Retrospective Review of Pediatric Blunt Renal Trauma: A Single Institution's Five Year Experience

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Abstract

Children are at higher risk of renal injury from blunt trauma than adults due to a variety of anatomic factors such as decreased perirenal fat, weaker abdominal muscles, and a less ossified thoracic cage. Non-operative management is gaining in popularity for even major injuries, although there are no universally accepted guidelines. We present a retrospective review of pediatric major blunt renal injuries (grade 3 or higher) at a children's hospital in Hawai'i over a 5-year period. Medical records were examined between January 2009 and September 2014 from Kapi'olani Medical Center for Women and Children in Honolulu, Hawai'i. Inclusion criteria were a diagnosis of renal trauma, or the diagnosis of blunt abdominal trauma with hematuria. Exclusion criteria were grade I or II renal injury or death due to an additional traumatic injury. Mechanism of injury, clinical characteristics on admission, blood product requirements, surgical interventions performed, and hospital length of stay were retrospectively analyzed. Eleven total patient records were examined, nine of which fit inclusion criteria. Uniquely, 33% of patients sustained their renal injury while surfing. No patients required laparotomy or nephrectomy, though 22% of patients received a blood transfusion and 44% of patients underwent ureteral stent placement. Non-operative management of major renal injuries in children is feasible and allows for preservation of renal tissue. A novel mechanism of surfing as a cause of major renal trauma is seen in the state of Hawai'i.

Keywords

Pediatric renal injury, Surfing injuries, pediatric trauma, renal laceration, hematuria

Introduction

Children, when compared to adults, are at a higher risk of renal injury from blunt trauma due to a variety of anatomic factors including decreased perirenal fat, weaker abdominal muscles, and a less ossified thoracic cage.[1,2] While there are strong trends toward non-operative management of blunt renal trauma, there are no explicit guidelines for high grade injuries.[3-5] Organ preservation in children is always a primary goal with solid organ injury due to these patients' projected lifespan. Nationally, trauma is the leading cause of death and disability in children with an estimated 90% of trauma being due to a blunt mechanism.[6] Exact statistics for renal trauma are difficult to ascertain on a national level. The National Trauma Data Bank (NTDB), the largest trauma database in the country with 805 responding hospitals, recorded 2,213 renal injuries secondary to trauma in children 19 years or younger from 2002 to 2007.[7] Children in Hawai'i age 5-14 years old have the highest utilization rate of the emergency department (ED) for traumatic injuries of all age groups at 244 injuries per 100,000 residents. This is more than three times higher than for other age groups (average 74 injuries per 100,000 residents).[8] While national data on pediatric renal trauma is limited, there is even less statewide data for Hawai'i. To increase statewide knowledge and analyze current practice patterns we retrospectively reviewed all cases of pediatric major blunt renal trauma managed at Kapi'olani Medical Center for Women and Children over a 5-year period. While the dataset is small, it does provide information on practice patterns with comparison to national data from Hawai'i's only pediatric trauma center.

Methods

All patients under the age of 18 who were admitted to Kapi'olani Medical Center with a diagnosis of renal trauma were retrospectively reviewed after obtaining approval by the Hawai'i Pacific Health Research Institute. The ICD-9 code 866 was used to identify patients with a renal injury. The time period examined was between January 1, 2009 and September 30, 2014. Inclusion criteria were either a diagnosis of renal trauma or a diagnosis of blunt abdominal trauma and hematuria. Exclusion criterion was death due to an additional traumatic injury. Children with minor renal injuries, grade I or II, were also excluded. The medical charts were examined by the authors and data was then de-identified and secured in an excel document. The mechanism of injury (fall, surfing, assault), injury severity score (ISS), injury grade (I-V), the presence of hematuria, and demographic data to include age, weight, and sex, were recorded and reviewed. The ISS grades injury severity from zero to 75. A score of 75 indicates an unsurvivable injury in any body region with lesser scores falling on a gradient for comparison to each other. [9] In addition, amount of blood product required, hematocrit nadir prior to transfusion to assist in ascertaining whether transfusion was necessary, surgical interventions performed, and hospital length of stay were also retrospectively analyzed. For reference, the normal range of hematocrit is 34.5% – 43.5% with less than 34.5% considered anemic. Due to the low sample size we used descriptive as opposed to inferential statistics in our analysis.

