Microdialysis Detects Ischemic Change Early in the Evolution of Acute Compartment Syndrome

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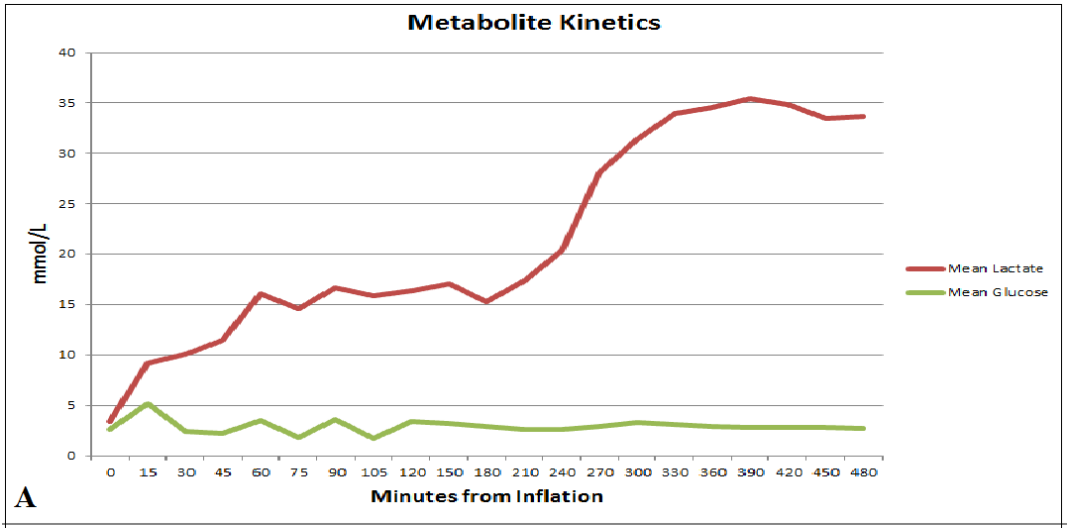
Purpose: Acute compartment syndrome (ACS) develops when intracompartmental pressure (ICP) elevates to a level impairing local muscle perfusion. In the setting of ischemia and hypoxia, myocytes transition from aerobic to anaerobic cellular respiration. Currently, microdialysis technology is used in the neurosurgical setting to detect evidence of brain hypoxia. The purpose of this study is to determine whether microdialysis is capable of detecting local extracellular metabolic changes in skeletal muscle indicative of ischemia secondary to ACS.

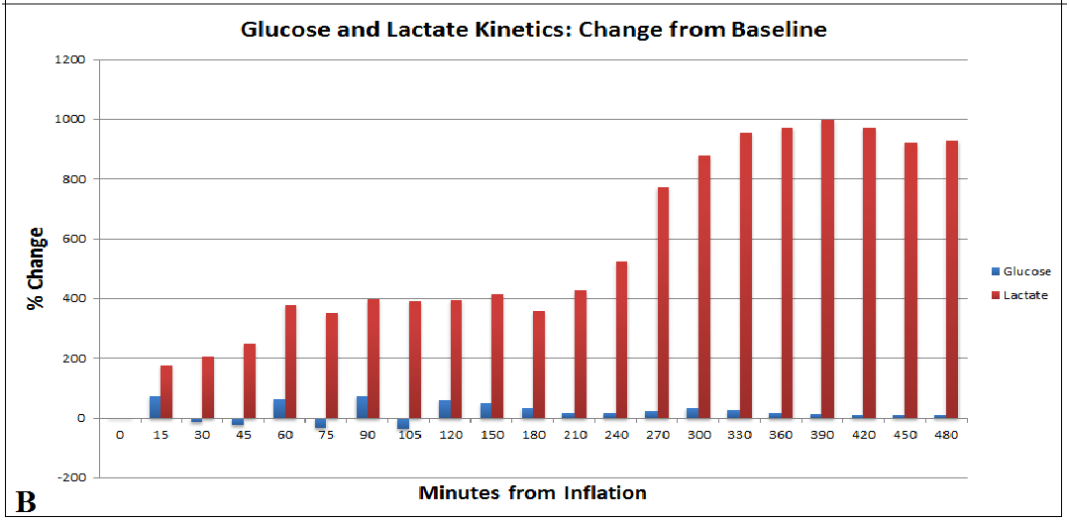
Methods: Following International Animal Care and Use Committee (IACUC) approval, an ACS was created in the anterior compartment of New Zealand White rabbits' legs using a previously validated balloon inflation model. After submuscular placement of the balloon, an intramuscular microdialysis (mDialysis) catheter was placed. The balloon was inflated and compartment pressures were measured using an Intra-Compartmental Pressure Monitor (Stryker). Dialysate was collected at 30-minute intervals over an 8-hour period. Glucose and lactate levels were recorded at each point and a lactate-glucose ratio was determined. Pearson's correlation coefficient (r) was used to determine correlation between glucose and lactate levels.

Results: An average ICP of 52 mm Hg was maintained via balloon inflation (mean delta P = 8 mm Hg). Mean intracompartmental glucose levels increased from 2.6 mmol/L at baseline to 5.2 mmol/L at 15 minutes. After this initial surge, glucose levels remained fairly constant over the remaining time (Figure 1A). Lactate underwent steady increase, indicating progressive ischemia. At 60 minutes, lactate levels had increased 377% from baseline and this was maintained through 180 minutes. Between 210 and 330 minutes, there was another marked increase in lactate (427% to 955%). Lactate remained markedly elevated (>900% from baseline) through the remainder of the trial (Figure 1B). The lactate-glucose ratio steadily increased from 1.4 at baseline to 10.1 at 75 minutes. This ratio peaked and remained elevated over the subsequent 7 hours and 15 minutes. There was a high correlation (r = 0.91) between percent change in glucose and lactate levels (from immediately previous values) in the first 60 minutes and this correlation gradually diminished by 2 hours (r = 0.65) and remained steady over the remainder of the trial (r = 0.65 at 8 hours).

Conclusion: Myocytes undergo predictable transition to anaerobic metabolism in the setting of ACS-induced ischemia, resulting in the steady production of lactic acid. This study is the first to demonstrate that microdialysis is capable of detecting local ischemia in acute compartment syndrome. In addition, microdialysis was able to elucidate local extracellular glucose and lactate kinetics that have been previously unreported in the setting of ACS. We believe this technology may provide a more sensitive and specific method of diagnosing ACS, can be used easily in the clinical setting, and may yield information leading to novel therapeutic strategies for prolonging muscle viability in the setting of ACS.

See pages 47 - 108 for financial disclosure information.





The FDA has stated that it is the responsibility of the physician to determine the FDA clearance status of each drug or medical device he or she wishes to use in clinical practice.