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A trial to estimate when to do operative or non-operative management in case of blunt abdominal trauma with splenic injury in pediatric age group.

Ahmad M.Elsadat[1], Abdelhafeez M.Abdelhafeez[2], Seham A. Emam[3], Amr S. Ramadan[4], Rimon Boshra Rizk[5], Ahmed S. Ahmed[6], Sherif El-prince Sayed[7].

[1] *Professor of paediatric surgery, General Surgery Department, Faculty of Medicine, Beni-Suef University.*

[2] *Lecturer of paediatric surgery, General Surgery Department, Faculty of Medicine, Beni-Suef University.*

[3] *Lecturer of paediatric surgery, General Surgery Department, Faculty of Medicine, Beni-Suef University.*

[4] *Demonstrator of paediatric surgery, General Surgery Department, Faculty of Medicine, Beni-Suef University.*

[5] *Lecturer of surgery, General Surgery Department, Faculty of Medicine, Beni-Suef University.*

[6] *Lecturer of surgery, General Surgery Department, Faculty of Medicine, Beni-Suef University.*

[7] *Ass. Professor of surgery, General Surgery Department, Faculty of Medicine, Beni-Suef University.*

Article Info

Corresponding Author:
Amr S. Ramadan
amrsaiedelkomy@gmail.com

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Abstract

Background: The spleen is considered the most affected organ in children with blunt trauma to the abdomen. The most common causes of splenic injury are traffic accident and falling from a height,

The management of blunt abdominal trauma with splenic injury had changed over the past years. Currently, conservative treatment (NOM) is the preferred management for children with splenic injury.

Materials and methods: A prospective study included 40 cases with blunt abdominal trauma involving spleen in the pediatric age group from October 2023 till October 2024. The study was conducted in Beni-Suef university hospital. Management of patients was conservatively or operatively according to hemodynamic stability, grades of splenic injury, Injury Severity Score, Shock Index, and presence of other injuries that required laparotomy. Stable patients

managed conservatively according to ATLS protocol and regular follow up clinically, and CBC, U\S,and CT with I.V contrast were done. Unstable patients were operated upon. **Results:** A total of 40 patients with blunt abdominal trauma with splenic injury were identified, with an average age of (10.70 ±3.98) years old. RTA as a mode of trauma was accounting for (57.5%) of the patients followed by falling from height (40%). CT was done for stable cases. Blood transfusion had been needed in the patients who were managed operatively more than in the patients who were managed non operatively. The initial management of all cases was aiming for stabilization 32 cases (80%) continued conservatively while 8 patients (20%) underwent splenectomy due to failure of resuscitation. Non-operative management had failed in one patient (3.1%) who underwent abdominal exploration and splenectomy. The mortality in the patients who were managed non operatively was zero, while one case was recorded in patients managed operatively. **Conclusion:** Non-operative management (NOM) had the upper hand in management of cases that responded to initial resuscitation and no substitutional deterioration during conservative management and with low grades of injury for spleen and they represented most of the cases and those with no associated morbidity requiring surgical intervention.

1. Introduction:

One of the commonest causes of mortality or morbidity in pediatrics is blunt abdominal trauma (**1**).

Splenic injuries are the most common injuries in children with blunt abdominal trauma. (**2**).

U\Sand CT are considered the best diagnostic modalities in hemodynamically stable patients due to their accuracy and non-invasive nature (**3**).

Due to high rate of mortality and morbidity of exploration, NOM (non-operative management) of blunt splenic injuries was widely accepted in stable cases. Currently, conservative treatment is the preferred management (**4**). NOM decreases the risk of laparotomies and preserving functions of the organs. (**5**).

2. Patients and Methods:

This is a prospective study included 40 patients with blunt abdominal trauma involving spleen in the pediatric age group. Management of patients was conservatively or operatively. Stable patients

managed conservatively according to ATLS protocol and regular follow up by vital signs, CBC,US, and CT with I.V contrast were done. Unstable patients were operated. Patients were recruited and assessed for eligibility from Beni-Suef university hospital.

Inclusion criteria: children aged less than18 years with blunt splenic injury.

Exclusion criteria: cases above 18 years old or with penetrating splenic injury or with other abdominal injuries, and no splenic injury.

Initially, the management of blunt splenic injury is focused on primary survey of trauma: ABCDE, According to ATLS. For all patients, the following was done:

Clinical evaluation:

- Vital signs :Blood pressure, HR, RR, and UOP
- Regular abdominal examination.

Laboratory investigations such as CBC, KFT, PT, PTT, bleeding, and clotting times were evaluated and other investigations according to situation as CRP, liver enzymes.

Radiology:

1- Abdominal U/S (once).
2- CT abdomen and pelvis with I.V contrast after stabilization.
3- CT chest to detect associated injuries in suspicious cases.

At this point, patients fall into one of these categories:

1-Stable patients: Within normal range of Shock index (SI) and Injury Severity Score (ISS)

2-Stable patients and turned unstable during monitoring and initial resuscitation.

3-Unstable but responded to resuscitation: abnormal vital signs but within normal range of Shock

Index (SI) and Injury Severity Score (ISS).