Results

Eleven patients were found to fit the initial search criteria. Two patients were excluded as they had minor grade injuries. Patient demographic data and clinical characteristics are detailed in Table 1. Demographics include male to female ratio of 2:1 and the average age of patients was 11.9 $\pm$ 4.6 years. Of the nine patients who underwent review, three (33%) children presented with a grade III renal injury, and six (67%) with a grade IV injury. Figure 1 shows a computed tomography (CT) image

of a grade IV renal injury in one of the study patients. There were no grade V injuries during the studied time period. The average (mean ± standard deviation) ISS on presentation was 15 ± 8.5 with a range of 11-36 and interestingly, surfing was the mechanism of injury in one third of the study patients (Figure 2). All patients were initially managed with a non-operative approach and no patients required laparotomy or nephrectomy. The only intervention required in 4 of 9 patients (44%) was a stent placement. Renal preservation was therefore achieved in all of the study patients.

Six patients presented with gross hematuria and 3 with microscopic hematuria. Only two patients (22%) required blood transfusions, with the average hematocrit nadir being 31 ± 5.3% (24.8-37.8). One of the two patients transfused had a concomitant grade IV splenic laceration with a hematocrit nadir of 24.8% and clinical symptoms consistent with shock. The other patient received blood products at an outside hospital prior to transfer for uncertain reasons given a nadir of 30%. Four patients (44%) underwent double J stent placement for grade IV injuries with urinary leak. One patient also required ultrasound guided percutaneous drainage of a right calyceal-retroperitoneal fistula. The average length of hospital stay was 5.1 ± 3.1 days, ranging from 2 to 12 days. The child with the longest length of stay was the child who required drainage of a right calyceal-retroperitoneal fistula. No child developed post-injury hypertension either during their admission or at their follow-up appointments and all patients were seen in follow-up at least once.

Table 1. Demographics	
Number of Patients	9
Average Age of Patients (years, range)	11.9 (3-16)
Male to Female Ratio	2:1
Number of Patients who Received Transfusions (% of total)	2 (22%)
Number of Patients Requiring Stent Placement (% of total)	4 (44%)
Number of Patients Requiring Interventions other than stents	0
Average Hemotocrit Nadir	31% (24.8-37.8)
Average Length of Stay (in days)	5 (2-12)

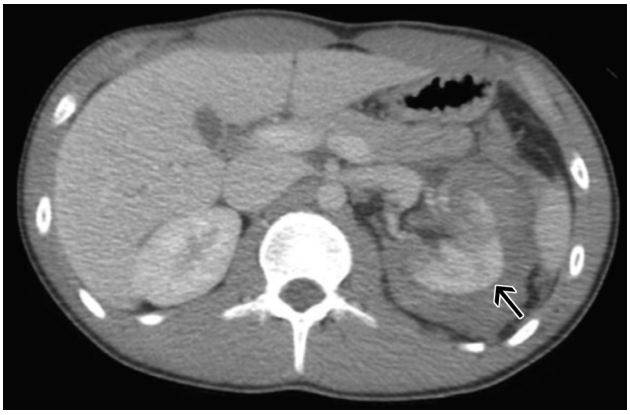

Figure 1. Arrival CT scan of a patient with a grade IV renal injury. The arrow indicates the area of hemorrhage.

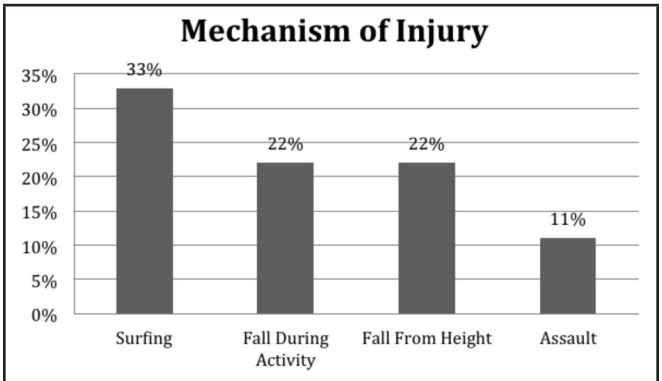

Figure 2. Mechanism of injury as a percentage of the total number of patients (total=9).

Discussion

Children who are involved in blunt trauma are at greater risk for renal injury than adults due to anatomical differences that result in less overall protection to the kidney. Pediatric kidneys are also large proportional to their surrounding organs and are predisposed to parenchymal disruption. Blunt abdominal trauma is reported to involve renal trauma in 10%-20% of cases.[10] This continues to be an important topic, as trauma continues to be the most common cause of death in the pediatric population.

