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Blunt renal trauma-induced hypertension in pediatric patients: a single-center experience

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Summary

Purpose
Children have a greater chance of sustaining a renal injury than adults and higher odds of having a high-grade renal injury. Hypertension is a rare complication of blunt renal trauma, with risk being higher in cases of major renal trauma. We reviewed the cases of pediatric blunt renal trauma-induced hypertension in our tertiary referral center in an attempt to better understand this rare condition.

Study design
A retrospective evaluation of children under the age of 18 who were admitted to our department during the last 20 years and were diagnosed with blunt renal trauma.

Results
Twenty-three children presented with blunt renal trauma, one of whom was treated with emergency nephrectomy. Four children (18%) developed post-traumatic hypertension. All four cases were associated with a reduction in blood flow to the kidney, either through injury to the renal artery (in three cases) or through extrinsic compression of the kidney by a large perirenal hematoma (Page kidney; in one case). The Page kidney case developed hypertension during the initial hospitalization, and it resolved spontaneously after five months through the gradual resorption of the perirenal hematoma. Among the three cases of renal artery injury, hypertension during the initial hospitalization was only observed in one case, with hypertension in the other two cases manifesting after two months and four years, respectively. All three cases of renal artery injury resulted in a complete loss of function of the injured kidney, and two cases were treated with nephrectomy. Following nephrectomy, the blood pressure level returned to normal within a few days.

Discussion
Development of hypertension following a blunt renal trauma can be heterogenous, with the time of manifestation stretching between days after the accident and years thereafter. Children have a higher risk of renal trauma and, according to published data out of the National Trauma Data Bank, a 20-times higher risk of renal artery injury in comparison to the adult population. Large multicenter studies are required to answer the question of whether children are therefore more prone to blunt renal trauma-induced hypertension than adults.

Conclusions
Our study highlights the importance of blood pressure monitoring in children following blunt renal trauma, as post-traumatic hypertension can develop even years after the accident. In cases of a poorly functioning kidney, nephrectomy may be regarded as a curative therapy.

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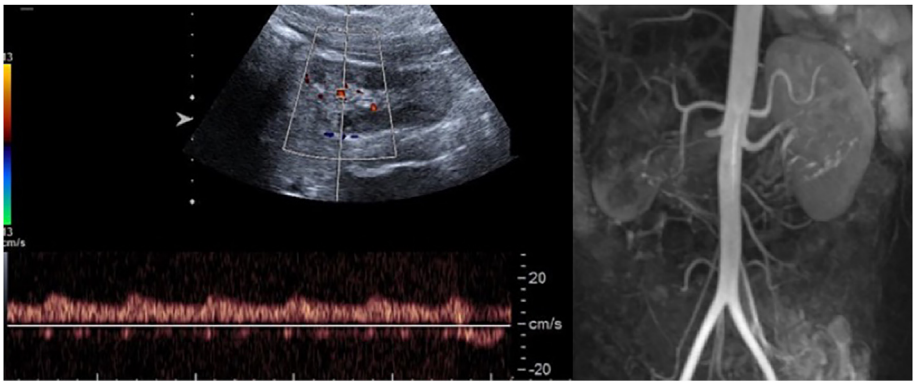

Summary Figure: Sonographic imaging of right renal artery injury, followed by magnetic resonance angiography of the kidneys. Intrarenal Pw- Doppler shows only very low flow velocity, flattened systolic rise and increased enddiastolic flow, compatible with poststenotic flow profile in A. segment. Magnetic resonance imaging reveals a complete occlusion of the right main renal artery (arrow). Minimal arterial blood flow to the right kidney through a small lower pole artery.

Introduction

Every year millions of children are admitted to an emergency room due to trauma, with trauma being the leading cause of death of children [1]. The relatively large size of the pediatric kidney compared to the remainder of the abdomen, decreased perinephric fat, smaller surrounding supportive musculature and a less ossified rib cage all lead to a higher anatomical vulnerability of the pediatric kidney, with children being more likely to sustain a major renal injury from blunt abdominal trauma than adults [2,3]. Hypertension has been reported as a rare complication of renal trauma, with an incidence of post-traumatic hypertension estimated at approximately 4.2% of all children with a blunt renal trauma [4]. The incidence has been reported to be much higher in cases of renal artery injury, an extremely rare form of renal trauma [5].

