Is Delayed Phase Computed Tomography Imaging Necessary After Blunt Renal Trauma in Children?

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OBJECTIVE To characterize the utilization of delayed phase computed tomography (CT) imaging in blunt renal trauma and determine if the omission of delayed phase CT imaging affected clinical outcomes in children.

MATERIALS AND METHODS A prospectively collected trauma database was reviewed between 2006 and 2016 to identify patients aged ≤21 years with a diagnosis of renal injury from blunt trauma. Demographic characteristics, injury grade, Injury Severity Score, non–kidney organ injuries, radiologic studies, and clinical course were reviewed. Patients were categorized into 2 groups: those who received CT with delayed images in the emergency room and those who did not.

RESULTS In total, 121 patients met the inclusion criteria. Delayed scans were obtained in 50 patients (41%) but omitted in 71 (59%). Age, weight, non–kidney organ injuries, and imaging location did not differ between groups. Injury Severity Score was higher in the no-delay group than in the delay group (median 16 vs 10, respectively, $P = .40$). Median length of stay was 3 days without significant differences by cohort ($P = .24$). The proportion of patients who received abdominal CT scans after admission, underwent a urologic procedure, or were readmitted did not differ significantly between groups.

CONCLUSION This study was unable to demonstrate a difference in outcomes between patients who had a CT with delayed imaging and patients who did not. This questions the universal necessity for delayed images after blunt renal trauma. Future prospective studies are necessary to develop pediatric trauma guidelines that balance imaging needs and radiation exposure. UROLOGY ■■: ■■–■■, 2017.

Children are uniquely vulnerable to kidney injury given less perirenal fat, smaller abdominal muscles, and lack of rib ossification.[1,2] Management of renal trauma in children has undergone significant changes over the last several decades, shifting from primarily surgical intervention to expectant management.[3] Renal injuries are optimally graded using computed tomography (CT) scans with intravenous (IV) contrast during the cortical and delayed excretory phases. Current American Urological Association guidelines recommend both cortical and delayed phases of the abdomen and pelvis after IV contrast administration in adult patients.[4] Acquisition of both studies allows optimal characterization of renal laceration and identification of any potential collecting system injury. The necessity of multiphase imaging, however, is questionable in an era where the vast majority of patients are managed expectantly and surgical intervention is dictated by clinical stability.

Despite the presence of guidelines in adults, little standardization exists in pediatric trauma. Complicating the development of pediatric trauma imaging guidelines is the effort to minimize radiation exposure in children because of increasing evidence of greater malignancy risk. Initiatives to promote as low as reasonably achievable radiation exposure have become commonplace in pediatric care. These initiatives are likely responsible for the decreasing CT dosing in pediatric hospitals.[5] It is currently unknown what, if any, clinical consequences exist as a result of omission of delayed phase imaging in pediatric blunt renal trauma. In the present study, we aimed to characterize the utilization of delayed phase CT imaging in blunt renal trauma and determine if the omission of delayed phase CT imaging affected clinical outcomes.

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MATERIALS AND METHODS

A prospectively collected trauma database was retrospectively reviewed to identify patients aged ≤21 years with a diagnosis of renal injury at a level 1 pediatric trauma center from 2006 through 2016. All patients with a penetrating mechanism of injury, renal congenital anomaly, surgery before CT imaging, or death in the emergency room (ER) were excluded. Demographic characteristics, Revised American Association for the Surgery of Trauma grade,[6] Injury Severity Score (ISS),[7] location of initial imaging (outside hospital ER vs pediatric trauma center ER), radiologic studies, non–kidney abdominal organ injuries, and clinical course were reviewed. ISS is an established medical score representing cumulative assessment of trauma injury over the admission.

Included patients were categorized into 2 cohorts: those who received a delayed phase CT scan (contrast visualized in at least 1 ureter or the bladder) in the ER and those who underwent a CT scan without any delayed phase imaging. Patients with only a single IV contrast scan on record but with contrast noted at the level of the ureter or bladder were included in the delay phase group. Frequency, median, and interquartile range (IQR) was used to describe patient characteristics in the overall study population and by cohort. Differences in continuous variables were evaluated with Pearson correlation coefficient and Wilcoxon rank sum tests, whereas chi-square tests of independence were utilized for categorical variables. Cohort differences in clinical course outcomes (hospital length of stay [LOS], CT scans after admission, and urologic procedures) were examined using negative binomial and logistic regression, while adjusting for baseline patient characteristics significantly associated with cohort status. Statistical significance was set at $P < .05$.

