Management and treatment of splenic trauma in children

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AIM: *To assess types of splenic traumas, accompanying injuries, their management and results.*
METHODS: *We studied the reports of 90 patients (64 boys, 26 girls) who were treated for splenic injuries as a result of blunt abdominal trauma between 2005-2012. Age, sex, hospitalization time, mechanisms of traumas, accompanying injuries and management methods were recorded.*
RESULTS: *Causes of trauma were falls from height (46 patients, 51%), pedestrian traffic accidents (17 patients, 19%), passenger traffic accidents (11 patients, 12%), bicycle accidents (10 patients, 11%) and falling objects from height (6 patients, 6.6%). Splenic injury alone was observed in 57 patients (63.3%) and other organ injuries together with splenic injury in 33 patients (36.7%). Splenectomy was performed in six patients (6.6%) due to hemodynamic instability and small intestine repair due to small intestine injury in one patient (1.1%). None of these patients died from their injuries.*
CONCLUSION: *A large proportion of splenic injuries recover with conservative therapy. Some of the advantages of conservative therapy include short hospitalization time, less need for blood transfusion, and less morbidity and mortality. Falls from height and traffic accidents are important factors in etiology. The possibility of other organ injuries together with splenic injuries should be considered.*

KEY WORDS: Trauma, Children, Management, Pediatric, Spleen, Splenic

Introduction

Spleen is the most injured organ due to blunt abdominal traumas. Liver and kidney traumas are frequently injured organs with spleen[1]. The spleen is the organ most commonly affected by blunt trauma to the abdomen. Blunt abdominal traumas are most commonly seen in traffic accidents, falls from height and bicycle accidents. Splenectomy is performed in particular for traumas and blood disorders [2].

In one study splenic laceration was seen mostly in boys (70%) and in those between 7-13 years of age [3]. Also, injury to other organs besides splenic injury was observed in 35% of patients [3].

The treatment alternatives for splenic injuries are conservative treatment, splenoraphy, ligation of the splenic artery, partial or total splenectomy. Splenectomy or splenoraphy were the most commonly used methods in the last quarter of the last century. However, because of the risk of sepsis due to gram positive bacteria in asplenic patients, conservative treatment is currently more popular [4].

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TABLE I - *The relationship between hemodynamic stability and hospitalization time in conservative and surgical treatment groups [*:mean (range)].*

	Group I (n. 84)	Group II (n. 6)	P
Systolic blood pressure	110 mmHg (100-120)*	105 mmHg (80-120)*	0.53
Diastolic blood pressure	70 mmHg (60-80)*	65 mmHg (60-80)*	0.54
Average Hb value	11gr/dL (10-12)*	8.5 gr/dL (7-11)*	0.00
Transfusion (number of patients)	38 (%45)	6 (%100)	0.01
Stay in intensive care unit (day)	1.5 (1-2)*	2.5(2-3)*	<0.01
Hospitalization time (day)	5 (4-7)*	8.5 (6-9)*	0.01

Accurate and speedy diagnosis for splenic injury minimizes morbidity and mortality. Abdominal x-ray graphy, ultrasonography (US) and computed tomography (CT) are the most commonly used monitoring methods for diagnosis and follow-up in case of splenic trauma. Surgical interventions are used less in solid organ injuries because of developments in radiology [5].
The aim of this study is to assess types of traumas, accompanying injuries, and the management and results of splenic traumas.