The purpose of our study was to revisit all of the cases of blunt renal trauma-induced hypertension in pediatric patients at our center, evaluating the incidence, causes and clinical presentation as well as the outcome of the disease in children, in an attempt to better understand this rare condition.

Materials and methods

In this study, we retrospectively reviewed all cases of children under the age of 18 with blunt renal trauma who were admitted to the Department of Urology and Pediatric Urology at the University Hospital in Erlangen, Germany, as a tertiary referral center between 2000 and 2020. Clinical parameters examined included age, sex, mechanism of injury, renal trauma grade, and therapy management. Injuries were graded using the American Association for the Surgery of Trauma (AAST) Organ Injury Scoring Scale for renal injuries [6]. A child was reported as hypertensive when, after having controlled the pain, either the systolic or diastolic blood pressure were, in repeated measurements, higher than the 95th percentile according to the age, sex and height percentile of the child [7,8], requiring anti-hypertensive medication. Hypertension was characterized as grade 1 ($\geq$95th percentile) and grade 2 ($\geq$95th percentile + 12 mmHg) according to the guidelines of the American Academy of Pediatrics [7]. Follow-up information was acquired through telephone interviews with the physicians (pediatricians and general practitioners) who were responsible for the care of the patients following their

Table 1 Characteristics of pediatric renal trauma, between the years 2000 and 2020, at the Department of Pediatric Urology at the University Hospital of Erlangen, Germany.

Characteristics	Grade I	Grade II	Grade III	Grade IV	Grade V
Boys	6	3	3	2	4
Girls	1	0	1	2	1
Age (mean) — in years	13	14	11	14	16
Age (range) — in years	5—17	13—17	6—17	12—17	13—17
MVA	2	0	2	1	2
Fall	1	1	1	2	1
Bicycle accident	3	0	0	1	1
Sport injury	1	2	1	0	1
Hospital stay (mean) — in days	10	10	22	24	17
Hospital stay (range) — in days	1—57	2—14	5—63	20—34	7—25
Transfusions (pro pat.)	2BU(1pat.)	—	4BU (1pat.)	1BU (1pat.) 5BU (1pat.)	1BU (1pat.) 5BU(1pat.)

MVA = motorized vehicle accident, BU = blood units, pat. = patient.

Table 2 Characteristics of the children in our study that developed post-traumatic hypertension.

	Case #1	Case #2	Case #3	Case #4
Age (at the time of the accident)	16	17	15	13
Sex	Male	Male	Male	Female
Body-mass-index	19.6 kg/m^2	34.4 kg/m^2	18 kg/m^2	17.3 kg/m^2
Body surface	1.81 m^2	1.97 m^2	1.85 m^2	1.42 m^2
Pre-existing hypertension	—	—	—	—
Kidney injured	Right	Left	Right	Left
Renal-trauma-grade	V	V	II (initial diagnosis)	V
Mechanism of injury	Motor-vehicle-accident	Motor-vehicle-accident	Bicycle accident	Fall from a horse
Injuries to other organs	Lesion of the liver treated conservatively	Hematoma of the spleen and multiple rib fractures treated conservatively	—	—
Management of renal-trauma	Ureteral stenting followed by conservative treatment	Conservative	Conservative	Revascularization-attempt
Blood-transfusion during initial hospitalization	5 units of blood	—	—	—
Time between accident and diagnosis of hypertension	6 days	5 days	2 months	4 years
Anti-hypertensive medication required	Amlodipine	Amlodipine, enalapril, nifedipine, urapidil	Amlodipine, enalapril, atenolol	Metoprolol
Function of injured kidney in renal scan	43% (3 months after the accident)	No renal scan performed	10% (2 months after the accident)	0% (2 days after the accident and 4 years later)
Therapy of hypertension	Spontaneous resolution after 5 months	Nephrectomy, 11 days after the accident	Nephrectomy, 2.5 months after the accident	Continuous anti-hypertensive medication (nephrectomy has been repeatedly denied by the patient)

discharge from the hospital as well as through a careful review of every patient's electronic hospital medical record, which contains the patient's medical history, diagnoses, medications, treatment plans, allergies, radiology images, and laboratory test results. This information is updated at every postdischarge visit of the patient to any department of our hospital.

