Characterization of Early Changes in Limb Compartment Pressure Following Electrical Contact Injury

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Firefighters' Burn and Surgical Research Laboratory

Introduction

Electrical injuries constitute a considerable portion of burn center admissions. A consequence of electrical injury can be compartment syndrome, which in severe cases may result in amputation and limb loss. Although the clinical diagnosis of compartment syndrome has been well studied, the early development of increased compartment pressures is not completely understood. This study investigates and characterizes the development of early increases in compartment pressures through quantification of limb size and pressure following high voltage injury in an animal model.

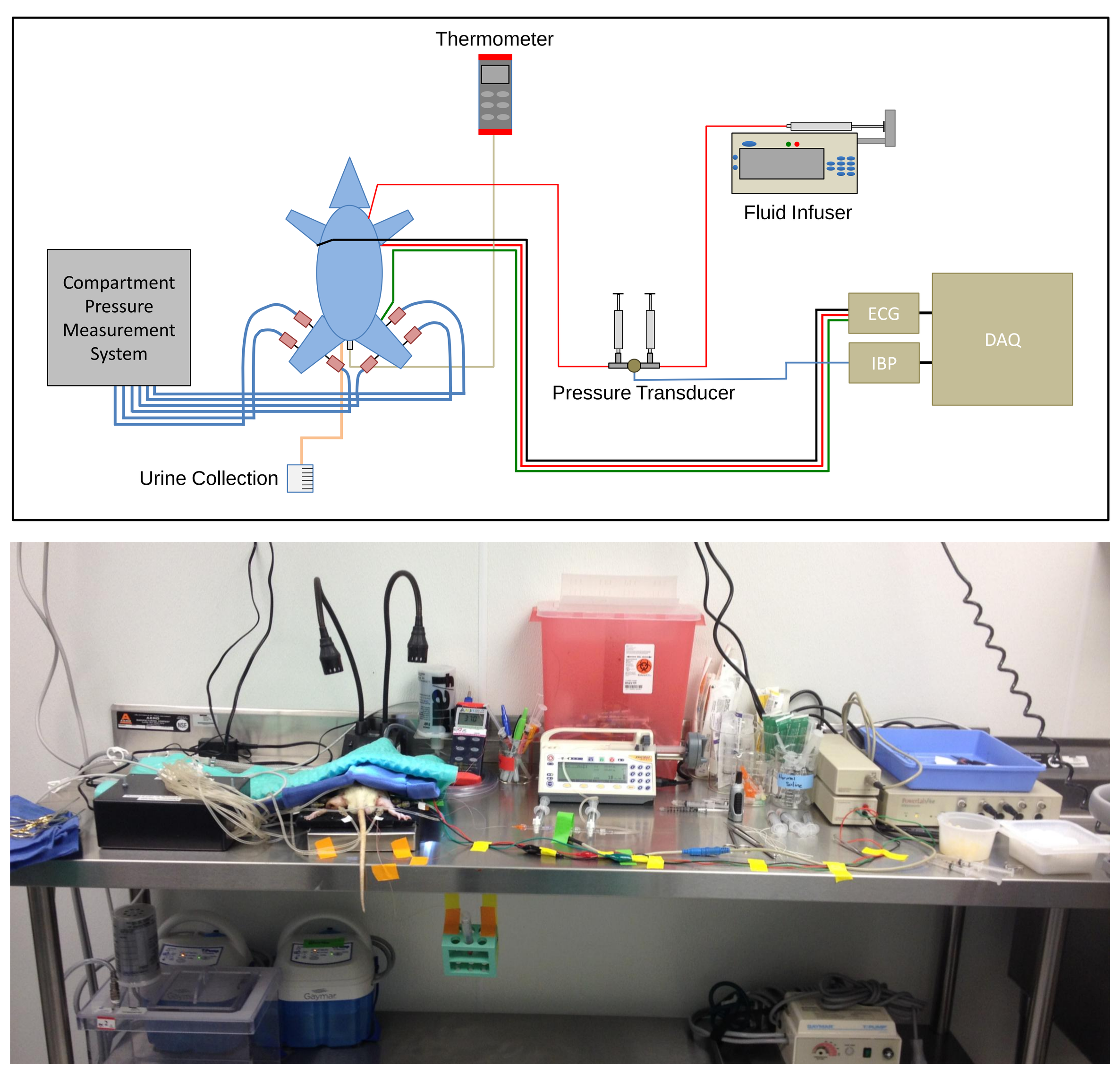

