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Rev Chil Pediatr. 2017;88(4):470-477
DOI: 10.4067/S0370-41062017000400005

ORIGINAL ARTICLE

Associated factors to non-operative management failure of hepatic and splenic lesions secondary to blunt abdominal trauma in children

Factores asociados a falla en el manejo no operatorio de lesiones hepáticas o esplénicas secundarias a trauma abdominal cerrado en niños

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Received: 9-10-016; Accepted: 17-12-2016

Abstract

Introduction: The non operative management (NOM) is the standard management of splenic and liver blunt trauma in pediatric patients.Hemodynamic instability and massive transfusions have been identified as management failures. Few studies evaluate whether there exist factors allowing anticipation of these events. The objective was to identify factors associated with the failure of NOM in splenic and liver injuries for blunt abdominal trauma. **Patients and Method:** Retrospective analysis between 2007-2015 of patients admitted to the pediatric surgery at University Hospital Saint Vincent Foundation with liver trauma and/or closed Spleen. **Results:** 70 patients were admitted with blunt abdominal trauma, 3 were excluded for immediate surgery (2 hemodynamic instability, 1 peritoneal irritation). Of 67 patients who received NOM, 58 were successful and 9 showed failure (8 hemodynamic instability, 1 hollow viscera injury). We found 3 factors associated with failure NOM: blood pressure (BP) < 90 mmHg at admission (p = 0.0126; RR = 5.19), drop in hemoglobin (Hb) > 2 g/dl in the first 24 hours (p = 0.0009; RR = 15.3), and transfusion of 3 or more units of red blood cells (RBC) (0.00001; RR = 17.1). Mechanism and severity of trauma and Pediatric Trauma Index were not associated with failure NOM. **Conclusions:** Children with blunted hepatic or splenic trauma respond to NOM. Factors such as BP < 90 mmHg at admission, an Hb fall > 2 g/dl in the first 24 hours and transfusion of 3 or more units of RBC were associated with the failure in NOM.

Keywords:
Blunt abdominal trauma;
splenic trauma;
hepatic trauma;
non operative;
management

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Introduction

Trauma is the main cause of morbidity and permanent disability in children between 1 and 14 years old[1-5]. In Colombia, a 14.2% of deaths in children between 1 to 4 years old are registered, and a 14% in the age group between 5 and 14 years old[3]. Traffic accidents are the leading cause of trauma mortality with 44% of all deaths[1,3,6,7], mainly in the population between 5 and 14 years of age. Penetrating trauma is much less common in young children, rating only 1% to 10% of the consultation reasons in pediatric trauma centers[1-3].

Although the principles of trauma in pediatrics are similar to those of the adult population, there are anatomical and physiological characteristics in the pediatric group that make it more susceptible to injury to intra-abdominal organs such as: the greater elasticity in the child's body, the relative proximity of the intra-abdominal organs, the thinness of the abdominal wall and the smaller adipose paniculus[1,3,4,9,10]. The spleen and liver are the most commonly injured intra-abdominal organs in pediatric patients, similar to adult patients (28% and 30%, respectively), cases of closed abdominal trauma. In most cases, these lesions can be managed without surgery[6,11-16]. This therapeutic approach is called non-operative Management (NOM) and it is defined as that management performed in the patient, after a primary and secondary revision and after the taking the relevant images, which support the decision of not perfoming surgery immediately[12,13].

We propose in this study to determine if there are clinical, paraclinical and imaging factors associated with failure in the non-operative management of splenic and/or hepatic lesions secondary to closed abdominal trauma in the age group from 0 to 14 years of age.

Patients and Methods

Design and ethical aspects of the study

The project was approved by the Research Unit and the ethics committee of HUSVF*. We analyzed the medical records of patients between 0 and 14 years old, who were admitted in the HUSVF Child Surgery Service, with a diagnosis of closed hepatic and/or splenic trauma between January 2007 and December 2015, who initially underwent NOM. For data collection, a format was used that assessed: anthropological characteristics, trauma mechanism, vital signs at admission, Pediatric Trauma Index (PTI), need and indication of immediate surgery, intraoperative findings, if NOM was requiered, as well as a performing of imaging at admission (FAST echo, conventional echo or abdominal tomography), if patients required angioembolization, or blood transfusion and hospitalization (CU, ICU, General Room), if Hemoglobin and hematocrit levels every 8 Hrs until stabilization was needed, if arteriography or Contrast Abnormal Tomography (CAT) was required, if NOM failure occurred, identifying the cause, and finally if complications or death occurred during process.

