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Raman Spectroscopic of Cardioprotective Mechanism During the Metabolic Inhibition of Heart Cells

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Abstract : Following ischaemia/reperfusion injury, as in a myocardial infraction, cardiac myocytes undergo oxidative stress which leads to several potential outcomes including; necrotic or apoptotic cell death or dysregulated calcium homeostasis or disruption of the electron transport chain. Several studies have shown that nitric oxide donors protect cardiomyocytes against ischemia and reperfusion. However until present, the mechanism of cardioprotective effect of nitric oxide donor in isolated ventricular cardiomyocytes is not fully understood and has not been investigated before using Raman spectroscopy. For these reasons, the aim of this study was to develop a novel technique, pre-resonance Raman spectroscopy, to investigate the mechanism of cardioprotective effect of nitric oxide donor in isolated ventricular cardiomyocytes exposed to metabolic inhibition and re-energisation. The results demonstrated the first time that Raman microspectroscopy technique has the capability to monitor the metabolic inhibition of cardiomyocytes and to monitor the effectiveness of cardioprotection by nitric oxide donor prior to metabolic inhibition of cardiomyocytes. Metabolic inhibition and reenergisation were used in this study to mimic the low and high oxygen levels experienced by cells during ischaemic and reperfusion treatments. A laser wavelength of 488 nm used in this study has been found to provide the most sensitive means of observe the cellular mechanisms of myoglobin during nitric oxide donor preconditioning, metabolic inhibition and re-energisation and did not cause any damage to the cells. The data also highlight the considerably different cellular responses to metabolic inhibition to ischaemia. Moreover, the data has been shown the relationship between the release of myoglobin and chemical ischemia where that the release of myoglobin from the cell only occurred if a cell did not recover contractility.

Keywords : ex vivo biospectroscopy, Raman spectroscopy, biophotonics, cardiomyocytes, ischaemia / reperfusion injury, cardioprotection, nitric oxide donor
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