Results

Over the last twenty years, twenty-three children under the age of eighteen were admitted to our hospital with blunt renal trauma [Table 1]. The mean age of the children was fourteen years. The mechanisms of injury were motor vehicle accidents (7 cases, 30%) or the fall of the child from a place of height (6 cases, 26%), followed by bicycle accidents (5 cases, 22%) and sport injuries (5 cases, 22%). The left kidney was injured in thirteen of the twenty-two cases (59%) and the right kidney in ten cases. No case of bilateral kidney injury was seen. Seven renal injuries were categorized as grade I (30%), three as grade II (13%), four as grade III (17%), four as grade IV (17%), and five as grade V (22%). Injury of the renal artery was detected through initial computed tomography in two cases (8.7%) and categorized as grade V. Gross hematuria was present in all except three patients (87%), two with a grade I blunt renal trauma and a patient with an isolated grade V renal artery injury. Consistent with previous studies [9], no correlation between the presence of hematuria and the degree of renal trauma was observed. Only one of the patients with a grade I-II renal trauma had injuries to any other organs, while ten of the remaining thirteen children presented with other injuries, mostly concerning the spleen during left kidney trauma or the liver during right renal trauma.

Thirteen children were treated conservatively, and no intervention was undertaken. The patients were kept under clinical observation through monitoring of their vital parameters, repeated physical examinations and an evaluation of their clinical symptoms as well as laboratory serial studies and routine ultrasound studies. Six children required ureteral stenting and a temporal urinary catheter to maintain a low-pressure-bladder and were thereafter monitored and treated conservatively. None of these children required further intervention. Selective angioembolization was performed in one case and was successful in stopping the hemorrhage. Emergency open surgery was required in two cases: a grade V renal trauma with hemodynamic instability ending in nephrectomy of the shuttered kidney and a grade V isolated unilateral avulsion of the renal artery causing complete devascularization of the kidney, in which case a revascularization attempt was undertaken.

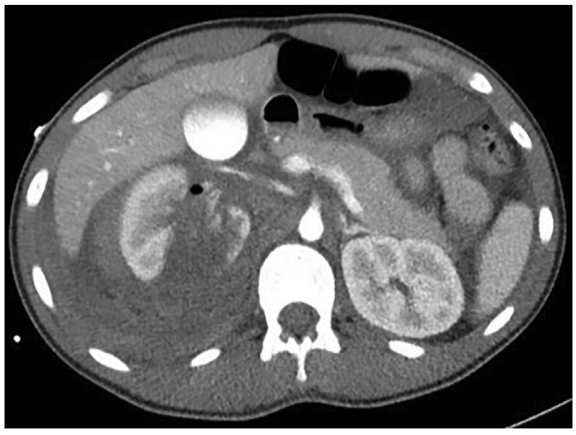

Illustration 1 CT of the abdomen of a 16-year-old boy following blunt abdominal trauma after a motor vehicle accident showing a grade V right shuttered kidney and a large perirenal hematoma. No active bleeding was detected.

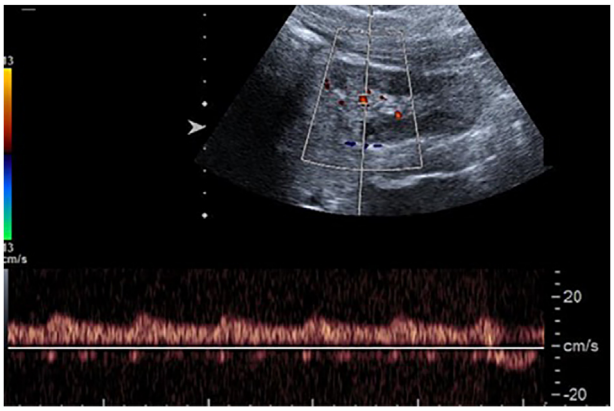

Illustration 2 Sonography from dorsal: inhomogeneous, small right kidney, intrarenal Pw- Doppler shows only very low flow velocity, flattened systolic rise and increased enddiastolic flow, compatible with poststenotic flow profile in A. segment.

Measurements of blood pressure were performed several times daily for all patients in hospital care. Blood pressure monitoring for patients in the intensive care unit was usually performed through an arterial blood-line. Of the twenty-two remaining cases (after exclusion of the emergency nephrectomy), two children (2 of 22, 9%) developed renovascular hypertension during their initial hospitalization. Follow-up information was obtained for twenty of the twenty-two patients (91%) with a median follow-up time of 54 months (IQR 10—110 months) after the trauma. Both children lost to follow-up had a grade I renal trauma. During follow-up, two more children (2 of 22, 9%) developed hypertension after two months and four years, respectively, bringing the overall incidence of post-traumatic hypertension following a pediatric blunt abdominal trauma in our center up to 18% (4 of 22). All four cases of post-traumatic renovascular hypertension are given in more detail below [Table 2].