Inclusion criteria

The included patient should present hemodynamic stability, absence of signs of peritoneal irritation[1,4,9,10,12,13,18,19,23,28,29], whose age were between 0-14 years old, with an initial NOM for hepatic or splenic trauma, no trauma to other solid organs or other voids rather than liver or spleen, which has required to proceed with surgery; patients who present evidence of tomographic images for classification of hepatic or splenic trauma and evidence of clinical and paraclinical data (Hb levels) in clinical history.

Exclusion criteria

Patient who died at admission, or who needed surgery on admission, or with clinical or paraclinical incomplete information, incomplete imaging or that does not allow an analysis of the proposed variables (figure 1: Flowchart number of patients recruited into the study).

Data analisys

Statistical tools, such as SPSS 21 version and Epidat 3.1 were used. In the quantitative variables, measures of central tendency and dispersion were calculated and relative frequencies (%) were calculated for qualitative variables. For some variables of interest, we also calculate the difference of proportions with their respective p value.

Results

From the 70 patients initially included, 46 were male (65.7%) and 24 were female (34.3%), with a mean age of 7.6 years (between 0.25 and 14 years old) and Standard deviation of 3.4 years. The most common cause of trauma was the pedestrian accident (37.5%), the second was the fall from high height (22.9%), the other trauma mechanisms in this series are described in figure 2.

40 out of the 70 patients evaluated (57.1%) had other traumatic injuries associated, the most common was renal trauma (40% of cases). Some of the patients

*TN: Spanish acronym for "Hospital Universitario de San Vicente Fundación", 'University Hospital of San Vicente Foundation' in english. It was decided to use its acronym in spanish, for it is an established name.

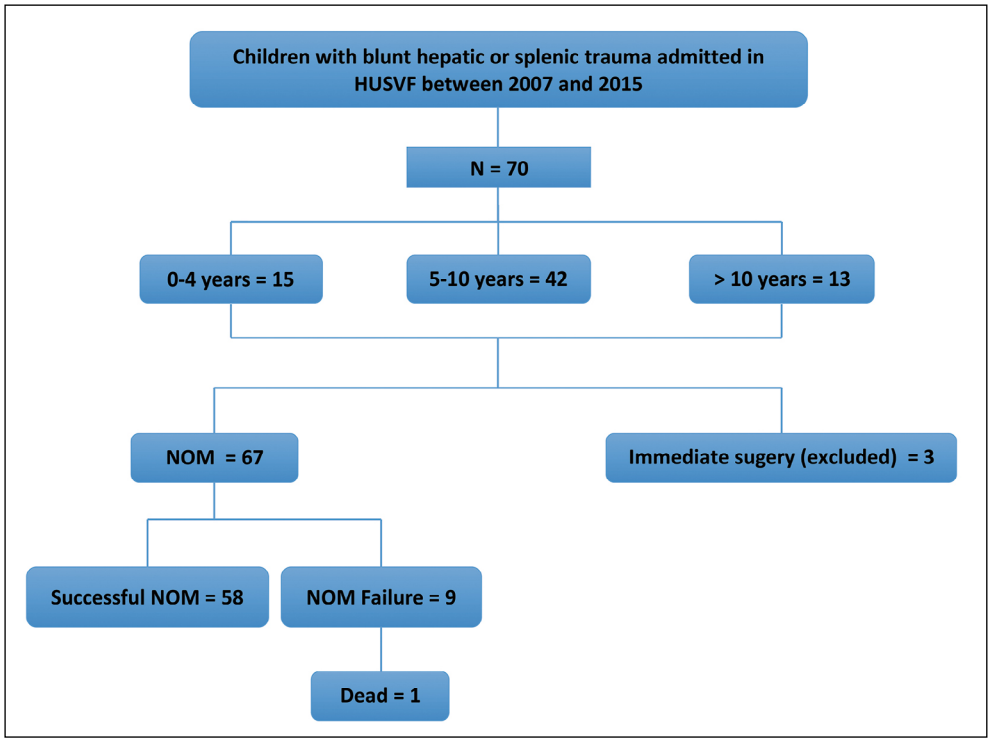

Figure 1. Flowchart of patients included in the study.

