Clinical predictors of immediate intervention for isolated renal trauma

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Introduction: *Evidence suggests overutilization of procedural intervention for renal traumas. The objective of this study was to assess clinical factors associated with procedural intervention for patients presenting to the emergency department (ED) with isolated renal trauma.*
Materials and methods: *A United States statewide trauma registry was queried for trauma patients presenting to level I or II trauma centers with isolated renal injuries (Grades I–V) from 2000-2013. Patient demographics, mechanism, American Association for the Surgery of Trauma (AAST) grade, trauma center level designation, presenting ED vital signs, Glasgow Coma Scale (GCS), intubation status, and blood product transfusion were assessed.*
Results: *Of 449,422 patients, 1383 patients (78% male, median age 29 years [range 2-92]) with isolated renal injuries had data available for analysis. Controlling for demographics, presenting vitals, GCS, trauma center level, mechanism and intubation status, level I status (OR 2.1 [1.3-3.4], p = 0.0021), white race (OR 2.5 [1.3-4.7], p < 0.005), AAST IV/V injury (OR 4.79 [3.1-6.5], p < 0.0001) and blood product administration (OR 2.7 [1.5-4.9], p = 0.0009) were independently associated with an immediate interventional radiology procedure. Independent predictors of immediate surgical intervention include level I status (OR 2.2 [1.2-4.0], p = 0.0075), penetrating mechanism of injury (OR 15.6 [8.4-28.9], p < 0.0001, AAST IV/V injury (OR 13.6 [8.7-21.1], p < 0.0001), and clinical hypotension (SBP < 95 mmHg, OR 2.1 [1.1-4.2], p = 0.03).*
Conclusion: *Level 1 trauma center designation, white race, penetrating mechanism of injury, high-grade injury, transfusion of blood products, and hypotension were all independent predictors of immediate procedural intervention following ED presentation with isolated renal trauma.*

Key Words: renal, trauma, intervention, surgery, embolization

Introduction

Regardless of mechanism, the kidneys are the most commonly injured genitourinary organ amongst trauma patients.[1] Due to the observed frequency of such injuries, the American Association for the Surgery of Trauma (AAST) developed a well-recognized renal injury grading scale (graded I-V) to categorize the severity of an injury and determine prognosis. Lower grade injuries (AAST grade I-III) are often managed with conservative measures while a greater likelihood for procedural intervention is often seen with higher grade (AAST grade IV-V) renal traumas.[2] Nevertheless, practice guidelines and reports from high volume trauma centers have evolved away from procedural intervention for even the highest-grade renal injuries in carefully selected, stable patients.[3-6]

Procedural interventions for renal trauma include diagnostic angiography and/or renal angioembolization (DA/RAE) along with open surgical renal procedures (e.g. nephrectomy, renorraphy). Importantly, the performance of such procedures may confer significant patient morbidity, thus highlighting

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the need to judiciously perform such procedures only when observational strategies have failed. Despite expert recommendations advocating such conservative measures, however, a recent report querying the Pennsylvania Trauma Systems Foundation (PTSF) suggested gross over-utilization of interventions for even the lowest-grade isolated renal injuries.[7]

The PTSF maintains the largest and most comprehensive trauma registry (termed 'Pennsylvania Trauma Outcomes Study' (PTOS)) in the country and is comprised of all 34 state-accredited trauma centers.[8] An important distinction of the PTOS compared to other large-scale trauma databases is its unique ability to distinguish isolated renal injuries from those suffering from confounding concomitant injuries. The goal of this study is to determine if there are clinical factors associated with immediate procedural intervention for isolated renal trauma upon presentation to the emergency department (ED). We hypothesize that while guidelines are moving away from procedural intervention, poor clinical status would be predictive of immediate procedural intervention in patients with isolated renal trauma.

