

Towards non-invasive characterisation of re-endothelialisation and restenosis following coronary stenting: an in vitro investigation using impedance spectroscopy

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Following the permanent implantation of a coronary stent, optimal arterial wall healing is characterised by re-endothelialisation, the regrowth of a functional Endothelial Cell (EC) monolayer over the exposed stent surface, which reduces the risk of thrombosis. However restenosis, arising from the proliferation and migration of medial Smooth Muscle Cells (SMCs) can cause luminal narrowing to reoccur. Previous research has suggested that the stent itself could be used as an electrode and, when combined with non-invasive impedance spectroscopy techniques, monitor post stenting recovery. This could then inform clinicians on cell regrowth without the need for invasive imaging techniques. In this study we investigated the feasibility of this concept using two in-vitro models representing the cellular regrowth scenarios: re-endothelialisation and restenosis.

Primary porcine ECs and SMCs were seeded onto platinum electrodes and electrical impedance spectroscopy measurements were made for up to 10 days in the frequency range 1 KHz to 100 KHz. Endothelium function was assessed through the measurement of the impedance response of confluent EC monolayers to the addition of a gap junction enhancer, dipyridamole, or an inhibitor (heptanol or carbenoxolone).

Our results show that confluent, stent surface comparable populations of SMCs and ECs give rise to distinct impedance signatures, providing a novel method of non-invasively characterising these cell types. Gap junction inhibition of EC monolayers dose dependently reduced total impedance. Conversely dipyridamole's enhancing effect on gap junction formation caused an increase in total impedance. These novel findings show the importance of intercellular gap junction communication in maintaining EC barrier function. Our current work is focused on the translation of this technology towards in-vivo monitoring of in-stent restenosis and recovery of a functional endothelium.

Acknowledgements this study was funded by the UK Engineering and Physical Sciences Research Council (EP/F50036X/1) and is the subject of granted and pending patents at the University of Strathclyde.

Accepted manuscript of the following research output: Holland, I., McCormick, C., & Connolly, P. (2017). Towards non-invasive characterisation of re-endothelialisation and restenosis following coronary stenting: an in vitro investigation using impedance spectroscopy. *Heart*, 103(Suppl 2). <https://doi.org/10.1136/heartjnl-2017-311433.18>