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Neonatal myocardium is more sensitive to ischemia than the adult one

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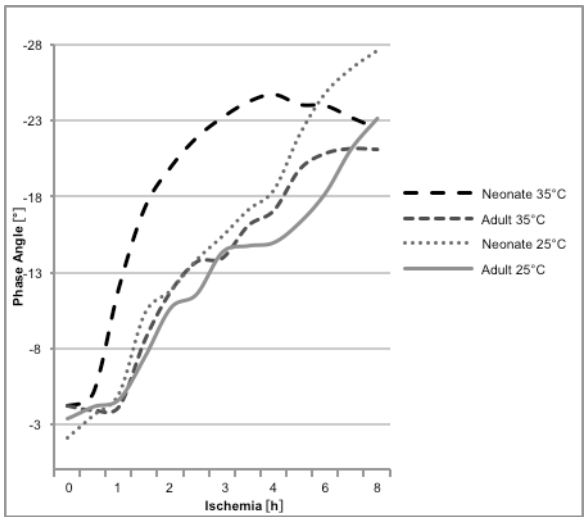
Objectives. Bioelectrical impedance measurement is a non-invasive method to determine alterations in tissue structures. Thus, neonatal and adult hearts were examined at different temperatures (35°C and 25°C) during ischemia to analyze distinctive organ specific changes in appropriate impedance spectra.

Material & Methods. Ischemic isolated hearts of piglets (NEO, n=9) and adult pigs (ADULT, n=9) were examined at 35°C or 25°C. Mean age of NEO was 7d (35°C) and 4d (25°C) and of ADULT 2.8 and 2.6 months, respectively. After harvesting of every heart an epicardial probe was placed on the left ventricle parallel to the LAD and continuous measurements of bioelectrical impedance were performed within a frequency range from 100 Hz to 1 MHz. All hearts were incubated at constant temperature (35°C, 25°C) for 24 hours. Furthermore, morphology was evaluated by ultrastructural analyses.

Results. In all groups the phase angle changed in an equivalent way demonstrating a sigmoid curve over time (see Fig.). However, significant differences between NEO and ADULT were evident, especially at 35°C (e.g. p=0.009 after 4hrs). The maximal changes of the phase angle as indicator for the measured impedance were much higher in both neonatal groups (35°C: -24,74°; 25°C: -28.22°) compared to the adults (35°C: -21.12° ; 25°C: -24,34°). Furthermore, at 25°C the onset of the increase in impedance occurred later in NEO and ADULT.
The calculated extracellular space index (ESI) as a marker for the ischemia-induced edema decreased from 54.9% (NEO) and 51.3% (ADULT), respectively, to 10.4% (NEO) and 13.5% (ADULT) at 35°C after 5 and 7 hours. At 25°C ESI decreased from 60.1% (NEO) and 52.5% (ADULT) to 8.4% (NEO) and 8.8% (ADULT) after 9 hours.
Ultrastructural analyses showed first reversible and later irreversible injuries.



Conclusions. Atraumatic measurements of bioimpedance provide an insight in intra-ischemic changes in myocardial membranes and in extracellular space. Ischemic stress-dependent alterations of myocardial tissue can be proven. Our results showed that neonatal myocardium is much more sensitive to ischemia-induced alterations, since irreversible myocardial injury occurs faster than in adult tissue. Thus, it's important to further expand our knowledge of neonatal myocardium during ischemia and thereby of intraoperative myocardial protection.