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Oxygen measurement in interstitially perfused cellularized constructs cultured in a miniaturized bioreactor

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Abstract:

Aims: The possibility of developing engineered tissue in vitro and maintaining the cell viability and functionality is primarily related to the possibility of controlling key culture parameters such as oxygen concentration and cell-specific oxygen consumption. We measured these parameters in a three-dimensional (3D) cellularized construct maintained under interstitially perfused culture in a miniaturized bioreactor.
Methods: MG63 osteosarcoma cells were seeded at high density on a 3D polystyrene scaffold. The 3D scaffolds were sensorized with sensor foils made of a polymer, which fluoresce with intensity proportional to the local oxygen tension. Images of the sensor foil in contact with the cellularize construct were acquired with a video camera every four hours for six culture days and were elaborated with analytical imaging software to obtain oxygen concentration maps.
Results: The data collected indicate a globally decreasing oxygen concentration profile, with a total drop of 28 % after six days of culture and an average drop of 10.5 % between the inlet and outlet of the perfused construct. Moreover, by importing the measured oxygen concentration data and the cell counts in a model of mass transport we calculated the cell-specific oxygen consumption over the whole culture period. The consumption increased with oxygen availability and ranged from 0.1 to 0.7 $\mu mol/h/10^6$ cells.
Conclusion: The sensors used here allowed a non-invasive, contamination-free and non-destructive oxygen measurement over the whole culture period. This study is the basis for optimization of the culture parameters involved in oxygen supply, in order to guarantee maintenance of cell viability in our system.

Keywords: Microfluidics, Cell culture, Perfusion, Bioreactor, Oxygen, Sensor