Pelvic Injury Predicts Shock Severity and Systemic Inflammation

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Background/Purpose: Multiply injured patients (MIPs) with pelvic injuries incur a substantial amount of mechanical and ischemic tissue damage. This population is at risk of significant blood loss and subsequent hemorrhagic shock (HS). Patients sustaining pelvic trauma have higher mortality rates and are more likely to require blood transfusion than MIPs without pelvic injury. Hemorrhage and tissue damage have been hypothesized to incite and propagate inflammation, which can manifest as the systemic inflammatory response syndrome (SIRS) and lead to multiple organ failure (MOF). The specific contribution of pelvic trauma to the overall injury complex and response to injury is unknown. We hypothesize the presence of a pelvic injury in MIPs will predict a higher degree of systemic inflammation, whole body tissue damage volume, shock, and organ dysfunction compared to MIPs without pelvic injury.

Methods: A retrospective analysis of MIPs (ISS >18) ages 18 to 65 years admitted to an ICU for a minimum of 7 days was conducted, identifying 77 consecutive patients. A cohort of patients with pelvic injury (Group 1, n = 39) was compared to a control group without pelvic injury (Group 2, n = 38). Trauma response was quantified by measuring daily SIRS scores (0-4) and averaging these values over the duration of the ICU stay. Daily Sequential Organ Functional Assessment (SOFA) scores (0-24) were measured and averaged over the ICU admission to assess organ dysfunction. Patient-specific whole body mechanical tissue damage was quantified using a novel index termed the Tissue Damage Volume Score (TDVS). TDVS is calculated by measuring the radius (and subsequent assumed spherical volume) of every injury detected on admission CT scans and radiographs (V = 4/3 pr3). Individual injuries were summed into a total TDVS score. Patient-specific hypoperfusion was quantified by measuring Shock Volume (SV), which is a composite value of the magnitude and duration of shock. SV is calculated by integrating sequential shock index (heart rate/systolic blood pressure) data points above a threshold of 0.9 for the first 48 hours after injury. A shock index >0.9 has been correlated with transfusion requirements, complications, and mortality. A Student t test was utilized to compare groups.

Results: Groups 1 and 2 were evenly matched with no demographic differences with respect to mean age (40 vs 38), gender (74% male, 26% female vs 79% male, 21% female), ISS (33 vs 30), ICU length of stay (15.1 days vs 15.6 days), body mass index (30.3 vs 30.4), and mortality (4 in each group). Pelvic injury patients had increased hypoperfusion compared to patients without pelvic injury. There was a trend toward more shock in the first 24 hours (SV = 11.45 Group 1 vs 8.76 Group 2, P = 0.08) and significantly more shock between 24 and 48 hours after injury with a 70% increase in hypoperfusion in pelvic injury patients in this time period (SV = 11.24 Group 1 vs 6.61 Group 2, P = 0.02). Patients sustaining pelvic injuries had 100% more mechanical tissue damage compared to patients without pelvic injury (TDVS = 1352 cm3 Group 1 vs 673 cm3 Group 2, P <0.01). Patients sustaining pelvic injuries had greater systemic inflammation with mean SIRS scores increasing by 25% (mean

SIRS = 2.31 Group 1 vs 1.88 Group 2, P <0.01). There was no difference in organ dysfunction between the groups (mean SOFA = 5.54 Group 1 vs 5.32 Group 2, P = 0.68).

Conclusion: This investigation demonstrated that MIPs with pelvic trauma had significantly more mechanical tissue damage and hypoperfusion than similarly injured MIPs without pelvic trauma. Interestingly, pelvic trauma appears to manifest in prolonged bleeding. Pelvic injury patients had significantly more shock volume in the second day after injury compared to MIPs without pelvic injury. The presence of a pelvic injury independently predicted higher levels of persistent inflammation after injury. However, greater inflammation did not extrapolate into higher degrees of organ dysfunction. This study applied two novel metrics that allow patient-specific measurements of injury to be investigated independently to determine how specific components of an injury complex manifest clinically. Future prospective studies should aim to further delineate how patient-specific injury characteristics and patient-specific response to injury predicts clinical trajectories.

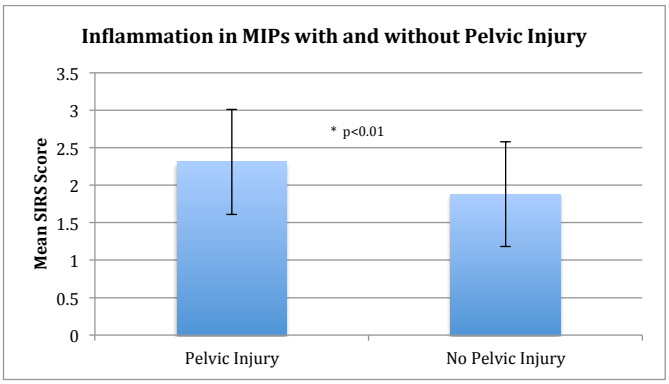

Figure 1. The presence of pelvic injury was associated with higher mean SIRS scores (p<0.01) compared to MIPs without pelvic injury.

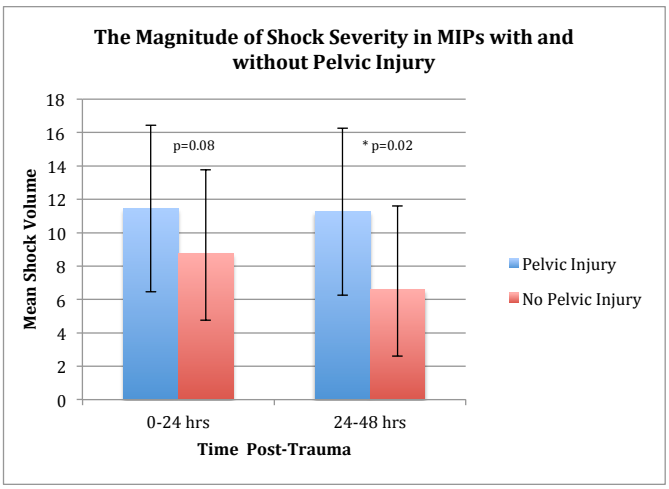

Figure 2. The presence of pelvic injury correlated with a greater magnitude and duration of shock 24-48 hours post-injury (p=0.02) compared to MIPs without pelvic injury and no statistical difference 0-24 hours post-trauma (p=0.08).

See pages 47 - 108 for financial disclosure information.