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Should blunt segmental vascular renal injuries be considered an AAST grade 4 renal injury?

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Abstract

Background—Renal segmental vascular injury (SVI) following blunt abdominal trauma is not part of the original AAST renal injury grading system. Recent recommendations support classifying SVI as an AAST grade 4 injury. Our primary aim was to compare outcomes following blunt renal SVI and blunt renal collecting system lacerations (CSL). We hypothesize that renal SVI fare well with conservative management alone and should be relegated a less severe renal AAST grade.

Methods—We retrospectively identified patients with SVI and G4 CSL admitted to a Level 1 trauma center between 2003–2010. Penetrating trauma was excluded. Need for surgical intervention, length of stay, kidney salvage (>25% renal preservation on renography 6–12 weeks after injury), and delayed complication rates were compared between the SVI and CSL injuries. Statistical analysis utilized chi squared, Fisher exact, and t-test.

Results—56 patients with SVI and 88 patients with G4 CSL sustained blunt trauma. Age, injury severity score, and length of stay were similar for the two groups. Five patients in each group died of concomitant, non-renal injuries. In the G4 CSL group, 15 patients underwent major interventions and 32 patients underwent minor interventions. Only one patient in the SVI group underwent a major intervention. The renal salvage rate was 85.7% following SVI versus 62.5% following CSL (p=0.107).

Conclusions—Overall surgical interventions are significantly lower among the SVI cohort than G4 CSL cohort. Further analysis using a larger cohort of patients is recommended before revising

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the current renal grading system. Adding SVI as a grade 4 injury could potentially increase the heterogeneity of grade 4 injuries and decrease the ability of the AAST renal injury grading system to predict outcomes, such as nephrectomy rate.

Level of Evidence—IV (retrospective, cohort study)

Keywords

kidney; trauma; staging system

Background

The kidneys are the most common urological organ to be injured following trauma¹. Regional and national estimates of adult trauma have noted the incidence of renal injury to be 1.12–2.8%, with approximately 85% of renal injuries secondary to a blunt etiology^{2–5}. Renal injury severity is graded using the American Association for the Surgery of Trauma (AAST) Organ Severity Score⁶. This grading system was originally published in 1989 (Table 1) and was based on expert opinion and data from the existing medical literature. The renal staging system was subsequently validated as a predictor for clinical outcome and the potential need for nephrectomy^{5,7}. As such, the renal AAST staging system has been widely used for clinical and scientific research.

Advances in radiographic imaging technology have resulted in an improved ability to describe previously undetected renal injuries. For instance, CT imaging has allowed an improved ability to detect renal segmental vascular injuries with better clarity; however, the original AAST renal staging system does not specifically address these injuries. As a means to update the AAST renal injury staging system to include all known renal injuries, a revised injury staging classification (RISC) was recently published (Table 2)⁸. The primary changes in the RISC were to the grade 4 and 5 subcategory. Main renal artery/vein injuries were previously coded as grade 4 or 5 injuries based upon variations of their radiographic appearance. To reduce confusion regarding how to code main renal artery/vein injuries, the authors of the RISC chose to include all main renal artery/vein injuries as grade V injuries in their revised classification. The RISC authors also placed two newly described injuries in the grade 4 subcategory: segmental vascular injuries (SVI) and renal pelvis/ureteropelvic junction injuries. The decision was based on the expert opinion of the authors. The frequency of complications associated with these newly described injuries would provide information about the validity of their current classification.

The original AAST staging system was shown to predict clinical outcome and the potential need for nephrectomy. Based on the experience at our level one trauma hospital, we have noted that blunt renal SVIs rarely require surgical or minimally invasive intervention. A typical appearance following blunt SVI is partial renal devascularization with minimal perinephric bleeding (Figure 1). We hypothesize that blunt renal SVI rarely result in the need for active intervention. Based on our hypothesis, renal SVI, a newly described injury in the RISC system, was compared to collecting system lacerations (CSL), an injury within the original grade 4 subcategory that has been noted to warrant a high-grade injury designation⁹.

Methods

A retrospective analysis of all renal trauma patients presenting to Harborview Medical Center from January 2003 – April 2010 was performed. Harborview Medical Center provides a diverse trauma population, as it is the only level 1 trauma center for Washington, Alaska, and portions of Wyoming, Montana, and Idaho. Institutional Review Board approval was obtained prior to study initiation (University of Washington IRB #37027). The trauma

registry provided a list of patients with AAST renal grade 3, 4, and 5 injuries that were managed at Harborview Medical Center. To ensure correct injury classification, all AAST grade 3, 4, and 5 renal injuries were reexamined using the existing CT scans from their index trauma hospitalization. Renal injury grade was upstaged to a more severe injury grade if injury progression was noted on repeat CT imaging during index hospitalization. In the setting of a concomitant CSL and SVI renal injury to the same kidney, the injury was graded with the more severe CSL score. Exclusion criteria included penetrating injuries and presence of main vascular injury or ureteropelvic junction disruption.