Figure 1: Experimental set-up diagram including: the compartment pressure measurement system, ECG, invasive blood pressure transduction, fluid Infuser and urine collection systems.

Methods

Male Sprague Dawley rats were subjected to (1000V) DC current for 20 seconds. Compartment pressure was examined by limb circumference, and a compartment pressure measurement system (CPMS) was used to invasively monitor intra-compartmental pressure changes. Blood pressure was measured via a carotid artery cannula, urine output by a urinary bladder drain, heart rate by ECG and blood gas metrics by arterial blood gas analysis. Additionally plasma was collected for measurement of creatine kinase and myoglobin.

Compartment Monitoring

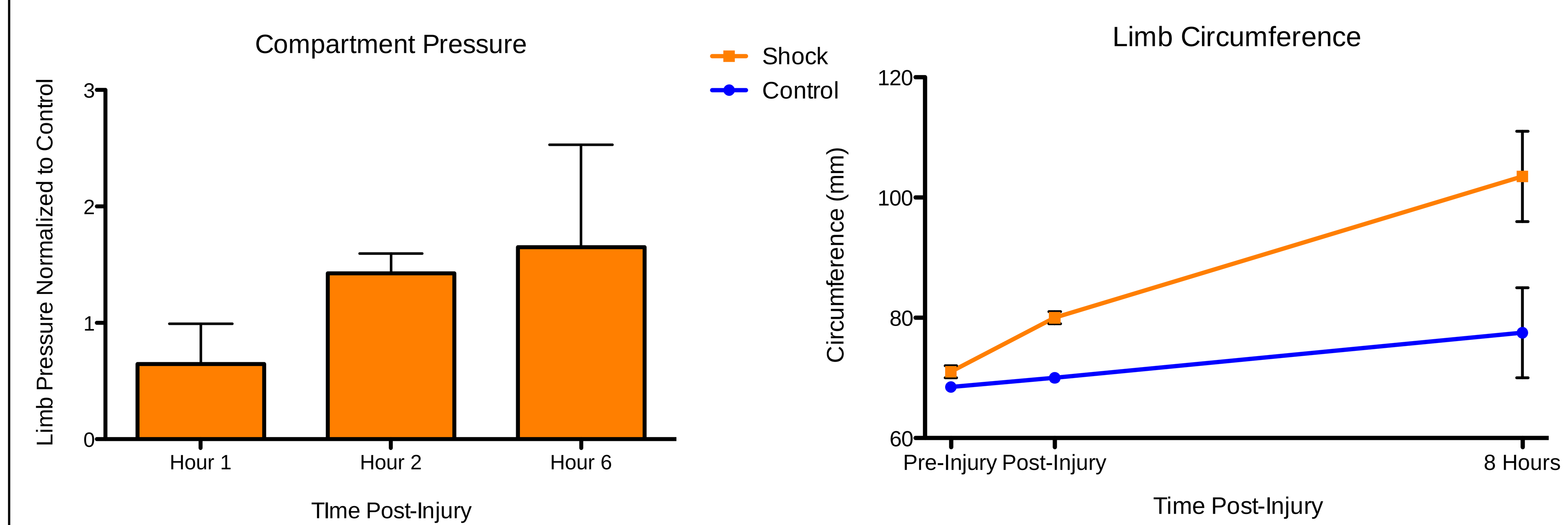

Figure 2: Limb compartment pressure and limb circumference of electrically injured animals