Materials and methods

Our institutional review board deemed this study as exempt from review as the trauma database is widely available and contains de-identified patient information. The PTSF designates trauma center level in accordance with the American College of Surgeons Committee on Trauma Resources for Optimal Care of the Injured Patient.[9] Briefly, level 1 trauma centers are designated by ability to provide all aspects of trauma care, including in-house surgical coverage and immediate specialty and ancillary coverage; level 2 trauma centers are expected to initiate definitive care of trauma patients but may transfer as needed. The PTOS database was surveyed to include adult (> 18 years old) patients who sustained isolated renal injuries (AAST grades I-V) and were treated at level I or level II trauma centers between 2000 and 2013. Excluded patients were those with incomplete data, treatment at a level 3 center, and/or immediate death on presentation to the ED. Recorded patient demographics included trauma center level designation, age, sex, race, mechanism of injury (blunt or penetrating), and payer status. Initial evaluation of patients in the ED included heart rate (HR), respiratory rate (RR), systolic blood pressure (SBP), whether a patient received a blood transfusion, intubation status, and mentation based upon the Glasgow Coma Scale (GCS). Clinical hypotension was defined as SBP< 95 mmHg.

All patients were analyzed using the PTOS database. The PTOS is comprised of deidentified patient data. This compiled dataset includes patient demographics, mechanism of injury, comorbidities, in-hospital complications, admission status, processes of care, and mortality. Injuries were recorded by trauma data registrars at each state trauma center using Abbreviated Injury Score codes. International Classification of Diseases (ICD)-9-CM codes were used to describe all interventions and treatments. After compiling the data of patients with isolated renal injury, a conversion of Abbreviated Injury Scores to AAST grading was performed using previously accepted methodology.[10] As this data analysis focused on data collection through ICD-9 coding, the dataset utilized was employed only through year 2013. As such, this study is intended to examine historical outcomes regarding immediate intervention in isolated renal trauma.

Chi-square and Fisher's exact tests were employed for univariate analysis of categorical variables. Wilcoxon tests were used for univariate analysis of continuous variables. A multivariate analysis using logistic regression was used to identify independent predictors of intervention stratified by AAST grade (low-grade: AAST I-III; high-grade: AAST IV-V) and adjusted for all available demographic variables. All p values were 2-sided with statistical significance considered at $p < .05$. Statistical analysis was performed using SAS version 9.3.

Results

A total of 449,422 patients were entered into the PTOS database from 2000 to 2013. Of patients treated at level 1 and level 2 centers, 1383 patients with isolated renal injuries were included in our study with complete demographic information available for all patients, Table 1. There were 378 (27.3%) grade I, 227 (16.4%) grade II, 393 (28.4%) grade III, 318 (22.9%) grade IV, and 67 (4.8%) grade V kidney injuries. The majority of patients experienced low-grade (AAST I-III) renal injuries (72.2%, 998/1383) while high-grade injuries were recorded in 385 (27.8%) patients. Level 1 trauma centers observed the majority (1030/1383, 74.5%) of renal injuries during the study period. Of the 1383 patients, 332 (24.0%) patients underwent immediate procedural intervention, 156 (11.3%) underwent procedures with interventional radiology, and 176 (12.7%) underwent surgery.

A multivariate analysis controlling for center level, race, age, sex, mechanism of injury, intubation status, injury grade, heart rate, respiratory rate, and systolic blood pressure is presented in Table 2. Level 1 status

TABLE 1. **Sample demographics**

	All patients	Interventional renal procedure	Surgical intervention
Total	1383	156	176
Center level			
Level 1	1030 (74.5%)	131 (83.9%)	157 (89.2%)
Level 2	353 (25.5%)	25 (16.0%)	19 (10.8%)
Race			
White	1082 (78.2%)	134 (85.9%)	100 (56.8%)
Black	245 (17.7%)	19 (12.2%)	69 (39.2%)
Other	55 (4.1%)	3 (1.9%)	7 (3.9%)
Sex			
Male	1066 (77.1%)	122 (78.2%)	148 (84.1%)
Female	317 (22.9%)	34 (21.8%)	28 (15.9%)
Age (years) Median (range)	29 (2-92)	39 (7-91)	31.8
Mechanism of injury			
Blunt	1231 (89.0%)	136 (87.2%)	93 (52.8%)
Penetrating	152 (10.9%)	20 (12.8%)	83 (47.2%)
AAST[1] injury grade			
1	378 (27.3%)	21 (13.5%)	4 (2.3%)
2	227 (16.4%)	18 (11.5%)	5 (2.8%)
3	393 (28.4%)	29 (18.6%)	30 (17.1%)
4	318 (22.9%)	73 (46.8%)	105 (59.7%)
5	67 (4.8%)	15 (9.6%)	32 (18.8%)