Patients and Methods

We studied the cases of 90 patients who were treated for splenic injuries as a result of blunt abdominal trauma between 2005-2012. The age of the patients range from 1-17 (median age 8.3±5.4 years old) years of age sixty-four (71.2%) of the 90 patients were boys and 26 (28.8%) were girls. All of these patients were included to study.
All patients were admitted to the intensive care unit and their vital parameters (heart rate, number of breaths, blood pressure, urine output and density) were assessed hourly and hemoglobin levels were measured at the 6th and 24th hours.
Injuries were diagnosed by history, physical examination, US and/or CT. Splenic injuries were graded according to the classification of the American Association for the Surgery of Trauma (AAST). US and CT examinations were carried out by a radiologist.
The need for blood transfusion and treatment modalities were evaluated. Patients with hemodynamic stability were treated conservatively. Patients with evidence of perforation of the bowels or low hemoglobin levels in spite of blood transfusions underwent surgery.
Patients were classified according to a retrospective analysis of their records. General information such as age, sex, hospitalization time, mechanisms of trauma, accompanying injuries and treatment methods were recorded. Hemodynamic stability was determined by blood pressure, hemoglobin levels and by performing blood transfusions.
Statistical analysis was performed using the statistical software package SPSS 15.0 for Windows XP. A Shapiro-Wilk test was performed to examine the data and to calculate the mean average. Independent comparisons between the two groups were analyzed using a Mann-Whitney U test. Comparisons of categorical data were performed using a pearson Chi-Square test. A p-value of less than 0.05 was considered statistically significant.

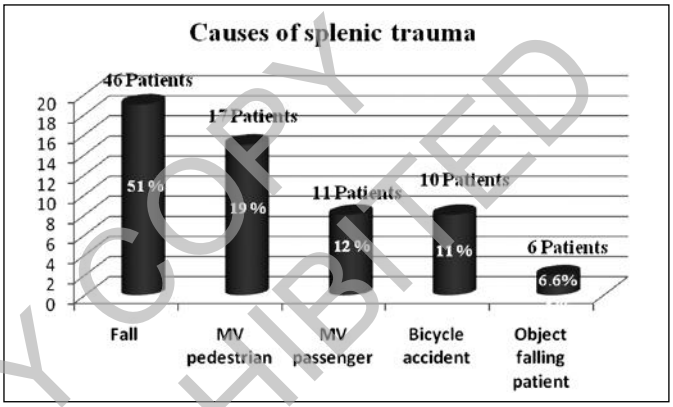

Fig. 1: Causes of splenic trauma [Motor vehicle (MV)]

Results

Patients were classed according to treatment methods, into the conservative (group I) or operative (group II). Blood pressures, hemoglobin levels, blood transfusion, stay in intensive care and hospitalization times were assessed (Table I).
Injuries resulted from falls from height (46 patients, 51%), pedestrian traffic accidents (17 patients, 19%), passenger traffic accidents (11 patients, 12%), bicycle accidents (10 patients, 11%) and falling objects (6 patients, 6.6%) (Fig. 1).
Systolic and diastolic blood pressures were lower in group II than in group I, but the difference was not statistically significant (p>0.05). Hb levels were significantly lower in group II than in group I. All of the patients in group II needed blood transfusions, whereas only 45.2% of patients treated in group I needed transfusions. This difference was statistically significant. Length of stay in intensive care and hospitalization time were significantly longer in group II than in group I (Table I). X-ray graphy, US and CT were used as diagnostic

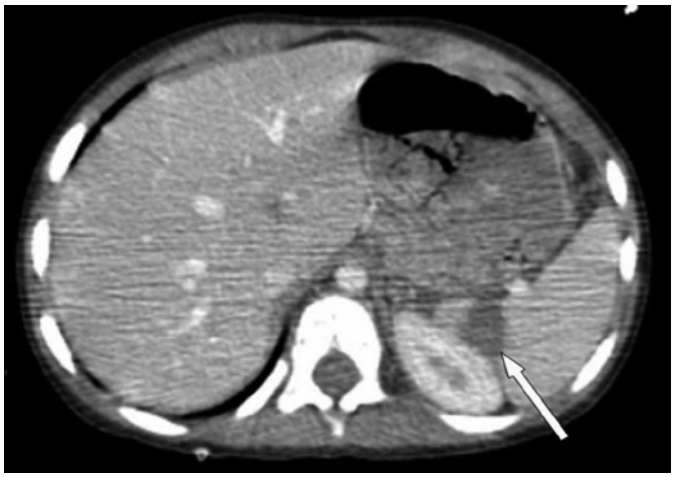

Fig. 2: Axial enhanced CT image showing grade 2 splenic lacerations.