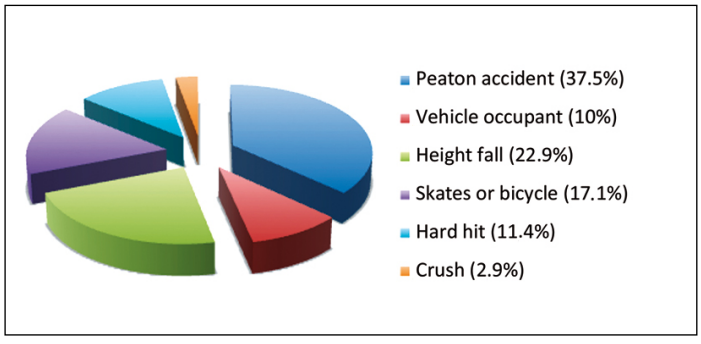

Figure 2. Trauma mechanism in blunt abdominal trauma in children HUSVF 2007-2015.

had more than one associated lesion. These data are described in table 1.

From the 70 patients, 3 were derived to immediate surgery: 2 patients due to hemodynamic instability at admission and 1 due to clear signs of peritoneal irritation. These patients were excluded from the study.

Thus, from the remaining 67 patients (95.7%), NOM was supported by diagnostic imaging and clinical follow-up, some other patients required transfusional management, and 4 patients with hepatic trauma required arteriography (which in all cases was applied together with embolization). In all of these, the extravasation of the contrast medium in the initial CAT was observed. All management's types are described in table 2.

Table 1. asociated injuries to splenic or hepatic trauma

Associated injuries	Nº of patients (%)
Renal trauma	16 (40)
Lung contusion	13 (32.5)
Hemothorax	8 (20)
Ribs fractures	6 (15)
Pelvis or isquipubic fractures	6 (15)
Neumothorax	4 (10)
Vertebrae fractures	4 (10)
Adrenal Hematoma	3 (7.5)
Femur fractures	2 (5)
Diaphragmatic Hernia	2 (5)

From the 67 patients who received NOM, 9 patients had a failure to manage (12.9%), 8 due to hemodynamic instability (1 patient underwent a control surgery for a several damage due to a complex hepatic trauma (hepatic trauma grade IV, requiring packing and open abdomen), who finally by an hypovolemic shock), poly transfusion and inotropic management in pediatric intensive care unit, and 1 due to peritoneal irritation secondary to associated hollow viscus lesion. Table 3 establishes a compari-

son of Clinical and Paraclinical information among patients, in whom the NOM was successful and those who presented failure in it.

The variables with a statistically significant relationship with NOM failure were: systolic blood pressure (SBP) < 90 mmHg, drop of more than 2 g/dl of hemoglobin (Hb) in the first 24 hours and the need for transfusion of 3 or more units of red blood cells (RBCU). On the contrary, no statistically significant relationship was found between NOM failure and trauma mechanism, severity of lesions, and hemoperitoneum of more than 2 quadrants. 44.4% of patients with an PTI score less than or equal to 7 had NOM failure and there was a tendency for NOM failure with PTI scores below 7.

Finally, we found that intrahospital complications occurred in 8 of our patients, 4 (44.4%) of these in the NOM failure group and the remaining 4 (6.8%) in the successful NOM group (RR of 5.9; CI = 1.9-17.5). The complications presented are listed in Table 4. Rebleeding was responsible for 50% of them. The hospital stay was 18.3 days on average (range 3-69 days).

Table 2. Handling of patients with blunt abdominal trauma in children

Handling of the patients (N = 70)	
Non operative management (NOM)	67 patients (95.7%)
FAST Sonography (inicial image)	3/67 (4.47%)
Conventional Sonography (inicial image)	19/67 (28.37%)
Abdominal tomography (inicial image)	64/67 (95.5%)
Embolization + arteriography	4/67 (5.97%)
Immediate surgery	3 patients (4,2%)
	1. hepatic packaging + laparostomy
	2. colon resection + anastomosis
	3.Nefrectomy
Tranfusional request	27/67 (40.2%)

Table 3. Comparison of the clinic and paraclinic variables between patients with NOM and those with failure in NOM

Variables	Successful NOM 58 N (%)	Failure in NOM 9 N (%)	P Value	RR
Transit accident	23 (39.9)	7 (77.7)	0.0751	4.31 (0.96-19.2)
Hemoperitoneum > 2 quadrants	14 (24.13)	3 (33.3)	0.8586	1.47 (0.41-5.2)
Trauma grade IV and V	9 (15.5)	2 (22.2)	0.9827	1.45 (0.34-6.09)
SAP < 90 mmHg	8 (13.7)	5 (55.5)	**0.0126**	5.19 (1.61-16.6)
Pediatric trauma index ≤ 7	10 (17.2)	4 (44.4)	0.153	3.02 (0.93-9.81)
Transfusion of 3 or more units of RG	1 (1.7)	6 (66.7)	**0.00001**	17.1 (5.4-53.7)
Drop more of 2 g/dl in hemoglobin	15 (25.9)	8 (88.8)	**0.0009**	15.3 (2.03-114.9)