[1]AAST = American Association for the Surgery of Trauma

TABLE 2. **Independent predictors of immediate intervention**

	Interventional renal procedure			Surgical intervention		
Variable	**OR**	**95% CI**	**p value**	**OR**	**95% CI**	**p value**
Center level 1	2.1	1.3-3.4	0.0021	2.2	1.2-4.0	0.0075
Male sex	1.2	0.8-1.8	0.5	1.4	0.8-2.4	0.19
Race: other	0.9	0.2-3.4	0.89	1.0	0.3-2.7	0.85
Race: White	2.5	01.3-4.7	0.005	1.1	0.6-1.9	0.84
Mechanism: penetrating	1.1	0.6-2.1	0.76	15.6	8.4-28.9	< 0.0001
Intubated	1.0	0.2-4.9	0.96	0.8	0.1-6.5	0.83
High grade injury (AAST grade4-5)	4.79	3.1-6.5	< 0.0001	13.6	8.7-21.1	< 0.0001
Heart rate > 110	1.5	0.9-2.5	0.05	0.9	0.5-1.5	0.61
Blood transfused	2.7	1.5-4.9	0.0009	1.3	0.6-2.6	0.49
Respiratory rate > 30	0.8	0.3-1.9	0.59	1.3	0.6-2.9	0.57
Clinical hypotension (SBP < 95 mmHG)	0.7	0.3-1.4	0.33	2.1	1.1-4.2	0.03

OR = odds ratio; CI = confidence interval; AAST = American Association for the Surgery of Trauma; SBP = systolic blood pressure

(OR 2.1, CI 1.3-3.4, p = 0.0021), white race (OR 2.5, CI 1.3-4.7, p < 0.005), high-grade injury (OR 4.7, CI 3.1-6.5, p < 0.0001) and the administration of blood products (OR 2.7, CI 1.5-4.9, p = 0.0009) were each independent predictors of the need for interventional radiology procedure. Similarly, independent predictors of the need for surgical intervention included level 1 status (OR 2.2, CI 1.2-4.0, p = 0.0075), penetrating mechanism of injury (OR 15.6, CI 8.4-28.9, p < 0.0001, high-grade injury (OR 13.6, CI 8.7-21.1, p < 0.0001), and clinical hypotension defined as SBP < 95 mmHg (OR 2.1, CI 1.1-4.2, p = 0.03), although the administration of blood products in the ED was not associated with a surgical intervention.

Discussion

Utilizing the largest and most comprehensive statewide trauma database in the United States, we determined in a large isolated renal injury cohort that clinical hypotension, penetrating mechanism of injury, and high-grade renal injuries were all independent predictors for immediate surgical intervention following presentation at level 1 and 2 trauma centers in the ED setting. Despite evidence-based recommendations and recent clinical guidelines,[3,11-13] prior population-based data suggested an over-utilization of procedural intervention for low-grade, isolated renal injuries.[7] Bjurlin and colleagues also demonstrated that 3% of grade 1 and 10% of grade 2 injuries underwent surgical management in a 5-year analysis of the National Trauma Databank (NTDB).[14] Our rigorous analysis attempted to further characterize this observation in an effort to help understand potential reasons for the previously reported findings. The observations of this study suggest the need for urologists, emergency room personnel and trauma specialists to recognize factors that might unnecessarily promote immediate intervention in the patient with an isolated renal injury.