Physiologic Metrics

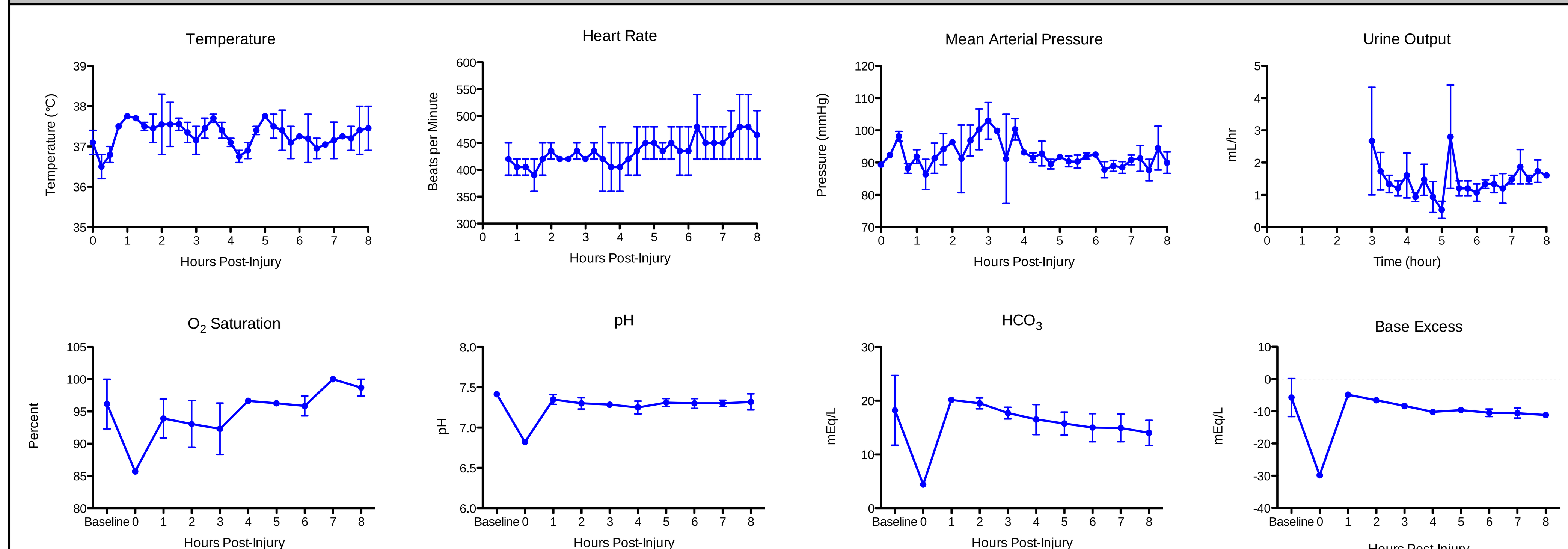

Figure 3: Physiologic metrics of electrically injured animals including: temperature, heart rate, mean arterial pressure, urine output, and blood metrics: hemoglobin oxygen saturation, pH, bicarbonate content and base excess.