Table 4. intrahospital complications in patiens with failure in NOM vs those with successful NOM

	Successful NOM 58 N (%)	Failure in NOM 9 N (%)	P Value	RR
Total complications	4 (6.8)	4 (44.4)	**0.0074**	5.9 (1.9-17.5)
Rebleed	2 (50)	2 (50)		
Sepsis	1 (25)	1 (25)		
Abdominal collection		1 (25)		
Atelectasis	1 (25)			

In most of these patients, the prolonged stay was secondary to other associated injuries, such as traumatic brain injury, complex pelvic fracture, unilateral or bilateral hemoneumotorax, renal trauma, diaphragmatic hernia and costal fractures. The hospital stay average for the NOM failure group was 12.5 days (3-27 days) and a 16.1 days (3-69 days) in the successful NOM group, from which 81% of the patients had a hospital stay of 8 days as maximum.

Discussion

In Colombia, pediatric trauma is responsible for 14.2% of deaths in children aged 1 to 4 years and 14% in the age group between 5 and 14 years[3]. Similar to what was previously reported in other series[1,3,6,7,15,23,27], pedestrian-like traffic accidents are the predominant trauma mechanism in the hepatic and splenic injuries due to closed trauma in our study group, followed by falls from high heights in second place and others less common causes, as trauma on bicycle or skateboards, trauma with blunt objects among others. The most affected group was the 5 to 10 years old children.

In our analysis, we found that abdominal CAT was used very frequently for the initial approach. In this study, we performed an analisys in 64 out of the 67 patients who decided to perform NOM (95.5%). Although it is clear that CAT is still the diagnostic image of choice for the evaluation of these patients, there is a strong and growing informed people who seek to reduce the number of CAT scans performed in children, due to the risk of ionizing radiation[32]. New studies have shown that groups of low-risk patients can be identified in which the use of variables, such as a Glasgow coma scale of 15, Pediatric Age-adjusted Shock Index (Heart Rate/Systolic Pressure) mechanism, are related to a low probability of having a solid organ lesion requiring interventions and that this group would not benefit from CAT as there would be no changes in the forecast and management[32].

Regarding what was mentioned above, we have tried to create diagnostic algorithms involving the FAST echo (Focused Abdominal Sonography for Trauma) which, when having a negative result, strongly suggests the absence of major intra-abdominal trauma with a high negative predictive value, defining the patient group who would benefit from a larger study, such as CAT[33,34]. Conventional ultrasound has been used, together with the clinical parameters described above and serial clinical evaluation, as a safe method of diagnosis that allows surgical decision making and to select those patients who really need to be taken to tomographic studies. In our study, it was evidenced that despite having these resources (FAST echo in 4.47% of cases and conventional ultrasound in 28.4%), they are almost not used in our area[35].

In the last 30-40 years, the NOM has been considered as a fundamental tool in the hepatic[17] and splenic lesions secondary to closed abdominal trauma management, supported by the use of CAT, along with a better knowledge of the pathophysiology of this type of injuries[1,4,11-13,18-21]. The success rates reported in the pediatric population according to the different series were between 83-100%[15-17], in agreement with our work, in which the success rate was 95.7%, being the main surgical indication the hemodynamic instability.

Arteriography and embolization are among the armamentarium available for the NOM, the usefulness of which has been confirmed in multiple studies, with success rates varying between 85-91%[13,15,26], depending on the different series. In our series, this resource was used in 4 patients with a 100% of success.

NOM could fail[12]. Certain conditions have been associated with this fact, such as severe hepatic or splenic lesions (IV-V), since the more severe the lesion, the greater the probability of hemodynamic instability or association with injury to other organs, the hemoperitoneum abundant (3-4 quadrants), pseudoaneurysms and/or leakage of radiological contrast IV in CAT[1,12-14,24,27,28,36]. However, other series have shown that 61-86% of grade IV lesions and 32-77% of grade V lesions (in the absence of hemodynamic instability) have been treated conservatively[6,7,12-15,22], and it does not matter the age, gender, mechanism of trauma and degree of injury[13,17], because it is hemodynamic instability the one that does not show improvement after 6 hours of adequate resuscitation, which predicts almost a 100% of correlation between the need for laparotomy and splenectomy in children with closed trauma spleen[29]. The above is clear, a periodic evaluations by trained personnel are necessary in order to allow the early detection of the surgical interventions need and to identify patients at high risk, avoiding failure of NOM[6,7,12-15,23,27,29-31]. The primary indication for surgical intervention in hemodynamically stable children is the requirement for serial transfusions exceeding half the blood volume or 40 cc/kg for 24 hours after injury[1,9,14,15,17]. Despite the above, laparotomy and angioembolization outcomes are rare (13,15,19,26).