Surfing was the mechanism of injury in 33% of the studied patients. All patients that presented with this mechanism were hit in the flank with a surfboard. All patients injured in this manner sought medical attention due to persistent flank pain. Motor vehicle collisions (MVCs) were not the cause of any of the injuries in the study population. This is in contrast to the published literature where MVCs were the cause in up to 33% of renal trauma in the pediatric population.[11] Studies looking at surfing-related injuries are not common, but have shown skin lacerations to be the most common injury, with most injuries involving the head and neck. [11,1,18] In a large survey-based study of 1,348 patients, surfing related injuries to the trunk were reported in 162 patients, mostly to the back (43%) and chest wall (35%). Chest wall injuries were predominantly rib fractures and rib contusions. There were only 19 abdominal injuries, including 2 splenic ruptures, and no documented renal injuries.[12] The average age of these surfers was 28.6 (11-60), which may account for the different injury patterns when compared with our pediatric cohort.

Though there is a growing body of literature supporting non-operative management of blunt renal injury, this approach has not been clearly defined and published guidelines are lacking.[3,4,10,13,14] In a recent meta-analysis, non-operative management of nonvascular grade IV trauma was successful in more

than 80% of children.[14] However, there is still variation within the literature. Fitzgerald, et al, from Detroit Medical Center retrospectively reviewed 39 children with blunt renal trauma and found a combined (Grade I to V) non-operative rate of 97%.[3] Henderson, et al, from Children's National Medical Center retrospectively reviewed 164 children with blunt renal trauma and found a non-operative rate of 70%. For high-grade renal injuries specifically (grades IV and V), the non-operative rate was only 56%. However, these numbers do not exclude patients who underwent non-kidney related surgeries and the authors maintain that if this is taken into account that the non-operative rate overall is mid 90%.[4] Renal salvage often still includes interventions such as percutaneous drainage and/or ureteral stent placement. Reported intervention rates vary from 20%-65%.[5] Our data demonstrated a 100% renal salvage rate. However, there was an intervention rate of 67% for grade IV injuries. None of these interventions were performed emergently and all of them were performed to treat collecting system injuries as opposed to parenchymal or vascular injuries. It is likely that the threshold for urologic interventions is low given that they are minimal risk procedures. The urology literature suggests that mild urinary extravasation can be treated with a Foley catheter and antibiotics whereas significant extravasation requires a double J stent with percutaneous drainage.[15] It should be noted that our study population did not include any grade V injuries. These severe injuries often present with massive hemorrhage and can necessitate operative intervention for clinical instability with published rates of non-operative management from 0% - 60%.[4, 10,16] Also of note, pediatric patients treated at adult trauma centers were three times as likely to undergo nephrectomy versus those treated at pediatric hospitals.[7]

Further debate over blunt renal trauma involves the utility of bed rest. In one study three children had repeated gross hematuria that lasted approximately one month and attributed this to inadequate bed rest.[17] However, others argue that bed rest is hard to justify given that the kidney is confined to an encapsulated space in Gerota's fascia, with a low threat of uncontrolled bleeding.[18] Reported mean lengths of bed rest range from 3 to 13 days.[10, 18] Unfortunately, we were not able to accurately determine the length of bed rest in these patients due to the retrospective nature of the study.

New-onset hypertension is an important variable in renal trauma, with rates ranging from 0% to 7.5%. A three-year prospective study is underway, as these children are at risk if they continue to have untreated hypertension.[18] However, it appears that patients who do not present with hypertension during the initial three to four weeks post-trauma, are highly unlikely to develop hypertension after this time period.[19] None of the children reviewed at our institution developed post-injury hypertension with the caveat that while all patients were seen in clinic for follow-up, not all patients had follow-up as far out as one month. Our center is actively seeking to obtain longer term follow up on these patients.

Although there are limitations to this study, it supports the previously published research that encourages non-operative management for blunt renal trauma. The main limitations to this study are small sample size and retrospectively gathered data. Another limitation is that pediatric patients, though predominantly are treated at Kapi'olani, are also seen at other hospitals. Therefore, this study is not representative of the state demographics for renal trauma. However, this study still importantly shows that surfing is a cause of renal injury in Hawai'i and may be a topic for future research. In the future, prospective multi-center studies should be pursued.

Conclusion

This study shows that over a period of five years at one center, no children with grade III or higher kidney injury required emergent surgical intervention and less than half required transfusion. Of the nine children reviewed, less than half eventually required any procedural intervention. This argues that the trend towards non-operative intervention for even high grade kidney injuries is prudent and likely to persist. Interestingly we also found that surfing in a pediatric population poses a potential risk of significant renal injury. Providers should maintain a high index of suspicion for renal injury in children who present with abdominal or flank pain, or even hematuria, after surfing. Renal salvage after any trauma should be pursued not only in pediatric but adult trauma centers.

Disclosure Statement

The views expressed in this manuscript are those of the authors and do not reflect the official policy or position of the Department of the Army, Department of Defense, or the US Government.

Conflict of Interest

The authors declare no conflict of interest.

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