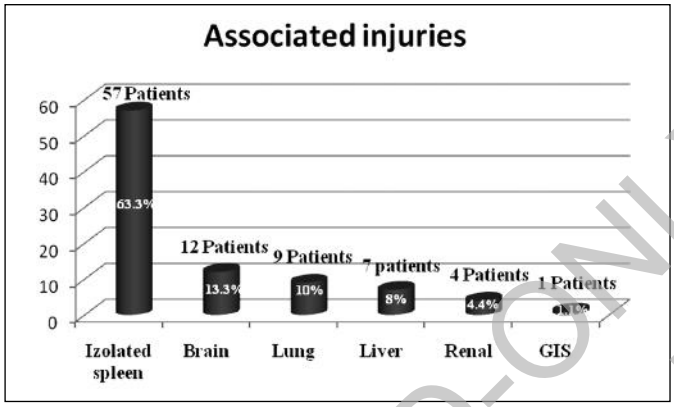

Fig. 3: Other organ injuries beside spleen [Gastrointestinal system (GIS)].

methods. CT was used for grading and other organ injuries in patients in whom splenic lacerations were detected in US. Intra-abdominal free fluid was seen in US in 65 (71.1%) patients. Splenic laceration was diagnosed directly in US in 64 (71.1%) patients. In CT assessments splenic injuries were classed as grade I in 11 (12.3%) patients, grade II in 24 (26.6%), grade III in 19 (21.1%) and grade IV in 36 (40%) patients (Fig. 2). Patients with grade I and II injuries were managed conservatively whereas patients who had grade III (two patients) and grade IV (four patients) injuries were managed surgically (Table II). None of our patients were grade V. One patient with sub diaphragmatic air was detected in X-ray.

Splenic injury alone was observed in 57 (63.3%) patients and in conjunction with other organ injuries in 33 (36.7%) patients. Other organ injuries included brain injuries in 12 (13.3%) patients, lung in 9 (10%), liver in 7 (8%), kidney in 4 (4.4%) and bowel in 1 (1.1%) patient (Fig. 3).

Eighty-four patients (93.3%) were treated conservatively, whereas 6 (6.6%) needed surgery. Splenectomy was performed as an open operation. Also, bowel repair was done in one (1.1%) patient who had intestinal perforation. None of our patients died from their injuries.

Resorption fever was seen in 15 patients (17.8%) in group I and one patient (16.6%) in group II had atelectasis.

TABLE II - *The relationship between grade of injury and management methods.*

	All patients (%)	Group I (%)	Group II (%)
Grade I	11 (12.3%)	11 (100%)	0
Grade II	24 (26.6%)	24 (100%)	0
Grade III	19 (21.1%)	17 (89.5%)	2(10.5%)
Grade IV	36 (40%)	33 (91.7%)	4(11.1%)

Discussion

Mechanism of trauma and organ injury have a parallelism in child injuries. Falls from height, passenger and pedestrian vehicle traffic accidents are the most commonly seen accident types. Other types include bicycle accidents, sports injuries and blunt abdominal traumas due to assault. The risk of intra-abdominal organ injuries is higher if there is ecchymosis, hematoma or dermal abrasions in the abdominal, waist, back and chest regions [6]. Kuzma et al. [7] reported that 36 (52%) of 69 patients had trauma due to domestic violence, 11 (16%) patients had trauma due to falls from height, 8 (11.5%) from traffic accidents and 14 (20%) patients from fights, sporting activities and other reasons. Fights and sports accidents are the most common causes of solid organ injuries in adults while falls from height, traffic and bicycle accidents and falling objects are the most frequent causes of injury in children [6]. Our study included patients who had traumas because of falls from height (46 patients, 51%), pedestrian traffic accidents (17 patients, 19%), passenger traffic accidents (11 patients, 12%), bicycle accidents (10 patients, 11%) and falling objects (6 patients, 6.6%) in our study.