Limb Perfusion

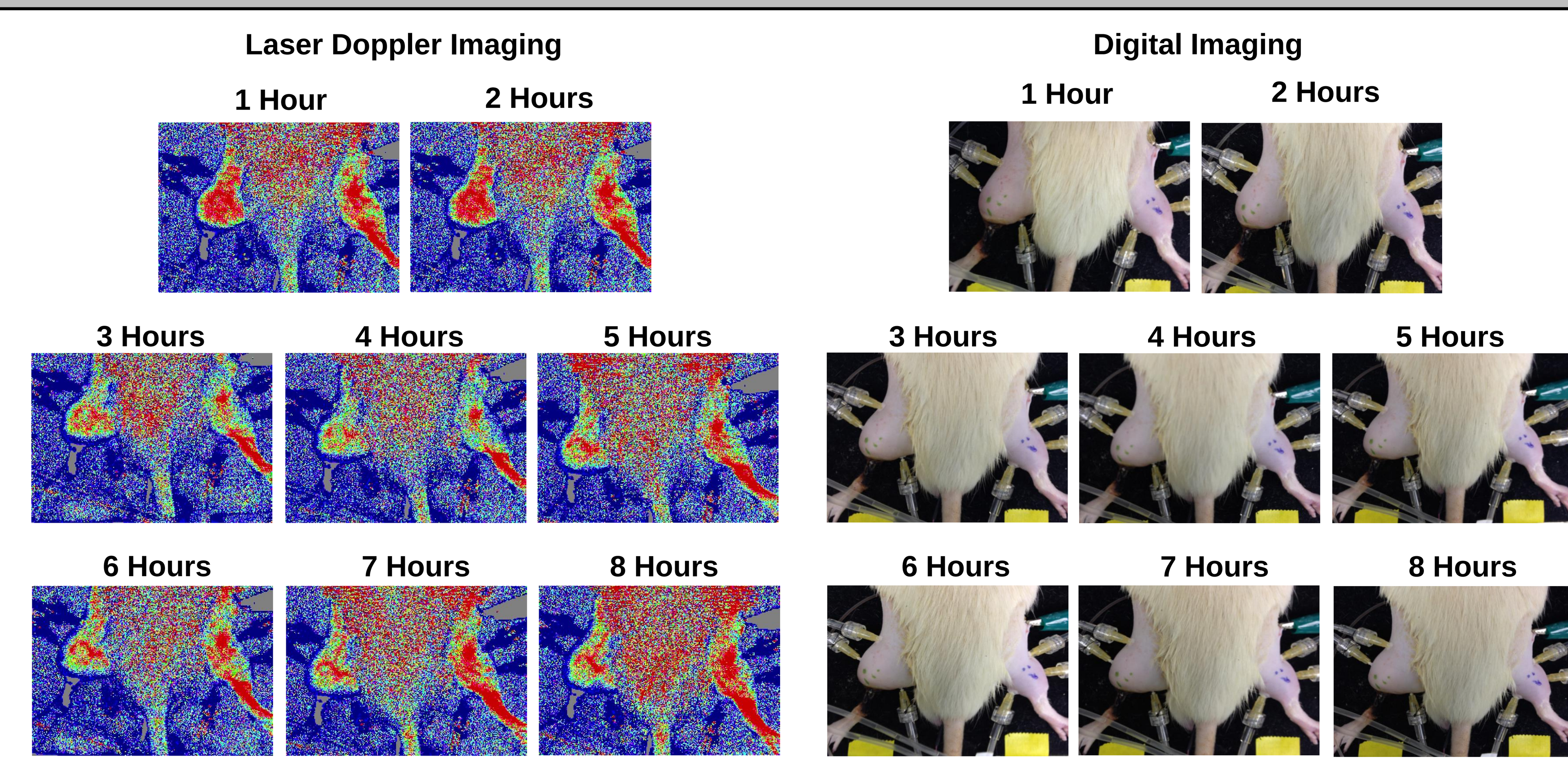

Figure 4: Laser Doppler digital images of electrically injured and control hindlimbs

Results

Increased compartment pressure was observed in the electrically contacted limb shortly following injury. Average limb circumference increased 9mm(13%) in the control limb and 32.5(46%) in the injured limb. Injured limb compartment pressure increased over the control and maintained an 1-3 fold difference over the subsequent hours. Levels of circulating myoglobin were similar between both groups while CK-MM was elevated in the shock group (p=0.02) over the control.