Case 1. A 16-year-old boy presented with a parenchymal grade V right renal trauma and a subsequent large perirenal hematoma caused by a motor vehicle accident [Illustration 1]. Following ureteral stenting and the placement of a suprapubic catheter to maintain a low-pressure bladder, conservative management of the hemodynamically stable patient was chosen. An additional injury involving the liver was also treated conservatively. Blood pressure levels were controlled six times per day (every four hours). On the sixth day after the accident, and while still inpatient, a sudden rise of the blood

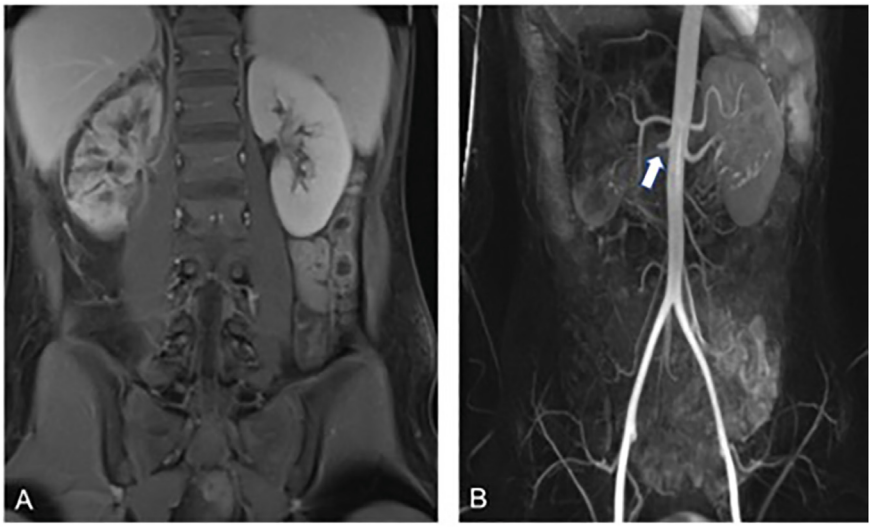

Illustration 3 A) Noncontrast-enhanced magnetic resonance imaging of the abdomen of a 15-year-old boy after a bicycle accident, performed at an external hospital. The child was initially diagnosed with a grade II right renal trauma. B) Magnetic resonance angiography of the kidneys performed two months after the accident, revealing an intimal dissection and a complete occlusion of the right main renal artery (arrow). Minimal arterial blood flow to the right kidney through a small lower pole artery.

pressure levels (grade 2 hypertension) was observed, persisting throughout the sixth day, so that a calcium channel blocker (amlodipine) was prescribed. The child responded to the medication and blood pressure levels, still monitored every four hours, returned to normal. Following his discharge from the hospital and in the course of the following months, a gradual absorption of the perirenal hematoma was documented through repeated ultrasound studies of the kidney. A DMSA (dimercaptosuccinic acid) renal scan, performed three months after the accident, showed the renal function of the injured kidney to be at 43%. After five months, his blood pressure returned to a normal level, and the anti-hypertensive medication was discontinued.

Case 2. Initial full-body three-phase computer tomography of a 17-year-old boy in hemodynamic stability, following a motor-vehicle-accident, revealed traumatic intimal dissection of the left renal artery causing complete devascularization of the left kidney. Due to an additional traumatic dissection of the abdominal aorta, an endovascular approach of the renal artery was not feasible and a decision against trying an open revascularization attempt was made. A conservative approach of both the aortic dissection as well as the renal trauma was selected. Five days after the accident, the child developed a grade 2 hypertension, requiring a combination of anti-hypertensive medications with amlodipine, enalapril, nifedipine and urapidil. The hypertension was not pain-related and was documented through an arterial line, persisting even during the patient's sleep. Following laparoscopic nephrectomy of the left kidney, performed eleven days after the accident, his blood pressure levels returned to normal.

