Changes in microregional perfusion, oxygenation, ATP and lactate distribution in subcutaneous rat tumours upon water-filtered IR-A hyperthermia

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Abstract

The effect of hyperthermia on microcirculatory and metabolic parameters in S.C. DS-sarcomas of different sizes on the hind foot dorsum of SD-rats was investigated. Hyperthermia was carried out using a novel water-filtered, infrared-A radiation technique. Heating was performed at a rate of O.S"C/min until 44°C was achieved in the tumour centre, which was maintained for 60 min. Using a multichannel laser Doppler flowmeter, red blood cell flux could be assessed continuously and at several sites within the tumour tissue simultaneously. Substantial inter-site variations in laser Doppler flux (LDF) were observed during hyperthermia which were independent of tumour size, site of measurement, and temperature at the site of measurement, indicating that single site measurements of tumour LDF are poor predictors of the mean response of a tumour to hyperthermia. When mean LDF was considered, decreases in red blood cell fluxes occurred that were more pronounced the greater the tumour volume. In no case was vascular stasis observed. Hyperthermia did not affect tumour oxygenation substantially. Microregional and global assessment of lactate and ATP concentrations demonstrated increased lactate and decreased ATP levels following hyperthermia. Tumour glucose levels were increased following hyperthermia, possibly due to an enlarged distribution space resulting from development of interstitial oedema. Changes in lactate and ATP levels and the lack of changes in tumour oxygenation suggest a modification of energy metabolism following hyperthermia in the form of increased ATP hydrolysis, intensified glycolysis and impaired oxidative phosphorylation.