Management of renal injury in children

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PURPOSE: *To evaluate types of trauma, other organ injuries and types and results of management in children who were admitted to our clinic because of renal trauma in the last 5 years.*
METHODS: *Thirty one patients who were treated in our clinic for renal injury occurring after blunt abdominal trauma between January 2005-2010 were assessed retrospectively.*
RESULTS: *The patients were aged between 1-16 (mean 8.2) years old. Twenty (64.5%) patients were boys and 11 (35.5%) were girls. The most common causes of injury were falls from height (13 patients, 41.9%). Sixteen patients (52%) had only renal injury and the others (48%) had other organ injuries. Two patients with grade III injury (20%), three patients with grade IV injury (27%) and one patient with grade V injury (100%) were operated on, although all of the patients with grade I and II injuries were managed conservatively. Twenty five patients (81%) were managed conservatively and six patients (19%) whose vital signs were not stable were operated on.*
CONCLUSION: *Conservative management should be preferred in patients with renal injuries who are stable hemodynamically. Most renal traumas in children can be treated conservatively. Conservative management has some advantages like shorter hospitalization time, less need for blood transfusion and less morbidity and mortality than surgical management.*

KEY WORDS: Children, Lacerations, Renal injury, Trauma, Kidney

Introduction

The most common reason for liver injuries in children is blunt abdominal traumas. However, penetrating traumas are one of the most common causes in older children [1,2]. Three percent of blunt abdominal traumas result in injury to the urinary system. The kidneys are the most commonly injured organ in the urogenital system in children. The reasons for this may be the large dimensions and low position of the kidneys in children, lack of a developed Gerota's fascia and the elasticity of the 11th and 12th ribs in children [3]. In addition pathologies of the kidneys like hydronephrosis and tumors result in the kidneys being more easily injured. There are additional pathologies in 4-19% of kidney injuries [4].
Ultrasonography (US), computerized tomography (CT) and intravenous pyelography (IVP) are used as diagnostic tools for renal injuries. The specificity of CT in renal injuries is almost 100%. The reliability of US is more limited. US is effective in detecting urinomas and hematomas, but is insufficient for parenchymal evaluation. It

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is used in follow-up for pathologies diagnosed by other monitoring methods [5].

The method of management for renal injuries due to blunt abdominal trauma is determined according to the degree of injury, other organ injuries and the clinical condition of the patient. Children with kidney injuries whose vital signs are stable and those with unstable vital signs should be managed conservatively [6]. The absolute indication for surgery is growing or pulsating perinephric hematoma in addition to decreasing hemoglobin levels and blood pressure (BP), signs of renal pedicle injury and other organ injuries that require surgery. Relative indications are marked extravasated urine, decreased blood supply to the kidney of over 20%, perinephric infection and urinary obstruction [7].

The aim of this study was to assess types of trauma, other organ injuries, management methods and the results of management in children who were admitted to our clinic because of renal trauma in last five years.

Patients and Methods

Thirty one patients who were treated for renal injury after blunt abdominal trauma in our clinic between January 2005-2010 were evaluated retrospectively. Patients were grouped according to their grade of injury. BP values, hemoglobin levels, blood transfusion and duration of stay in intensive care and hospital were compared between the groups. No patients were excluded from the study.

The records of patients were analyzed and categorized according to their specific details. General information, age, sex, duration of stay in hospital, mechanisms of trauma, other organ injuries, and methods of treatment were noted. Hemodynamic data included BP pressure values on admission, hemoglobin levels and need for blood transfusion.

All patients were admitted to the intensive care unit and vital signs (heart rate, respiration rate, BP, amount and density of urine) were recorded hourly; hemoglobin levels were analyzed at the 6th and 24th hour.

Injuries were diagnosed by history, physical examination, US and/or CT. Renal injuries were graded according to the American Association for the Surgery of Trauma (AAST) classification (Table I) [8]. All US and CT imagies were examined by radiology department personnel. Patients who hemodynamically stable were managed conservatively. Patients that had signs of perforation or decreasing hemoglobin levels in spite of blood transfusions were operated on immediately.