Although the NTDB is a much larger nationwide dataset,[15] the present statewide registry confers additional advantages that allow for a more accurate assessment of predictors for immediate procedural intervention following renal injury. Specifically, the ability to distinguish renal injuries from concomitant abdominal injuries, such as liver and splenic injuries, is a unique quality of the PTOS dataset that helps eliminate confounding variables. Additionally, numerous presenting variables in the ED setting are captured as well as the added ability to determine immediate disposition to the operating room or interventional radiology immediately following presentation. Finally, these data are highly reliable as fidelity is ensured through the use of abstraction software with a data definition manual, automatic data checks, and routinely scheduled internal and external data audits.[8]

Importantly, on immediate presentation in the ED setting, clinical hypotension was independently associated with immediate surgical intervention. Although hypotension, especially with concomitant penetrating injury, may be an indication for emergent laparotomy,[16] this independent risk factor also suggests that overtreatment for lower grade injuries exists. Both urologists and trauma surgeons alike would agree that non-interventional strategies should be employed for most, if not all, low-grade injuries.[17] However, given the high rate of multi-organ injury in penetrating trauma,[18,19] it is likely that confounders make the decision for expectant management more difficult. Not surprisingly on multivariable analysis, penetrating mechanism of injury (OR 15.6, CI 8.4-28.9, p < 0.0001) and higher-grade injuries (OR 13.6, CI 8.7-21.1, p < 0.0001) were independently predictive of surgery immediately following presentation. Separately, these factors have also been found to be predictors of failure of non-operative management.[14] Additionally, it is worth keeping in mind that the data for this study is from 2000-2013, and many of the patients may have been treated under old and outdated guidelines.

Similar to a prior report from our institution, regardless of AAST grade, level 1 trauma center designation was predictive of surgical and radiologic intervention following isolated renal injury. This finding might be attributable to a lower threshold for intervention employed at level 1 centers, as often, greater complexity traumas more commonly present at these centers. This finding may also be a result of patient requiring procedures in level 2 centers being transferred to level 1 centers. This may be true for a subset of patients and is worth keeping in mind. Nevertheless, these findings are alarming and might further indicate the importance of multidisciplinary treatment approaches with urologists, trauma surgeons, and interventional radiologists involved in the management of urotrauma patients.

Our reported 12.7% (176/1383) rate of surgical intervention following isolated renal trauma is consistent with reports from other large assessments. Buckley and McAninch reported approximately 10% of renal traumas were managed operatively at San Francisco General Hospital over a period of 25 years,[4] while Hotaling and associates analyzed the NTDB to determine that roughly 12% of patients with renal injuries at level 1 and 2 centers underwent surgical intervention.[15]

Although the PTOS is the largest, centrally maintained statewide trauma database, our analysis is not without limitations. While the PTOS does have the ability to capture patients with isolated renal trauma, it is difficult to determine the proportion of patients with known isolated renal trauma prior to intervention. As a result, it is unknown how many patients had their injury diagnosed on pre-procedural imaging (CT, US, etc.) or were found during intervention (i.e. negative exploratory laparotomy). Additionally, with the endpoint of the study occurring in 2013 due to limitations of the dataset, the effect on patient related outcomes following the subsequent release of specialty specific urotrauma guidelines could not be analyzed.

Nevertheless, this historic analysis represents a large population-based assessment of predictive factors that led to immediate intervention following presentation with isolated renal injuries. Additionally, the presence of data from 2000-2013 provides a historic examination of renal trauma practice patterns before the release of the AUA urotrauma guidelines. Continued work is needed to further elucidate clinician-specific factors associated with intervention for renal trauma.

Conclusions

Using the largest statewide database for trauma outcomes reporting, we identify predictive risk factors for immediate procedural intervention following presentation with isolated renal injuries. Despite overwhelming evidence supporting conservative management for a majority of low-grade renal injuries; clinical hypotension, level 1 trauma center designation, and penetrating injuries were all independently associated with procedural intervention following presentation. Urologists, emergency room clinicians and trauma specialists must understand such factors that might promote unnecessary early intervention in patients presenting with isolated renal injuries. □

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