Pre-Clinical Acute Compartment Syndrome with a Porcine Continuous Measurement Model

Yazan Honjol, BA, MD; Rachel Monk, BS; Drew Schupbach MD; Géraldine Merle, PhD; ***Edward J Harvey MD, MSc***
McGill University, Montreal, QC, Canada

Purpose: Acute compartment syndrome (ACS) is a surgical emergency that can have lasting and devastating consequences if not treated adequately or within an appropriate time. With the risk of missed diagnosis or overtreatment, there exists a need to reliably and accurately identify a compartment syndrome. Our laboratory has validated a wireless micro-electro-mechanical sensor to continuously and accurately monitor compartment pressures. We investigated the use of a balloon catheter versus an ischemia-reperfusion injury with superimposed direct crush of the anterior compartment in a porcine model. The objective of the study is twofold: (1) to establish and validate a porcine model of ACS, and (2) to determine the consistency of in vivo monitoring using novel pressure sensing technology. The ideal model would be reproducible and quantifiable increase in pressure after injury with return to normal pressures after compartment release.

Methods: In each hindlimb of six anesthetized Landrace Hybrid swine, two techniques were simultaneously performed to induce compartment syndrome. In one hindlimb, a balloon catheter was inserted in the anterior compartment and inflated between the tibia and the muscle. In the contralateral limb, two custom-made tourniquet cuffs were used to induce an ischemia-reperfusion injury with superimposed direct crush of the anterior compartment. The inflation was for a period of 5 hours. A 2-hour observation period ensued after deflation of both the balloon catheter and tourniquet cuffs. Percutaneous fasciotomy using a fasciotome was attempted in all hindlimbs before opening the complete compartment.

Results: Continuous monitoring of compartment pressure was successfully performed in vivo using novel pressure sensing technology. The ischemia-reperfusion with superimposed direct crush injury model was found to consistently yield higher post injury compartment pressures than the balloon catheter model. All animal legs had a return to baseline after complete release.

Conclusion: The use of novel pressure sensing technology can successfully measure compartment pressures in vivo. Both porcine models are effective at inducing compartment syndrome; however, the ischemia-reperfusion + crush model was found to be superior in numerous aspects including consistency, reproducibility, and ease of set-up. Release of the fascia resulted in an ideal modeling of return to baseline pressures.