On discharge patients were advised to take absolute bed rest for 15 days and then only limited physical avtivity for six weeks. They were given antibiotics and controlled by US on the 15th day.

Statistical analysis was performed using the statistical software package SPSS 19.0 for Windows XP. A Shapiro-Wilk test was performed to examine the data and to calculate the mean average. Independent comparisons among multiple groups were analyzed using a Kruskal-Wallis test. Comparisons of categorical data were performed using a Pearsons Chi-Square test. A p-value of less than 0.05 was considered statistically significant.

TABLE I - *Classification according to the American Association for the Surgery of Trauma (AAST)* [8]

Grade	Classification of renal injury	N.
Grade 1	Contusion: microscopic or gross hematuria; no depiction of injury with any imaging method; Hematoma: subcapsular hematoma with no parenchymal laceration.	2 (6%)
Grade 2 I	Nonexpanding perirenal hematoma or cortical laceration <1 cm deep with no urinary extravasation.	5 (16%)
Grade 3	Parenchymal laceration extending > 1cm the cortex with no urinary extravasation.	10 (32%)
Grade 4	Parenchymal laceration extending through the corticomedullary junction and into the collecting system.	11 (36%)
Grade 5	Multiple major lacerations resulting in a shattered kidney or avulsion of renal hilum that devascularizes the kidney	3 (10%)

Results

The patients were aged between 1-16 (mean 8.2±5.4) years old. Twenty (64.5%) patients were boys and 11 (35.5%) were girl. The most common causes of injury were falls from height (13 patients, 41.9%), pedestrian traffic accidents (5 patients, 16.1%), bicycle accidents (4 patients, 12.9%) and objects falling on the body (4 patients, 12.9%) (Fig. 1).

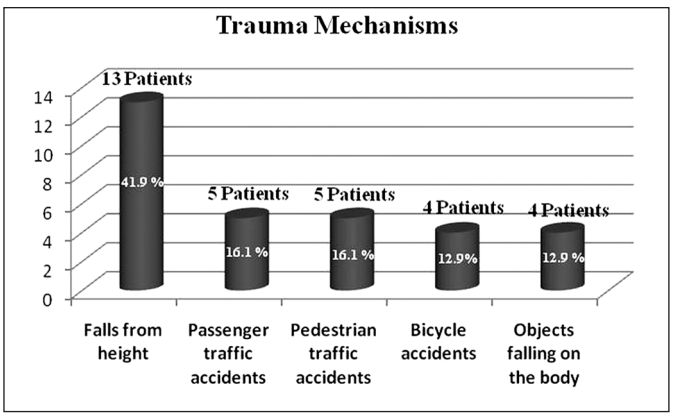

Fig. 1: Trauma mechanisms.

TABLE II - *Associated system and organ injuries*

Affected system		Associated intraabdominal injuries	
Head	4 (13%)	Only kidney	16 (52%)
Torax	2 (6.4%)	Liver	4 (13%)
Extremity	2 (6.4%)	Spleen	4 (13%)
Multiple	2 (6.4%)	Pancreas	1 (3.2%)

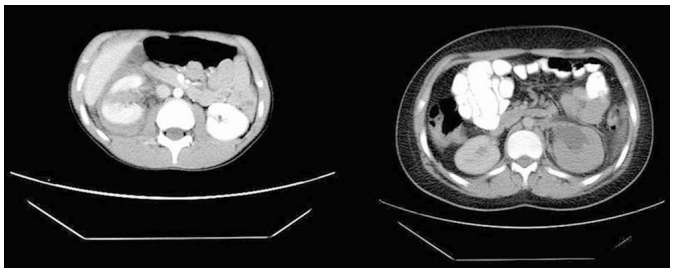

Fig. 2: CT imagines of patients with renal laceration.