Case 3. Following a bicycle accident, a 15-year-old boy was initially admitted to an external hospital, where a noncontrast-enhanced magnetic resonance imaging of the abdomen took place, leading to the initial diagnosis of a grade II right renal trauma. The trauma was managed conservatively, and the patient was released from hospital care two days later. Two months after his initial treatment, the boy was referred to our hospital with newly diagnosed grade 2 hypertension. Hypertension was diagnosed by the pediatrician of the child through repeated blood pressure measurements and confirmed through a 24 h-ambulatory-blood-pressure-monitoring (ABPM), before referring the child to our hospital for therapy. Therapy of his hypertension required a triple-combination of anti-hypertensive medication (amlodipine, enalapril and atenolol). An ultrasound examination of the kidneys, performed in our clinic, revealed a significant reduction in the size of the kidney (vol. 50 ml), which was previously described as inconspicuous as well as a perfusion reduction and a poststenotic flow profile [Illustration 2] with a reduced resistance index recorded by Doppler sonography. A magnetic resonance angiography of the kidneys showed an intimal dissection of the right main renal artery with subsequent almost complete devascularization of the right kidney [Illustration 3]. Minimal arterial blood flow to the right kidney was only observed through a small lower pole artery. A DMSA renal scintigraphy revealed the function of the injured kidney to be at only 10%. Following laparoscopic nephrectomy of the kidney, his blood pressure levels returned to normal within three days and the child was discharged without medication.

Case 4. A 13-year-old girl, after a fall from a horse, was referred to our hospital with an isolated avulsion of the left renal artery. An emergency revascularization attempt through thrombectomy and suture of the renal artery was undertaken. Revascularization was achieved within eight hours of the accident. Magnetic resonance angiography of the kidneys, performed 48 h after the operation, showed the new-onset of renal artery thrombosis causing complete occlusion of the renal artery. A DMSA renal scan revealed a

total loss of kidney function (0%). As the child was in good condition with no complaints at the time, a decision against nephrectomy was made. Following the accident, regular controls of the patient's blood pressure were conducted showing normal blood pressure levels. Four years after the accident, grade 2 hypertension was diagnosed by the family's general practitioner, through repeated blood pressure measurements on different occasions. An anti-hypertensive medication with a ß blocker (metoprolol) was initiated by the general practitioner. The repetition of the DMSA renal scintigraphy scan confirmed the loss of renal function of the then-small atrophic left kidney. A proposed nephrectomy has since then been repeatedly refused by the patient, and the young woman has been receiving a single anti-hypertensive medication (metoprolol) for the last 13 years, with her blood pressure levels remaining stable under medication.

None of the children in our study had pre-existing hypertension and only one of the four children that developed post-traumatic hypertension was obese [Table 2]. Hypertension was diagnosed through repeated blood pressure measurements over time or through a 24 h-ambulatory-blood-pressure-monitoring. Repeated measurements can, according to guidelines, reduce confounders in the diagnosis of hypertension such as stress or other medication intake.

During the months after the accident (between 2 and 6 months after the accident), DMSA renal scans were performed in an additional four children with major renal trauma and large perirenal hematomas, revealing that the function of the injured kidneys was between 32 and 44%. None of these children developed hypertension.

Discussion

Hypertension in children can lead to a series of long-term adverse health effects and shows a direct relationship with mortality and cardiovascular disease. Survival analyses have shown that untreated hypertension in patients younger than 35 years decreases their life expectancy by 16.5 years [10]. Blunt renal trauma-induced hypertension is believed to be renin-mediated following upregulation of the renin-angiotensin system as a result of an overall reduction of blood flow to the kidney due to external compression of the kidney from a perirenal hematoma (Page kidney), renal artery thrombosis, renal artery stenosis (Goldblatt kidney), segmental arterial thrombosis, renal artery dissection or arteriovenous fistulae [11]. Hypertension, following a blunt renal trauma, has been shown to usually develop during the initial hospitalization or during the first year following the accident [12—14]. Cases have however been reported of renovascular hypertension developing decades after a renal trauma [15,16]. Although the evidence is very limited, some studies have suggested that in approximately 50% of the cases, blunt renal trauma-induced hypertension will resolve spontaneously within the weeks and months following the accident [13,17].

