

High Grade Renal Injuries: Application of Parkland Hospital Predictors of Intervention for Renal Hemorrhage

Miranda J. Hardee, William Lowrance, William O. Brant,* Angela P. Presson, Mark H. Stevens and Jeremy B. Myerst

From the Division of Urology, Department of Surgery (MJH, WL, WOB, JBM), Center for Reconstructive Urology and Men's Health (MJH, WL, WOB, JBM) and Division of Epidemiology (APP), University of Utah, Salt Lake City and Department of Surgery, Intermountain Medical Center (MHS), Murray, Utah

Purpose: Investigators from Parkland Hospital proposed substratification of the AAST (American Association for the Surgery of Trauma) grading scale based on 3 risk factors, including active vascular extravasation, a medial laceration and a perinephric hematoma of greater than 3.5 cm. We hypothesized that these characteristics would also be associated with intervention for renal hemorrhage in our large trauma series.

Materials and Methods: From January 2005 to January 2011 we retrospectively reviewed the renal trauma records at adult level 1 trauma centers in Utah. AAST grade 3 and 4 injuries were characterized based on the mentioned 3 risk factors. Our primary outcome was intervention to control renal hemorrhage.

Results: AAST grade 3 or greater injury was identified in 147 patients, including 115 who had grade 3 and 4 injuries as well as imaging available for review. There were 63 grade 3 (53%) and 52 grade 4 (43%) renal injuries. Eight patients (7%) underwent intervention for renal hemorrhage. Vascular extravasation (OR 16.4, 95% CI 2.6–179.8, $p < 0.001$) and perinephric hematoma greater than 3.5 cm (OR 8.4, 95% CI 1.4–52.5, $p = 0.0099$) were associated with intervention, while a medial laceration was not ($p = 0.454$). Patients with 1 or fewer, 2 and 3 risk factors had an intervention rate of less than 2.9%, 18% and 50%, respectively ($p < 0.001$).

Conclusions: Vascular extravasation, a perinephric hematoma greater than 3.5 cm and the number of risk factors (0 to 3) were associated with intervention for renal hemorrhage. Our findings are similar to those at Parkland Hospital. These imaging features may serve as useful prognostic indicators for renal trauma.

Key Words: kidney; wounds and injuries; hemorrhage; tomography, x-ray computed; risk assessment

RENAL injuries are relatively uncommon and account for only 1.2% to 3.25% of all traumatic injuries. However, of all genitourinary traumas the kidney is by far the most commonly injured organ.^{1–3} Extrapolations based on large trauma series estimate an annual incidence of 245,000 traumatic renal injuries worldwide.² Blunt in-

jury is the leading mechanism of injury, accounting for 81% to 95% of cases.²

A review of the national trauma database evaluating 6,231 renal traumas showed an 11% rate of surgical intervention and a 7% nephrectomy rate.¹ An important aspect of these findings is an increasing trend in

Abbreviations and Acronyms

CT = computerized tomography
RPART = recursive partitioning and regression tree

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† Correspondence: Department of Surgery, University of Utah, 30 North 1900 E, Room 3B420, Salt Lake City, Utah 84132 (FAX: 801-585-2891; e-mail: Jeremy.myers@hsc.utah.edu).

conservative management for high grade renal trauma.⁴⁻⁷ Widespread CT use to evaluate patients with trauma as well as advances in surgical critical care have enabled trauma surgeons to approach the management of solid organ injuries successfully in this fashion.⁸

Currently, the AAST grading scale is the gold standard for assessing renal injury.⁹ Multiple studies have shown that it provides excellent prognostic information.^{10,11} However, with increasing nonoperative management for high grade injuries a greater emphasis has been placed on correctly identifying patients who need intervention for renal hemorrhage.^{4,12,13}

To further refine the AAST grading system, Dugi et al from Parkland Hospital proposed substratification to include 4a and 4b classifications.¹⁴ In patients with AAST grade 3 and 4 renal injuries they found that 3 imaging characteristics were independent risk factors associated with intervention for bleeding, including active vascular extravasation, a medially located laceration and a perinephric hematoma of greater than 3.5 cm. Patients with 0 or 1 of these risk factors were at 7% risk for intervention for renal hemorrhage and were classified as grade 4a. Those with 2 or more of these risk factors were at 67% risk for intervention and were classified as grade 4b.