Multiple organ injuries occur after abdominal traumas in children because the dimesions of children are big, the surface area of children is limited and the intra-abdominal organs are closer to each other. The liver is the most commonly injured organ with the spleen [8]. Liver injuries came after brain and lung injuries in our study. This finding is different from those in the literature.

Conservative management including frequent physical examination, monitoring, bed rest and hemoglobin measurements is the preferred made of treatment in children, because splenic traumas in children are well defined. Infection risk after splenectomy is higher in children than in adults, so conservation of the spleen is very

important. A significant number of grade 1-4 and 40% of grade 5 lacerations recovered well with conservative management. In general, studies have shown that improvement with conservative therapy has a success level of 90-98% in children [7,8,9]. While all grade 1 and 2 lacerations were managed conservatively in this study, two patients who underwent splenectomy had grade 3 lacerations and four had grade 4 lacerations. There were no grade 5 patients. The number of patients who healed with conservative treatment was 84 (93%). This result is compatible with the literature.

Abdominal CT findings such as intra-abdominal free fluid and enhancement of this fluid with contrast medium are used for adults in need of surgery; however, this is not true for children [10]. US and CT are most used diagnostic imaging methods recently [11]. Insufficient recovery of vital signs in spite of adequate fluid replacement, another pathology requiring laparotomy and the need for blood over the level of 40 ml/kg/day in pediatric patients are important criteria in determining surgical indications [12]. Grading at CT was not effective in deciding when surgery was necessary in this study; however, six patients with deteriorated hemodynamic and whose hemoglobin level did not rise in spite of blood transfusion underwent surgery. Fifty of 55 patients (90.9%) who had grade 3-4 laceration on CT were treated conservatively.

Surgical treatment was the preferred made of treatment for splenic traumas in the 1960s; conservative treatment is currently preferred. Davies et al. [13] assessed splenic traumas over the last 50 years and reported that the rate of conservative treatment was 42% in the 1960s and 97% in 2000s and hospitalization time decreased to 5 days. Surgery is required for patients had severe trauma, espacially who are instable hemodynamically. Consevative management is accepted by many authorities especially in children[11]. Conservative management in splenic traumas does not extend hospitalization time. Length of stay in intensive care and hospitalization time for splenic trauma patients treated surgically are longer than for patients treated conservatively in many studies [14]. At the same time, length of stay in intensive care and hospitalization time were significantly longer in patients treated surgically.

There must be a sufficient number of enough personnel to monitor on patients in intensive care units and appropriate radiologic equipment for the conservative treatment of patients with solid organ injuries [15]. Patients that have solid organ injury should not be treated conservatively unless suitable conditions exist for emergent operations, anesthesia and blood transfusion [10]. If the patient requires a blood transfusion of more than half of his/her blood content, surgical treatment is most likely necessary [16]. In a five year study Wesson et al. reported that 70% of patients were treated conservatively and 24% of patients underwent splenectomy. Pearl et al. reported that 87% of children with splenic injuries were treated conservatively and only 4% needed splenectomy. Surgical treatment is mostly performed in adults [16,17]. In their study Arikan et al. [15] reported that 89% of adult patients had splenectomy, 7% had splenoraphy and 4% had partial splenectomy. Stella managed splenic parenchymal laseration with radiofrequency thermal energy. In this way, spleen is protected and there are no problems about asplenism[18]. We treated 93% of our patients conservatively and only 6.6% needed splenectomy.

Stephen et al. [20] reported that postoperative sepsis risk after splenectomy in adult patients was 4.2% and this rate was 200 times higher than in the general population. n their study Arikan et al. [15] reported incidences of abscess in two patients, dermopancreatic fistula in one patient and aspiration pneumonia in one patient. There are increased risks about infection and sepsis who had splenectomy. Thus, conservative treatment is important for children particularly.