There are no evidence-based criteria for the diagnosis of renovascular hypertension in children [7]. Diagnosis is based on sonographic, radiological or radionuclide imaging that indicates a reduce of the blood flow to the kidney. Although, the levels of plasma renin activity (PRA) have been proposed as a potential marker of renovascular hypertension, PRA has been shown to be normal in more than a third of the patients with renovascular hypertension [18,19]. Numerous studies have attempted to utilize measurements of PRA to identify renovascular hypertension. Peripheral PRA has been disappointing in clinical use [20]. It is not sensitive enough under routine conditions to reliably diagnose renovascular hypertension [21]. It is elevated in only two thirds of the patients with renovascular hypertension and is variably affected by ethnicity, age, medications, volume status and other variables [22] and was not used in our study. While the presence of pre-existing hypertension in adult renal trauma patients is an important potential confounder, making it difficult to accurately identify patients with hypertension directly related to the traumatic event, the lack of pre-existing hypertension and comorbidities in the pediatric population allows for a potentially more accurate depiction of the association between renal trauma and hypertension.

Following blunt renal trauma, the incidence of hypertension in pediatric patients has been estimated at 4.2% [4]. Its incidence following a high grade pediatric renal trauma (grades IV and V) has been reported as being as high as 17.6% [14] and although studies are scarce, when only the cases of blunt renal artery injury are taken into consideration, the incidence of post-traumatic hypertension in the general population (children and adults) can increase to 42% [5]. In our study, blunt renal trauma-induced hypertension in children under the age of 18 was observed in 18% of the cases. When only including patients with grades IV and V injuries, the rate of hypertension was 37.5%. As a specialized center of pediatric urology in a large university hospital, it is the opinion of our study group that the patient population of our department does not necessarily reflect the general epidemiological picture of pediatric blunt renal trauma, where low-grade traumas compose the vast majority of cases and where renal artery injury is reported in less than 1% of renal traumas. Indeed, a number of our high-grade injuries were referred to us from smaller hospitals. Low-grade renal injuries are not usually referred to us but are instead treated locally in a conservative manner.

It is a well-acknowledged fact that children are more susceptible to major renal trauma than adults [2,3]. A large study of motor vehicle accidents in 2017 has estimated that following a blunt abdominal trauma, children have a 50% greater chance of sustaining a renal injury than adults and a 33% higher odds of having a high-grade renal injury [3]. Using reported data out of published studies from the National Trauma Data Bank (NTDB) of the Committee on Trauma of the American College of Surgeons, we can easily calculate that the risk of renal artery injury is 20-times higher in children under the age of 16 in comparison to adults [23,24]. Sangthong et al. [24] reported that between 1991 and 2003, out of a total of 945,326 blunt trauma admissions in the NTDB, 517 cases (0.05%) of renal artery injury were identified. This study provided no further information regarding the incidence of the injury in children versus adults. Hamner et al. [23], in their study on blunt intraabdominal artery injury in pediatric patients, also analyzing the NTDB, stated that between the years of 2000

and 2004, out of 4265 children under the age of 16, 38 cases (0.9%) of renal artery injury were reported [23]. Renal artery injury was the most frequent intraabdominal blunt artery injury in pediatric patients under the age of 16. Since both epidemiological studies were based on the same databank during overlapping time-periods, we can assume that children under the age of 16 have an approximately 20-times higher risk of blunt renal artery injury than adults.

One could therefore hypothesize that, since the incidence of post-traumatic hypertension is higher in cases of renal artery injury, the incidence of blunt renal trauma induced hypertension in children could also be higher than that of the adult population. One should, however, keep in mind that renal artery injury is extremely rare, with an incidence of only 0.9% in pediatric blunt abdominal trauma and that not all children with a renal artery injury will develop hypertension. Although studies of the incidence on the basis of age are lacking, studies of the general population have shown that the incidence of post-traumatic hypertension following renal artery injury lies between 11 and 42% [25,26].

With conservative therapy becoming the gold standard of blunt renal trauma management, even in cases of high-grade renal trauma with hemodynamic stability, we can assume that the prevalence of the Page kidney model will become increasingly significant. The Page kidney, named after Dr. Irvine Page, who first described this pathology in his canine experiments [27], refers to renovascular hypertension, secondary to external renal compression, that reduces the blood flow to the kidney and induces an upregulation of the renin-angiotensin system. In our study, one child with a large perirenal hematoma after a grade V right renal injury developed a Page kidney during the initial hospitalization. Gradual resorption of the hematoma and the relief of the compression of the kidney led to a spontaneous resolution of hypertension after five months. However, the danger exists that as a consequence of long-standing blood collection, a fibrocollagenous shell may form, making long-term anti-hypertensive therapy necessary [28].

