advanced physical techniques (such as microdiffraction, computed microtomography, holotomography), based on synchrotron radiation, all the structural changes of various biological tissues (mice bone under conditions of micro and macro gravity and / or of transgenic type, dental implants of various origins, tendons treated with collagen membranes, infarcted rat hearts treated with cardiac progenitor cells, mice dystrophic muscle injected with human AC133+ cells). A particular attention is paid to the vascularization issue of the regenerated tissue using an innovative imaging technique - the computed holotomography. She is author of around 54 peer-reviewed journal papers, chapters on 7 books internationally distributed and numerous works and abstracts related to National and International Congress presentations. Her researches in Physics applied to Tissue Engineering and Regenerative Medicine have been the subject of >45 presentations to Congresses and Schools, the most of them as invited speaker.

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