In our study 15 patients had fever in group I and one patient had wound infection in group II. It is difficult to evaluate postoperative complications because of the limited number of patients managed surgically in this series.

Kuzma et al. [7] reported mean systolic blood pressure in a conservatively treated group as 98 mmHg and in a surgically treated group as 84 mmHg. We observed the same parameter at the level of 110 mmHg in group I and 105 mmHg in group II; mean diastolic blood pressures were 70 mmHg in group I and 65 mmHg in group II. Hypotension is an important parameter when considering surgery. There was marked hypotension in group II in our study.

Rhodes et al. [4] found that there were 12 patients at grade I, 15 patients at grade II, 30 patients at grade III, 17 patients at grade IV and 8 patients at grade V. In their study splenectomy was performed in six patients with grade IV injury (35.6%). In this study three of the 27 patients with grade IV splenic injury (8.3%) underwent splenectomy. We can there for conclude that the need for surgery in cases of high grade injury is lower in children than in adults.

In Thompson et al. study the level of hemoglobin in the nonoperative group was 12.1 g/dl and in the operative group was 11 g/dl [18]. This parameter was 11g/dl in group I and 8.5 g/dl in group II in our study. Blood transfusions were performed in four patients (12%) in the nonoperative group and in five patients (83%) in the operative group in Thompson et al. study. Jerzy et al. [7] indicated that patients in the conservative treated group needed 0.81 unit of blood and the operative group they needed 2.91 units of blood ($p<0.001$). In this study the rate of blood transfusion in group I was 45% and in group II it was 100%. If hemodynamic stability cannot be obtained in spite of adequate blood transfusions, surgery must be performed. Blood transfusions must be carried out and hemodynamic stability must be observed in patients with splenic traumas before deciding on surgery.

Conclusion

Most splenic traumas can be treated conservatively in pediatric patients. There are some advantages to conservative management like short hospitalization time, less need for blood transfusions, and a lower morbidity and mortality rate in splenic injuries. Patients must be observed closely before deciding on surgery. Falls from height and traffic accidents are important causes of splenic injuries. Other organ injuries should be considered besides splenic trauma.

Riassunto

Lo studio è finalizzato alla valutazione dei tipi di lesioni traumatiche associate a lesioni spleniche in bambini, il loro trattamento ed i relativi risultati, e si è avvalso di 90 pazienti trattati nella nostra clinica tra gli anni 2005-2012 per le lesioni della milza a seguito di un trauma addominale chiuso. Sono stati presi in considerazione età, sesso, durata della degenza ospedaliera, meccanismo del trauma, lesioni associate e metodi di trattamento adottato.

Tra le cause del trauma si è riscontrata la caduta dall'alto (46 pazienti, 51%), il coinvolgimento in incidenti stradali in pazienti a bordo dei veicoli (11 pazienti, 12%) o in semplici pedoni (17 pazienti, 19%), caduta dalla bicicletta (10 pazienti, 11%), impatto di oggetti caduti dall'alto (6 pazienti, 6,6%).

Nel 63,3% dei casi (57 pazienti) si erano registrate lesioni alla sola milza, mentre il 33 dei pazienti (36,7%) presentava lesioni associate di altri organi.

84 pazienti (93.3%) sono stati trattati in modo conservativo. Sei pazienti (6,6%) emodinamicamente instabili sono stati sottoposti a splenectomia. Oltre alla splenectomia in un paziente (1,1%) si è provveduto al trattamento di una perforazione del piccolo intestino.

In conclusione la maggior parte dei traumi della milza nei bambini può essere guarito con un trattamento conservativo. Il trattamento conservativo ha vantaggi come la minore durata della degenza ospedaliera, una minore necessità di trasfusione, una minore morbilità e mortalità. Le cadute dall'alto e gli incidenti stradali svolgono un ruolo importante nell'eziologia delle lesioni spleniche, ma insieme a quelle della milza non bisogna ignorare le eventuali lesioni di altri organi.

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