Real-time monitoring of relaxation and contractility of smooth muscle cells on microarrays

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In this report novel aspects of bioelectronic real time monitoring of viable cells and tissues on microarrays will be introduced. The main effort of the last years is the development of High Content Screening (HCS) systems based on novel multi-well-microelectrode-array technology in combination with transparent semiconductor electrode materials. Therefore, bioimpedance spectroscopy, electrophysiological recording and optical analysis in parallel using viable cells or tissues on biochips are available for fast real time and online characterisation and drug screening [1-5].

In this context an example will be demonstrated how to monitor cellular events and behaviours like relaxation and contractility of vascular smooth muscle cells (SMC). These processes play a major key role involved in pathology e.g. hypertension and atherosclerosis. For understanding the physiological and molecular mechanisms we established a non-invasive and label-free monitoring technique for a quantitative detection of SMC characteristics. Hence, a novel multiwell-interdigital electrode sensor-array in a standardized layout has been designed and fabricated. Electrode geometries and surfaces including a special passivation mediating an optimal smooth muscle cell-electrode interface could be realized for a sensitive impedimetric recording of relaxation and contractility. Furthermore a validation of this multi-well sensor-array demands the generation and cultivation of a primary SMC culture model that is switchable from a non-contractile pathological to a functional contractile phenotype. Applying reference compounds e.g. acetylcholine and amlodipine influencing and regarding to the SMC behaviour, we could detect and quantify cellular changes related to the contraction. In conclusion the frequency dependent impedance could be used for a real-time monitoring of the switching processes from relaxation and contraction in viable smooth muscle cells [6]. Moreover the physiological progress of aging in correlation and/or relation to altered and attenuated contractility could be demonstrated on this novel microarray and was verified by high resolution laser scanning microscopy.

References:

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