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The Impact of Prophylactic Fasciotomy following porcine limb ischemia/reprofusion injury

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The Impact of Prophylactic Fasciotomy Following Porcine (Sus scrofa) Hind Limb Ischemia/reperfusion Injury

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**Background:** Prophylactic fasciotomy has been used as an adjunct to alleviate the compartment syndrome after an ischemia reperfusion injury. It has been purposed that prophylactically treating compartment syndrome will improve neuromuscular recovery of the limb therefore improving functional limb outcome. The purpose of this study is to quantify the neuromuscular recovery of prophylactic fasciotomy in a porcine model of hind limb ischemia.

**Method:** Swine (*Sus Scrofa*; 76 +/-6kg) were randomly assigned to no fasciotomy or prophylactic fasciotomy after ischemia via external iliac artery occlusion and arteriotomy. Class III shock was induced via a 35% blood volume variable rate hemorrhage and external iliac artery repair was achieved after 0, 3, or 6 hours of ischemia. Prophylactic fasciotomy of the anterior compartment was performed at the time of reperfusion. Compound motor action potential, sensory nerve action potential, nerve conduction velocity and gait testing was evaluated during the 14-day survival period to calculate the composite physiologic model of recovery (PMR). Necropsy was performed for evaluation of nerve and muscle histology.

**Results:** In hemorrhage alone, according to the PMR the recovery was 94+/-28%, 63+/-37% and 55+/-44% at 0, 3 and 6 hours of ischemia respectively. A significant difference was noted between 0 and 6 hours of ischemia (p<0.05). With fasciotomy, a recovery of 97+/-72%, 98+/-80% and 42+/-39% was noted after 0, 3 and 6 hours of ischemia. Compound motor action potential showed the greatest decrement with ischemic insult. Histologic analysis is currently on going.

**Conclusion:** This study demonstrates the feasibility of fasciotomy in a porcine model. It validates the previous model of functional limb outcome with hemorrhage in a porcine model and shows an apparent trend towards improved functional limb outcome if vascular repair and prophylactic fasciotomy are performed within 3 hours of ischemic time.
Vascular injury is five times the rate of previously reported wars, with the majority of those injuries taking place in the extremities. Recent research has shown the ischaemic threshold of 6 hours has been decreased to < 6 hours in the absence of hemorrhage and < 3 hours in the presence of hemorrhage. Prophylactic fasciotomy has been used to extend the ischaemic threshold by alleviating compartment syndrome after ischaemia reperfusion injury. The functional improvement after prophylactic fasciotomy has yet to be investigated in a translatable large survival model. The objective of this study is to establish a model of extremity compartment syndrome following vascular injury, hemorrhage and ischemia/reperfusion. An additional objective is to determine the effect of fasciotomy on measures of neuromuscular recovery. We hypothesize that prophylactic fasciotomy will improve functional outcome through the alleviation of compartment syndrome.

Methods

Thirty five female yorkshire swine (75 +/- 5kg) underwent 35% blood volume hemorrhage, followed by 1, 3 and 6 hours of ischemia via a right retroperitonael iliac artery occlusion followed by standardized repair with dacron patch angioplasty and reperfusion (n=17; 1HR, 3HR, 6HR). A second cohort (n=18) underwent prophylactic fasciotomy of the anterior compartment of the hind limb following the blood volume hemorrhage and arterial repair, (1HR-F, 3HR-F, 6HR-F). Compartment pressures and measures of electromyographic (EMG) recovery were performed pre-operative, post-operative and on POD 1, 2, 7 and 14. The EMG variables were combined and compared to baseline to create the Physiologic Model of Recovery (PMR). On day 14, necropsy was performed and histologic analysis of the peroneus tertius and peroneal nerves was performed.

Results

Physiologic model of recovery (combination of Compound Motor Action Potential (CMAP), Sensory Nerve Action Potential (SNAP) and Nerve Conduction Velocity (NCV))

Compartment pressures

Histologic Results

Physiologic Model of Recovery

Table. Characteristics at day 14.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Means (SE)</th>
<th>1HR</th>
<th>3HR</th>
<th>6HR</th>
<th>p-value</th>
<th>1HR vs. 3HR</th>
<th>1HR vs. 6HR</th>
<th>3HR vs. 6HR</th>
<th>p-value</th>
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<tr>
<td>CMAP [mV]</td>
<td>13.8 (1.0)</td>
<td>16.2 (1.2)</td>
<td>15.4 (1.0)</td>
<td>13.8 (0.9)</td>
<td>0.034</td>
<td>0.046</td>
<td>0.884</td>
<td>0.230</td>
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<tr>
<td>SNAP [mV]</td>
<td>10.5</td>
<td>13.0 (1.0)</td>
<td>11.5 (1.4)</td>
<td>11.5 (1.2)</td>
<td>10.5</td>
<td>0.04</td>
<td>0.046</td>
<td>0.046</td>
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<tr>
<td>AST (U/L)</td>
<td>40.1 (10.6)</td>
<td>19.7 (1.2)</td>
<td>21.3 (2.6)</td>
<td>20.7 (1.2)</td>
<td>0.046</td>
<td>0.230</td>
<td>0.046</td>
<td>0.046</td>
<td></td>
</tr>
<tr>
<td>Myoglobin (mg/dL)</td>
<td>64.1 (12.2)</td>
<td>58.7 (9.5)</td>
<td>58.7 (9.5)</td>
<td>51.4 (5.3)</td>
<td>0.057</td>
<td>0.046</td>
<td>0.230</td>
<td>0.046</td>
<td></td>
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<tr>
<td>Lactate (mM)</td>
<td>5.1 (1.4)</td>
<td>5.3 (1.4)</td>
<td>5.3 (1.4)</td>
<td>5.3 (1.4)</td>
<td>0.034</td>
<td>0.046</td>
<td>0.046</td>
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</table>

Conclusion

Although not statistically significant, fasciotomy at 3 hours of ischemia improved recovery, 3HR 66 +/- 9% vs. 3HR-F 81 +/- 9%.

Fasciotomy at 3 hours of ischemia improved recovery, 3HR 66 +/- 9% vs. 3HR-F 81 +/- 9%.

Obstacles

- Compartment pressure had a statistically significant rise between all groups (1HR, 3HR & 6HR).
- Fasciotomy released compartment pressure in a statistically significant manner at 3 and 6 hours of ischemia.
- Increasing intervals of ischemia without fasciotomy showed worsening muscle damage that was mitigated by fasciotomy.

Fasciotomy did not improve recovery at 6 hours of ischemia, 6HR 47 +/- 8% vs. 6HR-F 52 +/- 11%.

Fasciotomy at 3 hours of ischemia improved recovery, 3HR 66 +/- 9% vs. 3HR-F 81 +/- 9%.

Conclusions

- Elevated compartment pressures can be obtained in a translatable model of ischemia/reperfusion injury.
- Fasciotomy successfully reduces compartment pressures and reduces the result for further damage caused by compartment syndrome.
- After 6 hours of ischemia in the presence of hemorrhage, fasciotomy does not improve the functional outcome of the limb.
- Although not statistically significant, fasciotomy at 3 hours of ischemia with hemorrhage trended towards improved functional outcome.
- Fasciotomy moves the ischemic threshold from less than 3 hours to 3 to 6 hours.

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References