Post-traumatic hypertension can develop during the initial hospitalization and also following discharge from hospital care. In our third case, a child with an initially grade II renal trauma developed thrombosis of the renal artery and consequently renovascular hypertension. In this case, an intimal dissection of the renal artery caused by the accident was not detected through noncontrast-enhanced magnetic resonance imaging, showing that despite improvements in imaging, a contrast-enhanced three-phase computed tomography during the initial staging remains the most accurate technique for the assessment of renovascular injury. Following traumatic dissection of the renal artery and consequent thrombotic occlusion of the renal artery, the child developed an initially uncontrolled therapy-resistant renovascular hypertension, which, if it had remained untreated, would certainly have had serious and possibly lethal consequences.

In our fourth case of post-traumatic hypertension, it developed four years after the renal trauma, showing the importance of long-term follow-up for such injuries. Hypertension has been reported as a delayed complication of renal trauma [12,16] and although other causes cannot without doubt be excluded, no other predisposing factors for the development of hypertension in the then 17-year-old girl were present, so that the only plausible cause for the hypertension remaining is that of a renovascular hypertension following the blunt renal trauma. Small atrophic kidneys can often be responsible for the development of renovascular hypertension. Although the kidney is atrophic and seems to be almost nonfunctional on renography, studies of renin-renal-vein-sampling of such kidneys during angiography or angioplasty have shown that the endocrine function of the atrophic kidney is usually preserved [29]. Nephrectomy of small atrophic kidneys in cases of renovascular hypertension can lead to a significant improvement of blood-pressure-levels in up to two thirds of adult patients [30]. Whether or not a nephrectomy would have led to a quick resolution of the hypertension and whether a nephrectomy now, 13 years after the onset of the presumed post-traumatic renovascular hypertension, can still lead to a cure of the hypertension cannot be answered with certainty. Although cases of nephrectomy being curative even after long-standing hypertension caused by traumatic renal artery thrombosis have been reported [31], rare cases of renovascular hypertension persisting after nephrectomy have also been reported [32].

Physicians should be aware of the risk of hypertension following all grades of blunt renal trauma, and monitoring of blood pressure during hospitalization and during long-term follow-up is strongly advised. An evaluation of renal function through a renal DMSA scintigraphy scan is advised. A poorly functioning kidney suspected of causing hypertension should be treated with nephrectomy [33]. In cases of adequate renal function, where renovascular hypertension is suspected, an angiography of the kidney to assess the possibility of endovascular treatment should be considered [4,34,35]. Endovascular intervention options include percutaneous transluminal angioplasty with or without stenting, depending on the cause of the hypertension [36]. Indications for surgical intervention are refractory renovascular hypertension caused by a kidney for which medical treatment and angioplasty have failed [36]. There are several possible surgical procedures, including, among others, reimplantation of the renal artery, resection of the narrowed arterial segment and primary reanastomosis, aortorenal bypass or autotransplantation [37,38].

The main limitations of our study are the small number of patients included, reflecting the rarity of this post-traumatic complication, and its retrospective design. Large multicenter studies are required for achieving a better understanding of this challenging condition.

Conclusions

Despite its small size, our study highlights the importance of blood pressure monitoring in children following blunt renal trauma, showing the heterogeneous danger of post-traumatic hypertension that can manifest even years after the accident. Since hypertension in children is an under-diagnosed disease [39] these patients should be followed up in a specialized center in order to avoid secondary long-term damage and to provide appropriate therapy.

According to our experience, the most frequent mechanisms of post-traumatic hypertension in children involve injuries of the renal artery causing a thrombosis of the renal artery or a Page kidney caused through extrinsic compression of the kidney by a large perirenal hematoma. Following a diagnosis of hypertension, sonography of the kidneys, including Doppler, should be performed primarily. If the findings are unclear, further diagnostics using angiography-imaging and a renal DMSA scan to assess kidney function are well advised. Children have a higher risk of renal trauma and, according to our calculations, a 20-times higher risk of renal artery injury in comparison to the adult population. Large multicenter studies are required to answer the question of whether children are therefore more prone to blunt renal trauma-induced hypertension than adults. The fact remains that special care is warranted in the management of pediatric blunt renal trauma.

Declarations of interest

None declared.

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