RESULTS

A total of 121 patients met the inclusion criteria, with 59% (n = 71) receiving no delayed phase imaging and 41% (n = 50) receiving a delayed phase. All patients received either a single or a double phase; no triphasic imaging was identified. The median age at the time of injury was 14 years (IQR 10-16) and there was a predominance of male patients (66.9%). Median ISS was 10 (IQR 5-8) for the overall study population. Just over half (51%) of all patients had associated non–kidney abdominal organ injuries and a slight majority of patients (55%) received CT imaging before transfer from an outside facility. No difference was identified in likelihood to receive a delayed phase scan based on the location of initial CT imaging ($P = .32$). Patients in the no-delay phase cohort were more likely to have associated non–kidney abdominal organ injuries (57.8% vs 42%); however, this did not reach statistical significance ($P = .09$). ISS was significantly greater among patients who did not receive a delay scan than in the delay phase cohort (median 16 vs 9, respectively; $P < .05$). Although female patients were more likely to have delayed imaging omitted compared with their male counterparts on univariable analysis ($P = .03$) (Table 1), there was no significant gender difference between groups after controlling for ISS.

The median LOS among all patients was 3 days (IQR 2-7) without significant differences by cohort ($P = .24$). In total, 35 patients did receive further abdominal CT imaging after admission, but the proportion of patients who received 1 or more additional abdominal CT scan did not differ significantly between groups ($P = .31$). During the hospital admission, 3 patients in the no-delay phase cohort (4.2%) vs 6 patients in the delay phase cohort (12.0%) underwent a urologic procedure, defined as cystoscopy with stent (n = 8) or nephrostomy tube (n = 1). This difference, however, did not reach statistical significance ($P = .16$) (Table 2). Clinical indications for urologic procedures in the no-delay group included fever (n = 2) and progression of urinoma on planned repeat imaging (n = 1). Clinical indications for urologic procedures in the delay phase cohort included urinary extravasation on initial imaging (n = 2) and progression of urinoma on planned repeat imaging (n = 4). Also, after controlling for ISS (analysis not shown) and excluding all patients with grade I and II renal lacerations, no statistical significance for any outcome of interest was identified (Table 3).

Seven patients overall were taken for emergent abdominal exploration after initial ER imaging; however, none had any kidney intervention and were taken to the operating room (OR) by trauma surgery for associated abdominal injury. One patient was taken back to the OR on the day after the initial exploration because of hemodynamic instability and did undergo a nephrectomy. This patient did have a vascular grade IV injury and was within the no-delay group. On 90-day follow-up, 4 patients (5.6%) from the no-delay phase and 3 patients (6%) from the delay phase group were readmitted for trauma-associated

Table 1. Baseline patient characteristics

		Cohort			
		Overall (n = 121)	No Delay Scan (n = 71)	Delay Scan (n = 50)	*P*
Age at injury (y)		14 (10-16)	13 (10-15)	15 (10-16)	.17
Gender	Male	81 (66.9)	42 (59.2)	39 (78.0)	**.03**
	Female	40 (33.1)	29 (40.9)	11 (22.0)	
Weight (kg)		52 (33-67)	50 (35-65)	57 (30-70)	.25
Injury Severity Score		10 (5-18)	16 (5-21)	9 (5-16)	**.04**
Non–kidney organ injuries	Yes	62 (51.2)	41 (57.8)	21 (42.0)	.09
	No	59 (48.8)	30 (42.3)	29 (58.0)	
Initial imaging pediatric trauma center	Yes	67 (55.4)	42 (59.2)	25 (50.0)	.32
	No	54 (44.6)	29 (40.9)	25 (50.0)	

Data are reported as median (interquartile range) for continuous variables and frequencies (percentage) for categorical variables. Boldfaced *P* values indicate clinical significance.