Sixteen patients (52%) had renal injury alone and the remaining 15 (48%) had other organs injuries. Other injuries included head (4 patients, 13%), thorax (2 patients, 6.4%), extremity (2 patients, 6.4%) and multiple trauma (2 patients, 6.4%). Of the intraabdominal organs the liver was injured in 4 patients (13%), the spleen in 4 patients (13%) and the pancreas in 1 patient (3.2%) (Table II). Injuries were observed in the right kidney in 17 patients (55%), in the left kidney in 13 patients (42%) and bilaterally in 3 patients (3%).

X-ray graphy, US and BT were used for diagnosis. Renal laceration was observed in US in 22 patients (71%) and free fluid in 18 patients (58%). Patients with lacerations observed in US were monitored with CT and graded according to AAST classification. Injuries were classed as grade I in two patients (6%), grade II in five patients (16%), grade III in 10 patients (32%), grade IV in 11 patients (36%) and grade V in three patients (10%) (Fig. 2). Two patients with grade III injury (20%), three patients with grade IV injury (27%) and one patient with grade V injury (100%) underwent surgery, although all patients with grade I and II injuries were managed conservatively.

Hospitalization time and duration of stay in intensive care, hemoglobin levels, number of blood transfusions and types of management according to CT grades are summarized in Table III. The relationships between CT grades and hemoglobin levels, duration of stay in intensive care and hospitalization time were significant statistically ($p<0.05$). However, the relationship between CT grades and BP levels, and management methods were not significant statistically ($p>0.05$).

Twenty five patients (81%) were managed conservatively and six patients (19%) whose vital signs were not stable were operated on. One patient (1.9%) with hypotensive shock who had multiple trauma died perioperatively.

Resorption fever occurred in three patients (9.6%), blood reaction in one patient (4%) and atelectasis in one patient in the conservatively managed group. One patient (3.2%) had atelectasis and pneumonia one patient developed (3,2%). Two patients (33%) had mild hydronephrosis and one had hypertension (17%) in the later stages.

Discussion

Renal injuries are the most common injuries in the genitourinary system and constitute 30-70% of all genitourinary injuries. The cause of 80-95% of renal injuries is traumas and 75% of these traumas are from traffic accidents [9]. The most important sign of renal trauma is hematuria. AAST classification is currently the most used grading method for renal traumas. This classification has been shown to be closely related with prognosis and has helped to identify nephrectomy rates in different studies [10,11]. Management of blunt renal trauma is determined accor-

TABLE III - *Evaluation of the relationship between grades and clinical survey: mean (range)*

	Grade I-II (n. 7)	Grade III (n. 10)	Grade IV-V (n. 14)	p
Systolic BC	104 mmHg (90-110)	98 mmHg (80-120)	95 mmHg (80-120)	0.16
Diastolic BP	64 mmHg (60-70)	62,5 mmHg (50-70)	58,5 mmHg (40-70)	0.19
Average Hb value	11,8 g/dL (9.8-13,2)	10,1 g/dL (6.5-14.6)	8,6 g/dL (7-9.7)	0.00
Hematuria	2	3	4	0.70
Transfusion	2	5	6	0.04
Duration of stay in intensive care (day)	1,4 (1-2)	1,6 (1-2)	2 (1-3)	0.02
Hospitalization time	4,5 days (3.7)	5,7 days (4-8)	6,7 days (4-9)	0.04
Conservative	7	8	10	0.42
Surgery	0	2	4	0.42

ding to the hemodynamic condition of the patient and the grade of renal injury. Hemodynamic instability, any suspicion of renovascular injury or other injuries that require surgery are indications for surgical intervention. The success rate of nonoperative management is 84-89% [12,13]. Nance et al. [14] reported the cases of patients with renal trauma whose average age was 10.4 years (0.5-18 years); 72% of patients were boys. The causes of injuries were falls from height (22.1%), pedestrian traffic accidents (22.1%), passenger traffic accident (18.9%), bicycle accidents (17%) and others (5.3%). Our patients average rage was 8.2 years (1-16 years) and 64.5% of patients were boys. The causes of traumas were falls from height (41.9%), pedestrian traffic accidents (22.1%), passenger traffic accidents (16.1%), bicycle accidents (12%) and objects falling on the body (12,9%). The rate of falls from height was higher and the traffic accident rate was lower in this study than in the literature.

