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Factors influencing the oxygen consumption rate of aortic valve interstitial cells (VICs): application to tissue engineering

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Objectives:

To investigate the metabolism of oxygen by aortic valve interstitial cells (VICs) in situ and in aortic valve leaflet tissue, with a view to generating input parameters to oxygen transport computational models.

Method:

Aortic valve leaflets and primary VICs were isolated from large white pigs. The oxygen consumption rates of fresh tissues (n=4) and VICs (10^6 /ml; passage 5 (P5) and P10 at 100% or 50% confluence; n=4) were determined using a respiration chamber (Strathkelvin Instruments) with a Clark-type oxygen electrode and a 782 oxygen meter at 37 °C. The dissolved oxygen concentration in the medium was continuously recorded at 1Hz. The consumption rates at individual oxygen concentrations were evaluated from the drop in the recorded oxygen tension over time. The maximum oxygen consumption rate ($\text{nmol}/10^6\text{cells}/\text{hour}$) was calculated using the Michaelis-Menten equation.

Results:

The oxygen consumption rate for all VICs tested was independent of oxygen concentration until it dropped below 4 % (v/v). There was no significant difference between the oxygen consumption rate of fresh tissue ($\sim 200\text{nmol}/10^6\text{cells}/\text{hour}$) and freshly isolated VICs in suspension at P5 50% confluence. Significant differences were found between P5 and P10 cells, as well as between cells at 50% and 100% confluent density.

Conclusions:

The consistency in the measured oxygen consumption rate of the P5 50% confluent cells in suspension and fresh tissue provided data for computational modelling of oxygen transport in aortic valves as well as an input into physiological requirements for culturing tissue engineered aortic valves in the bioreactor.