Myocardial energy metabolism in the newborn lamb in vivo during pacing-induced changes in oxygen consumption.

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Myocardial energy metabolism was studied in newborn sheep to determine whether the metabolic responses to pacing-induced increases in heart rate were similar to those previously found during catecholamine stimulation. Open-chest newborn sheep, 3 to 9 d old (n = 11), underwent atrial pacing at a respiratory rate harmonic just above the intrinsic heart rate. Pacing rate was increased by 30 beats/min every 5 min until conduction block or a drop in systemic arterial pressure occurred. Phosphorous metabolites were monitored simultaneously (n = 7) using a 31P magnetic resonance surface coil over the heart within a magnet operating at 4.7 tesla. Myocardial oxygen consumption was monitoring via an extracorporeal shunt from the coronary sinus. Rate pressure product increased with heart rate and was found to relate to myocardial oxygen consumption (r = 0.75), which increased maximally by 47 +/- 9% due to increases in coronary blood flow. Phosphocreatine/ATP ratio decreased significantly, and calculated ADP increased between baseline and peak performance but returned to near baseline levels during recovery at the initial pacing rate. These findings indicate that intracellular high-energy phosphate concentrations do change with alterations in myocardial oxygen consumption induced by cardiac pacing in the newborn. These changes are similar to those found during epinephrine infusion. Furthermore, the ATP hydrolysis products probably participate in myocardial respiratory regulation in the newborn in vivo.