Keller et al. [15] evaluated 17 patients and reported six spleen injuries (35%), three liver injuries (18%), three extremity fractures (18%), two pneumothorax (12%), one GIS injury (6%), one adrenal gland injury (6%) and one pulmonary contusion (6%) as other organ injuries. Four patients in our study had liver injury (13%), four patients had spleen injury (13%), two had pulmonary contusions (6.4%) and one had pancreas injury (3.2%). In our study the right kidney was injured in 17 patients and the left kidney was injured in 13 patients. Liver injuries are common in right kidney injuries and spleen injuries are common in left kidney injuries. Organs that accompanied renal injuries in our study were the liver and spleen with equal rates, although spleen injury only was reported in the literature.

US is not a reliable preliminary diagnostic tool. Only 22% of total renal injuries and 60% of grade III renal injuries are diagnosed by US [16]. In this study US detected renal injury in 22 patients (71%) and free fluid in the abdomen in 18 patients (58%). The sensitivity of US in renal injury was higher in this study than in the literature, but the sensitivity of US decreased in low grade injuries. US is a cheap, easy applicable and radiation-free diagnostic method; on the other hand the most important disadvantage of US is subjectiveness and this causes low sensitivity.

Wessel et al. [17] assessed 64 patients with renal traumas. Twenty eight patients (43.7%) had Grade I injury, 22 patients (34.3%) had grade II, eight patients (12.5%) had grade III, five patients (8%) had grade IV and one patient (1.5%) had grade V injury. The number of patients with grade I injury was 2 (6%), 5 patients had grade II injury (16%), 10 patients had grade III (32%), 11 patients (36%) had grade IV and 3 patients (10%) had grade V injury. The rate of patients with low grade injury was lower and high grade injury was higher in our study than in the literature. Accordingly, we could say that our patients experienced more severe traumas.

Salem et al. [18] studied 40 children with high grade injuries (grade III, IV, V) and reported that 16 (40%) patients needed blood transfusions. In our study, two of seven patients (28%) needed blood transfusion, whereas 11 of 24 patients (45%) with grade III, IV and V injuries needed transfusion. The relationship between grade of injuries and number of transfusions was statistically significant ($p<0.05$). In our study patients received transfusions when their hemoglobin levels fell below 10 mg/dl. Need for blood transfusion was similar to the literature in this study.

Nguyen et al. [13] reported the cases of 46 children with blunt trauma injuries. Four of fourteen patients (29%) with grade I renal injury, 6 of 9 patients (67%) with grade II injury, 6 of 10 patients (60%) with grade III injury, 6 of 9 patients (67%) with grade IV injury and 2 of 4 patients (50%) with grade V injury had macroscopic hematuria. However, we detected hematuria in two of seven patients (29%) with grade I-II injury, three of 10 patients (30%) with grade III injury and four of 14 patients (29%) with grade IV-V injury in this study. The rate of gross hematuria for low grade injuries is similar to the literature although this rate did not increase for high grade injuries some unlike studies in the literature. The relationship between grades in CT and hematuria was not statistically significant because of the small number of patients. Macrsocopic hematuria was determined in 60% of renal traumas in other studies, but a relationship between grades in CT and hematuria was not observed [3].

Rogers et al. [19] reported the cases of 20 patients with high grade renal injury; the hospitalization time was 11 days (3-29 days) for grade IV injuries and 16 days (5-29 days) for grade V. Duration of stay in intensive care was two days (1-3 days) and hospitalization time was 6.7 days (4-9 days) for grade IV-V injuries in this study. Hospitalization time was significantly shorter in this study than in the literature. We advised our patients to take absolute bed rest for 15 days and only limited physical activity for six weeks. Patients duration of stay in intensive care and hospital was kept as short as possible. The relationship between grades in CT and duration of stay in intensive care and hostital was significant statistically ($p<0.05$).