Renal SVI and CSL data were abstracted from the index hospitalization, potential urology-specific inpatient readmissions, and urology-specific outpatient visits. Management of renal trauma was classified according to three categories: observation, minor intervention, and major intervention. Observation was defined as no active intervention during index hospitalization. Minor interventions included: retrograde pyelography with ureteral stent placement, percutaneous nephrostomy tube placement, and perinephric drain placement. Major interventions included: super-selective renal angioembolization and open surgical intervention, including, renal exploration, renorrhaphy, and simple nephrectomy.

Failure of initial intervention was defined as the need for a subsequent procedure to successfully manage the SVI or CSL. Renal salvage rates were determined based upon a nuclear renogram obtained at 6–12 weeks following renal injury. Renal salvage was defined as preservation of more than 50% of the affected kidney function (more than 25% split function on a diuretic renogram).

Statistical analysis was conducted to compare the two groups using chi-squared and Fischer exact tests. The student two-tailed t test was used to compare continuous variables.

Results

Between January 2003 and April 2010, 144 patients were diagnosed with either a SVI (n=56) or CSL (n=88) renal injury. Demographics, injury severity score (ISS), management, and outpatient follow-up of the two cohorts were compared (Table 3). Five patients died within each cohort from non-urologic causes during their index hospitalization. Mean age, ISS, gender, and percent mortality from concomitant injuries were not statistically different between the two cohorts.

In the SVI group, 50/51 patients (98%) were successfully managed with observation alone. The lone patient with an intervention had selective renal angioembolization to manage a small pseudoaneurysm due to decreasing hematocrit. Among the CSL cohort, initial observation was pursued in 68/83 patients. Observation alone was only successful in 36/83 patients (43.3%). A total of 32 CSL patients underwent a *minor* procedure. Cystoscopy with retrograde pyelogram was performed in all 32 patients. Ureteral stents were placed for persistent contrast extravasation in 18/32 patients, while percutaneous perinephric drains were necessary for management of a worsening urinoma in 6/32 patients. A total of 15 CSL patients underwent a *major* procedure (5 renorrhaphies, 3 nephrectomies, and 7 super-selective angioembolizations). There was no difference in hospitalization duration between the two cohorts (Table 3).

A higher percentage of patients with a CSL underwent repeat CT scans during their initial hospitalization to assess injury progression compared to the SVI group (72.7% vs. 44.6%). Among the 24 patients with a CSL who were initially observed and did not undergo a repeat CT, 3 failed initial observation. Following index hospitalization discharge, 8 patients in the

CSL cohort developed complications requiring either an inpatient or outpatient procedure (7 perinephric drain, 1 ureteral stent placement).

Follow up was higher in patients with CSL, as 52 patients returned to clinic compared to 19 patients in the SVI group (62.6% vs. 37.2%, $p=0.015$). Among those with follow up information, kidney salvage rates in the SVI and CSL groups were 85.7% and 62.5%, respectively, as determined by a diuretic renal scan performed 6–12 weeks following initial renal injury ($p=0.107$).

Discussion

Despite a similar age and ISS, the management and outcome of renal SVI and CSL differed. The overwhelming majority of patients with a renal SVI were successfully observed (50/51, 98.0%). Initial observation was less successful in patients with a CSL. Among this later cohort, 68 patients (81.9%) underwent initial observation, and only 36/83 patients (43.4%) were successfully managed with observation alone.

Patients with blunt renal SVI uniformly did well. Our results reveal that it may be unnecessary to repeat CT imaging 48 hours after initial imaging to exclude injury progression among patients who sustain a renal SVI (a current recommendation for all grade 4 renal injuries¹). Based on our findings, we have begun to avoid repeat CT imaging 48 hours after renal SVI that has little to no perinephric hematoma on initial CT imaging (see Figure 1(b)). We do not advocate this approach for patients with a renal CSL, as additional interventions were frequently necessary among our cohort.

Issues arise when attempting to formulate a grading system. There is conflict between the need to reflect injury severity and the need to indicate when a potential intervention to preserve organ function is necessary. For example, renal injuries such as thrombosis of the renal artery pose little threat in terms of immediate acuity and bleeding but a more significant long-term impairment in kidney function. In contrast, avulsion of the renal hilum is a potentially life threatening situation secondary to acute bleeding and needs immediate intervention. Both injuries are considered grade 5 renal injuries, but they have very different initial management strategies with potentially similar long-term outcomes.

Perhaps an additional renal staging system should exist to aid in decisions to proceed with active intervention following injury. Dugi and colleagues sub-stratified AAST grade 3 and 4 injuries into high risk and low risk groups based on the presence of two of three radiographic criteria: intravascular contrast extravasation into the hematoma, site/complexity of parenchymal lacerations, and perirenal hematoma size¹⁰. This radiographic model better predicted the risk of intervention for control of bleed with sensitivity and specificity of 66.7% and 92.9%, respectively, compared to 55.6% and 77.4% for the original AAST grade 4 staging system. Identifying such radiographic criteria to better predict the need for intervention in the acute setting could potentially be utilized to complement current staging systems.