We evaluated AAST grade 3 and 4 blunt renal injuries in Utah using these characteristics to determine whether they are associated with intervention for renal hemorrhage.

MATERIALS AND METHODS

After obtaining approval from each institutional review board, we retrospectively reviewed all renal trauma records from January 2005 to January 2011 at our 2 adult level 1 trauma centers in Utah. In patients with high grade injury (AAST 3 to 5) images were regraded and characterized based on initial CT for active bleeding, a medial laceration and a perinephric hematoma of greater than 3.5 cm. One point was assigned for each of the 3 possible risk factors (range 0 to 3). We used the criteria described by the Parkland Hospital group¹⁴ to determine the presence of each risk factor. The AAST grading system was used to define injury grade,⁹ incorporating the suggestions to refine the grading system by Buckley and McAninch.¹⁵ These suggestions are meant to eliminate the grading ambiguity between severe grade 4 injury and the grade 5 shattered kidney.

Our definition of grade 5 injury was injury involving kidney devascularization due to arterial intimal injury or renal hilar avulsion but not injury in which the kidney was still intact and vascularized (see figure). We also recorded patient age, gender, injury mechanism, injury severity score,¹⁶ hemoglobin at hospital admission and interventions. The primary study outcome was interven-

tion to control renal hemorrhage, including angioembolization, nephrectomy or renorrhaphy.

Patient characteristics were summarized by the frequency for categorical variables, and the mean \pm SD and median with IQR for continuous variables. The Wilcoxon rank sum test was used to compare interventions for renal hemorrhage with hemoglobin in gm/dl at hospital admission. The Fisher exact test was used to compare interventions for 1) perinephric hematoma greater than 3.5 cm, 2) laceration (coded as none, medial, lateral or complex/both) and 3) vascular extravasation. The Cochran-Armitage trend test was used to compare interventions with the number of risk factors (range 0 to 3). RPARTs were used to find the optimal perinephric hematoma distance predicting intervention.¹⁷ Default RPART values were used with a minimum of 20 observations for a node to be split and a complexity parameter of 0.01. Significance was assessed at the 0.05 level and all tests were 2-tailed. All statistical analysis was performed with R, version 2.15.0 (<http://cran.r-project.org/>).

RESULTS

We identified 147 high grade renal injuries (AAST 3 to 5) from January 2005 to January 2011. Excluded from analysis were 32 patients with penetrating trauma (2), emergent exploration without imaging (11), films not available for review (12), bilateral injuries (2) and grade 5 injuries (5), as defined. Seven excluded patients underwent nephrectomy and 4 underwent renorrhaphy. All 5 patients with grade 5 injury had kidney devascularization from an intimal arterial flap but none had renal hilar avulsion. We included all other patients with AAST grade 3 and 4 injuries due to a blunt mechanism.

Of the 115 patients who met study inclusion criteria, including 66 at the University of Utah and 49 at Intermountain Medical Center, 70% were male. Mean age was 33 years. The injury mechanism was motor vehicle related in 73 cases (63%), sports related in 24 (21%), due to being struck or to falling in 17 (15%) and due to crush in 1 (1%). Isolated renal injuries were present in 23 patients (20%). The mean injury severity score was 21. Nine patients (8%) died.

There were 63 grade 3 (53%) and 52 grade 4 (43%) renal injuries. Eight patients (7%) underwent intervention for renal hemorrhage, of whom all had grade 4 injury. Nephrectomy was required in 6 of these patients (5.2%), and 1 each (0.9%) underwent embolization and renorrhaphy. When stratifying the 8 patients (7%) who underwent intervention for bleeding based on the 3 imaging risk factors, 7 (87.5%) had a medial laceration, 6 (75%) had active bleeding and 4 (50%) had a perinephric hematoma of greater than 3.5 cm.

The table shows the analysis of risk factors for intervention for renal hemorrhage. A perinephric hematoma greater than 3.5 cm was associated with

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