Disproportionate Acidosis After Traumatic Bladder Rupture: A Case-Control Study

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Abstract

Background: Traumatic bladder injury is rare and often missed on initial evaluation. We sought to identify early markers of bladder injury with a high sensitivity.

Methods: A retrospective review from 1999 to 2008.

Results: There were 28 patients diagnosed with traumatic bladder injury. The most common mechanism was car accidents with pelvic fractures. 93% (26) of the patients presented with significant metabolic acidosis, without evidence of hemorrhagic shock. For intra- and extraperitoneal bladder ruptures, the mean hemoglobin level on arrival was 12.4 ± 2.0 (range 9.0–16.0) and 11.4 ± 1.9 (range 8.2–14.7). The average pH on arrival for intraperitoneal ruptures was 7.22 ± 0.16 (range 6.86–7.37) and for extraperitoneal ruptures, 7.22 ± 0.16 (range 6.85–7.37). The pH improved in all patients with intraperitoneal rupture after surgical repair, up to a mean of 7.27 ± 0.11 (range 7.06–7.36, p = 0.5) within 12 h. Extraperitoneal ruptures recovered more quickly with a pH after catheter drainage of 7.34 ± 0.04 (range 7.27–7.37, p = 0.1) within 12 h. The ISS for intraperitoneal and extraperitoneal ruptures were similar, 30 ± 12 (range 13–57) and 32 ± 13 (range 13–57, p = 0.7). A cohort of trauma patients, matched by ISS, age, and pelvic fracture, but without bladder rupture, was used for comparison. Their mean ISS was 30 ± 10 (range 14–57). The average pH for this group on arrival was 7.33 ± 0.11 (range 7.16–7.42), and 47% of these patients had a normal pH. There was a significant difference between the pH on arrival in the ruptured compared to the nonruptured cohort (intraperitoneal pH 7.22, p = 0.008, extraperitoneal pH 7.22, p = 0.02). Three patients died (mortality 10.7%).

Conclusions: Disproportionate acidosis in the trauma patient is a sensitive indicator of bladder injury, especially with a pelvic fracture or hematuria. Fully resuscitated patients with persistent acidosis and an appropriate mechanism should be evaluated for bladder injury.

Key Words

Bladder rupture · Bladder injury · Pelvic fracture · Acidosis

Introduction

Traumatic bladder rupture was historically diagnosed by the previously well-known triad of gross hematuria, pelvic fracture, and an appropriate biochemical profile, with elevated blood urea nitrogen (BUN) and creatinine [1, 2]. This has fallen out of general knowledge due to the widespread use of screening computed tomography (CT) to evaluate every blunt abdominal trauma patient. While retrograde cystography remains the gold standard, with sensitivity and specificity rates of 95–100 and 100%, respectively, CT scanning has supplanted cystography due to rapid availability and ease of performance [3, 4]. In many trauma centers, retrograde CT cystography has replaced the conventional retrograde cystogram due to equally high sensitivity and specificity rates [3].

However, the overall sensitivity of CT when it is used to diagnose traumatic bladder injury ranges...
widely, from 60 to 100%, with poor results in classifying both intraperitoneal (80% accuracy) and extraperitoneal (55% accuracy) [3–7]. This is because a standard CT scan of the abdomen and pelvis performed with intravenous contrast to evaluate a trauma patient does not include the necessary retrograde filling of the bladder with 300 cc of contrast to fully distend and evaluate the bladder. This can result in “missed” injuries or delays in diagnosis, especially since 6–19% of patients with bladder rupture will not have gross hematuria (although all have microscopic hematuria) [7, 8]. Furthermore, trauma patients with multiple other injuries and a suspected bladder rupture may actually have a retrograde cystogram performed less than half the time [7]. This is understandable when considering that a significant percentage of these patients will require emergency neurosurgical or orthopedic procedures that take precedent, or will have a CT finding of free fluid in the abdomen that leads to an emergency laparotomy.

Regardless, the retrograde cystogram or CT cystogram is not a commonly performed procedure in the emergency setting unless the patient presents with gross hematuria. Moreover, gross hematuria alone is not indicative of a traumatic bladder rupture, since other injuries also cause this, including renal injury. However, the combination of a pelvic fracture and gross hematuria should greatly increase suspicion [9]. Interestingly, in the context of isolated traumatic pelvic fractures with urologic injury of any type, 23% were initially missed, with a delay in diagnosis of 19 h for intraperitoneal bladder ruptures and 6.7 days for extraperitoneal ruptures [10].

Thus, traumatic bladder rupture is not a straightforward diagnosis in the multi-injured patient. Our personal experience has been that the BUN and creatinine were not dramatically elevated initially so as to raise suspicion of a bladder injury. However, our anecdotal experience has been that all of these patients are profoundly acidic due to reabsorption of excreted hydrogen ions in the urine. We decided to perform a retrospective study of our experience with traumatic bladder rupture and determine if the presence of significant acidosis after resuscitation could be used as a sensitive indicator of the diagnosis prior to imaging, and as a red flag that may signal the need for a retrograde CT cystogram.

**Methods**

We performed a retrospective review of our prospectively collected trauma registry at Hurley Medical Center, a Level 1 trauma center in central Michigan. The review included all trauma patients with bladder rupture or perforations from 1999 to 2008. Inclusion criteria were blunt traumatic injury to the abdomen or penetrating injury with bladder rupture. Patients with renal or ureteral injuries, iatrogenic injuries, and pre-existing renal disease were excluded.

Patients were divided into two groups: intraperitoneal bladder perforation (IBP) and extraperitoneal bladder perforation (EBP). The two groups were compared with regard to age, sex, mechanism of injury, hemodynamic parameters at presentation, diagnostic modalities, electrolytes, arterial blood gas (ABG) profiles at various intervals, time of actual intervention (surgical or catheter drainage), and discharge status.

Within each of these two groups, the electrolyte profile, BUN, creatinine, and the ABG profiles from time of presentation until 48 h after actual intervention were collected and compared.

We used our trauma registry to accrue a similar cohort of trauma patients for comparison who were matched by three criteria: injury severity score (ISS), age, and the presence of a pelvic fracture without bladder injury. We surveyed our database of over 1,050 patients with similar mechanisms of injury and found 45 matching patients. Of these 45, only 17 of them had a blood gas analysis performed on arrival, and these data were used for the comparison.

In addition, the pH and base deficits were compared between all groups. Base deficit was plotted in addition to pH, since the pH could be low secondary to respiratory insufficiency with retained CO2. To ensure accuracy, the logarithmic conversion of the pH into hydrogen ion concentration was also used for statistical analysis. If bladder injury was diagnosed after the patient left the emergency room (ER), it was defined as a delay in diagnosis.

The pH, base deficit, BUN, creatinine, and potassium were graphed from the time of arrival to 48 h later to show the trends. If a patient lacked a specific time data point, the other data points were used to extrapolate the curve. Not every patient’s data were charted to avoid overcrowding the graph; rather, a random sample of the data was plotted to show a representative trend. This study was approved by the Institutional Review Board of Hurley Medical Center prior to its initiation.

Since the data was found to be normally distributed, we used a two-tailed Student’s t test with equal variance for statistical analysis. All values are expressed as the mean ± standard deviation (SD), and a p value of less than 0.05 was considered significant.