Systemic Markers

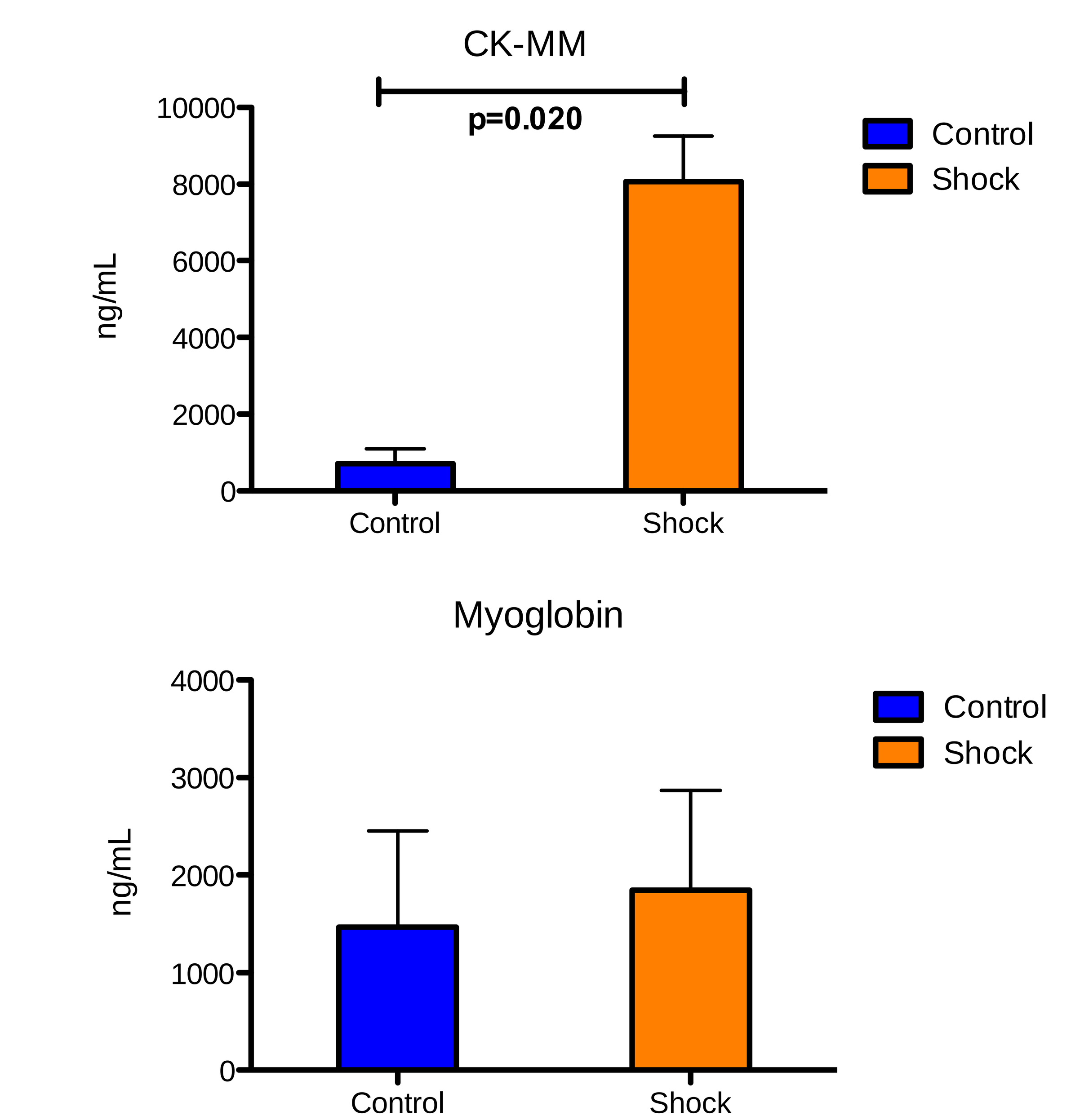

Figure 5: Levels of circulating protein markers CK-MM and myoglobin

Conclusion

High voltage electrical injury induces increased compartment pressure rapidly in contacted limbs and increases pressure in un-injured limbs as well. Following a period of rapid inflammation, the injured limb then more slowly increases pressure and size over the post-injury period. These observations suggest that there may be pathways involved in inflammatory regulation and control during this period and points to potential compartment pressure progression biomarkers.