We found 3 factors that presented a statistically significant relationship with failure in this management: SBP < 90 mmHg at admission (p = 0.0126) (RR = 5.19, 1.61-16.6), drop in Hb of more than 2 g/dl in the first 24 hours (p = 0.0009) (RR = 15.3, 2.03-114.99) and need for transfusion of 3 or more RBCU (p = 0.00001) (RR = 17.1, 5.4-53.7). Multiple studies are in agreement with what is found in our series of patients, although most of these are focused on determining cut points to move from NOM to surgical management

and not to establish factors that act as predictors of this outcome or to prevent the complications associated with the delay of these[6,7,23,27]. These findings may have a especial significance when using pediatric abdominal trauma algorithms[23], since they allow us to anticipate the patient's clinical condition, in order to reduce the associated morbidity and mortality. The majority of algorithms used as a cutoff point for surgical intervention are a requirement for serial transfusions that exceed half of the blood volume, 40 cc/kg or 4 RBCU during the 24 hours after the injury. On the contrary, in our series we evidenced that 88% of the patients in whom the NOM failed, they required transfusion of 3 or more RBCs. This may lead to better timing of surgical intervention and it may decrease the occurrence of complications associated with transfusion therapy, as well as increasing vascular permeability, such as pleural effusions, respiratory distress, rebleeding, transfusion reactions, among others[1].

The pediatric trauma index (variables: weight, airway status, SBP, presence of wounds and fractures and sensorium evaluation), in the particular evaluation of closed abdominal trauma with hepatic and splenic lesions, seems to be a useful clinical tool to determine the NOM failure, with a tendency of presenting an important link with this one, although without a statistically significant association in our study.

In our series, we found no relationship between NOM failure and the mechanism or severity of hepatic or splenic trauma, and the presence of hemoperitoneum in more than 2 quadrants, although other series have found such association[1,12-14,24,27,28], we did not. It is possible that these differences are due to the small number of patients from the different studies mentioned.

The NOM complications are low, with an overall morbidity rate of 25% and mortality < 5%, counting among the advantages[1,6,7,20-23]: less hospital and ICU stay, lower incidence of infections and less need for transfusion compared to conventional surgical management. The main complications reported are[1,4,7,11,18-22]: bleeding, biliary leakage (biliary fistula, bilioma)[24], arterial pseudoaneurysm with hemobilia, abdominal compartment syndrome, presence of other inadvertent visceral lesions, hepatic, gallbladder or splenic necrosis, hepatic or splenic abscess and left pleural effusion in splenic lesions[25]. In our series, the rate of complications was very low in 6.8% of the patients in the successful NOM group, 50% of which were due to rebleeding with a mortality rate lower than that reported in other series presenting only in 1 patient with hypovolemic shock. It should be determined if earlier surgical intervention in the group of patients with NOM failure based on criteria, such as those mentioned above, may reduce the incidence of these complications or if it may improve morbidity and mortality. The retrospective nature and sample size were the main limitations in our study, which is consistent with the low precense of this type of trauma in the pediatric population.

In conclusion, most of children with closed hepatic or splenic trauma respond adequately and without complications to NOM. However, the population in which this management presents failure had a high risk of complications, associated with morbidity, which is why we identify the presence of some factors, such as SBP < 90 at admission, drop of Hb in more than 2 g/dl during the first 24 hours and the need for transfusion of 3 or more RBCs, which can help us to detect patients who will present NOM failure and to define at an early stage if they benefit from performing surgical or non-surgical interventions (such as embolization), in order to decrease morbidity and mortality in this group. No relationship was found between the imaging findings, lesion degree and magnitude of hemoperitoneum and NOM failure in our study.

Ethical Responsibilities

Human Beings and animals protection: Disclosure the authors state that the procedures were followed according to the Declaration of Helsinki and the World Medical Association regarding human experimentation developed for the medical community.

Data confidentiality: The authors state that they have followed the protocols of their Center and Local regulations on the publication of patient data.

Rights to privacy and informed consent: The authors have obtained the informed consent of the patients and/or subjects referred to in the article. This document is in the possession of the correspondence author.

Conflicts of Interest

Authors declare no conflict of interest regarding the present study.

Acknowledgements

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