This study is subjected to limitations due to its retrospective nature. Further, there is inherent poor follow-up among trauma patients. At our institution, there is a large number of patients from surrounding states that potentially could have developed delayed complications and elected to follow-up at other institutions. In addition, renal trauma rarely occurs in isolation from other systemic injuries¹¹. Such polytrauma, could result in unnecessary renal interventions that occurred as a result of active intervention for a more severe concomitant abdominal injury. This was evident in our cohort, as the mean ISS was 29. In such a scenario, renal angiography could have occurred as a secondary intervention following interventional radiology intervention for a more severe hepatic or splenic injury.

In conclusion, we observed that patients with a renal SVI require fewer interventions than patients with a renal CSL following blunt abdominal injury. We support the inclusion of renal SVI in the AAST staging system; however, relegation of such injuries to a lower injury classification may be necessary. If the renal AAST staging system is to be used for prognostic purposes, then additional research using a larger cohort from multiple institutions is necessary to more accurately classify previously undefined renal injuries not included in the original AAST staging system.

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Figure 1.

(a) Arterial phase of transverse CT scan revealing a left segmental vascular renal injury (arrow). The CT was performed at the time of presentation to the emergency department. A collecting system injury was not present, as there was no evidence of contrast extravascular on subsequent delayed imaging. Follow up imaging 48 hours later was negative for collecting system injury. (b) Delayed imaging from transverse CT scan of a right renal segmental vascular injury (arrow) 48 hours after blunt abdominal trauma. The CT scan was performed to assess for renal injury progression using a low-dose radiation protocol.

Table 1

Original American Association for the Surgery of Trauma (AAST) Organ Injury Severity Score for the kidney (1989)⁶.

Grade	Type	Description
I	Contusion	Microscopic or gross hematuria, urologic studies normal
	Hematoma	Subcapsular, nonexpanding without parenchymal laceration
II	Hematoma	Nonexpanding perirenal hematoma confined to renal retroperitoneum
	Laceration	Perenchymal depth of renal cortex < 1.0 cm without urinary extravasation
III	Laceration	Perenchymal depth of renal cortex > 1.0 cm without collecting system rupture or urinary extravasation
IV	Laceration	Parenchymal laceration extending through renal cortex, medulla, and collecting system (positive urine extravasation)
	Vascular	Main renal artery or vein injury with contained hemorrhage
V	Laceration	Completely shattered kidney
	Vascular	Avulsion of renal hilum that devascularizes kidney

* Advance one grade for bilateral injuries up to grade III.

Table 2

Revised American Association for the Surgery of Trauma (AAST) Organ Injury Severity Score for the kidney (2011)⁸.

Grade	Type	Description
I	Parenchyma	Subcapsular hematoma and/or contusion
	Collecting System	No Injury
II	Parenchyma	Laceration < 1 cm in depth and into cortex, small hematoma contained within Gerota's fascia
	Collecting System	No Injury
III	Parenchyma	Laceration > 1 cm in depth and into medulla, hematoma contained within Gerota's fascia
	Collecting System	No Injury
IV	Parenchyma	Laceration through the parenchyma into the urinary collecting system **
		Vascular segmental vein or artery injury
	Collecting System	Laceration, one or more into the collecting system with urinary extravasation **
		Renal pelvis laceration and/or complete ureteral pelvic disruption
V	Vascular	Main renal artery or vein laceration or avulsion main renal artery or vein thrombosis

* A renal unit can sustain more than one grade of injury and should be classified by the higher grade of renal injury

** These injuries are the same as the original AAST staging system⁶.

Table 3

Demographics of SVI and CSL cohort.

	SVI (%)	G4 CSL (%)	P-value
Total number of patients	56	88	
Mortality during index hospitalization	5	5	0.227 ¹
Mean age - years (SD)	32.2 (15.4)	30.6 (19.2)	0.566 ²
Male gender	43/56 (76.7)	55/88 (62.5)	0.036 ¹
Mean injury severity score (SD)	29.89 (16.3)	27.92 (16.8)	0.489 ²
Management			
Observation successful	50/51	36/83	
Minor intervention	0	32	<0.001 ³
Major intervention	1	15	<0.001 ³
Average/median hospital stay in days (SD)	11.8/6 (13.8)	10.2/5 (12.5)	0.478 ²
Patients undergoing a repeat CT scan	25/56 (44.6)	64/88 (72.7)	<0.001 ¹
Follow-Up			
Interventions/readmissions after initial discharge	0	8	<0.001 ³
Nuclear medicine scan performed?	14/51 (27.4)	37/80 (46.2)*	0.015 ¹
Kidney salvage rate	12/14 (85.7)	25/40 (62.5)*	0.107 ¹
Outpatient follow-up	19/51 (37.2)	52/83 (62.6)	0.002 ¹

* 3 patients removed secondary to previous nephrectomy

¹ Chi squared

² t-test

³ Fisher exact test

SD: standard deviation