There were 95 children in Nance et al study. [14]. They managed all 22 patients with grade I injury, 37 of 40 patients (93%) with grade II injury, all 20 patients with grade III injury, 10 of 11 patients (90%) with grade IV injury and 2 of 5 patients (40%) with grade V injury. In total 90 of 95 patients (95%) conservatively. Patients with grade I, II and V injuries did not have surgical intervention. However, 3 of 40 patients (7%) with grade II injury and one of 11 patients (10%) underwent surgery and a laparotomy was performed. In our study, we managed all of seven patients (100%) with grade I-II injuries conservatively. Eight of ten patients (80%) with grade III injury were also managed conservatively, and the other two patients (20%) were operated on.

Eight of eleven patients (83%) with grade IV injury were treated conservatively and the other three patients (17%) had surgical management. Conservative treatment was carried out for two patients (66%) with grade V injury and surgical treatment was performed for one patient (33%) with grade V injury. In total, six of the 31 patients (19%) were treated surgically while the other 25 patients (81%) were treated conservatively. Nephrectomy was performed in five of six patients and the remaining patient had a renorraphy. One patient who had grade V injury died perioperatively because of serious liver and kidney laceration and hypotensive shock. Surgical management was performed more in our study than in the literature while the rate of conservative management was less than in the literature. The reason of for this was that there were more patients with high grade injuries in our study, so we preferred surgical treatment to conservative management. The relationship between grades in CT and types of treatment was significant statistically ($p<0.05$).

Abscess, fistula, infection, urinoma, hydronephrosis and blood reaction are among the early stage complications, where as hypertension, arteriovenous fistula and hyronephrosis are some late period complications [20,21]. In this study, three patients (9.6%) had resorption fever, one (4%) had a blood reaction and one (4%) had atelectasis in the conservatively managed group; and one patient (3.2%) had atelectasis and one patient (3.2%) developed pneumonia in the surgically treated group. Hydronephrosis developed in two patients in the late stage. One patient had hypertension, but that did not continue. The early and late period complication rate was 32% in our study, but none of these complications were permanent.

Conclusion

Conservative treatment should be preferred especially for patients who are hemodynamically stable. Most renal traumas are treated conservatively. Conservative management has some advantages like shorter hospitalization time, less need for blood transfusion and a law morbidity and mortality rate. Patients should be followed up closely for some time before a decision is made to proceed with surgery. Falls from heights and traffic accidents have an important place in the of renal trauma etiology. Other organ injuries shold not be ignored.

Riassunto

Scopo: La valutazione delle tipologie di trauma dei bambini che si sono ricoverati nella nostra clinica per trauma renali, per lesioni su altri organi, delle tipologie di cura e dei consequenti risultati.

Metodo: Somo stati valutati trentuno pazienti curati nel nostro ospedale a causa di lesioni renali derivanti da trauma addominale tra 2005 – 2010 Gennaio.

Risultati: I pazienti avevano età compresa tra 1 e 16 anni (in media 8.2). Venti pazienti (64.5%) erano di sesso maschile e undici erano di sesso femminile (35.5%). La causa più frequente consisteva nella caduta dall'alto (13 pazienti, 4.9%). In sedici pazienti vi erano solo danni renali (52%) invece negli altri vi erano anche lesioni di altri organi (48%). Due pazienti con lesioni di III grado (20%), tre pazienti con lesioni di IV grado e un paziente con lesioni di V grado sono stati sottoposti ad intervento chirurgico. Su tutti i pazienti con lesioni di I e II grado é stata adottato il trattamento conservativo, cioè su venticinque pazienti (81%), invece sei pazienti i cui dati vitali non erano stabili sono stati sottoposti ad intervento chirurgico.

Risultato: Per i pazienti con ferite renali con stabilità emodinamica dovrebbe essere preferito il trattamento conservativo. Numerosi casi di trauma renale nei bambini possono essere risolti con le cure conservative, che hanno il vantaggio di necessitare un minor tempo di ricovero, di un minor bisogno del trasfusioni di sangue e inferiore morbilità e mortalità rispetto all'intervento chirurgico.

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