4-Unstable but did not respond to initial resuscitation: with high ISS and high Shock Index.

At this point, the management of patients falls into one of two categories: NOM and operative management:

NOM: Stable patients: will be admitted in The Pediatric ICU and managed conservatively

-Bed rest, I.V fluids, transfusion of blood if indicated, evaluation of vital signs, Serial abdominal examinations, CBC, Serial ultrasound, Analgesics, and start Oral intake once bowel habits are normalized.

Operative management: for patients who had

-High Shock Index

-Hemodynamically unstable patients.

-High grade splenic injury.(high ISS)

-Failure of conservative management.

- Presence of peritonitis.

The operative patients received vaccines for encapsulated organisms (Pneumococci, Meningococcal, haemophilus influenzae). After at least one week post-operatively, and monthly, long-acting penicillin is given to protect against overwhelming post-splenectomy infections.

Criteria for discharge of patients:

• Clinically: when patient's vital signs become stable and free abdominal examination with good bowel habits.

• Laboratory: Normal hemoglobin.

•Radiologically: Abdominal ultrasound: becomes free

Follow-up:

- Weekly clinic visit for abdominal examination and U/S
- Resume Daily activity
- And no sports activity for at least 3 months.
- Continue visits for at least 3 months
- No routine laboratory investigations except for CBC
- Special regards towards monthly vaccination to guard against OPSI.

Statistical Analysis of Data:

Analysis of the data was carried out via the use of a statistical program for social science (SPSS). The quantitative variables were described as mean ± SD. When appropriate, the qualitative variables were described as frequency and percentage. Pearson correlation was utilized for correlating quantitative variables fulfilling normal distribution. *P*-value was estimated that was either non-significant when higher than 0.05 and significant when less than 0.05 or highly significant when less than 0.01.

3. Results:

As shown in table (1): patients' ages ranged between (2.5 years old) and (18 years old) with an average age of (10.70 ±3.98) years old, they were 19 males (19, 47.5 %) and 21 females (52.5 %), they were all exposed to blunt abdominal trauma. On admission, the most common cause of trauma was road traffic accidents 23 patients (57.5%) as shown in **Figure (1)**, falling from height 16 patients (40%) as shown in **Figure (2)** and fight in one patient (2.5%) due to direct trauma to the abdomen.

Fig. (1) : A male patient, 8 years old, with abdominal bruises due to run over accident.

Fig. (2): A female patient, 6 years old, with abdominal bruises due to fall from height.

Table 1: Baseline data of studied participants; (N= 40):

		Descriptive statistics
Age; (years)	**Mean ±SD**	10.70 ±3.98
	Minimum – maximum	2.5 - 18.0
Sex; N (%)	**Male**	19 (47.5 %)
	Female	21 (52.5 %)
Mode of trauma; N (%)	**RTA**	23 (57.5 %)
	FFH	16 (40.0 %)
	Fight	1 (2.5 %)

SD: standard deviation, **RTA:** Road traffic accident, **FFH;** Fall from height

As shown in table (2): For all patients, U/S was done to evaluate if there is collection and its amount and the source of collection if possible on emergency basis FAST.

Table 2: UltraSound evaluation of the studied patients; (N= 40):

	Frequency	Percent
Mild collection	21	52.5%
Moderate collection	14	35
Marked collection	5	12.5%

As shown in table (3), after stabilization of the patient, CT with I.V contrast was done after assessment of renal function for assessment of the degree of splenic injury according to AAST grades of splenic injury and to detect other associated injuries.

Table 3: CT evaluation of the studied patients; (N= 40):

	Frequency	Percent
Grade I	3	7.5%
Grade II	11	27.5%
Grade III	17	42.5%
Grade IV	7	17.5%
Grade V	2	5.0%

As shown in table (4), regarding grading system of splenic injury, the higher grades are mostly associated with instability of vital signs and have poor response to resuscitation as shown in **Figures (3 and 4)**.

Table 4: Relation between grades of splenic injury and vital signs (N= 40):

	Stable	Stable and became unstable	Unstable and Responded to resuscitation	Unstable and not Responded to resuscitation
Grade I	3	-	-	-
Grade II	10	-	1	-
Grade III	7	3	6	1
Grade IV	-	-	2	5
Grade V	-	-	-	2
Total	20	3	9	8

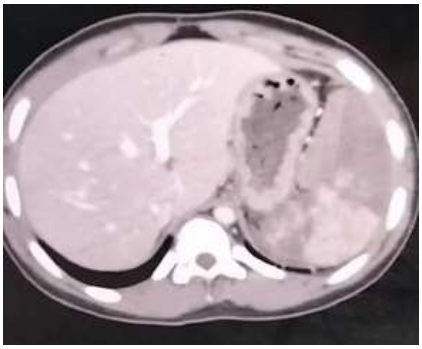


Fig. (3) : A patient with multiple splenic laceration and moderate collection managed conservatively.

Fig. (4) : A patient with splenic laceration grade IV managed operatively.

As shown in table (5), regarding the associated organ injuries, the most common associated injury is liver injury then thoracic injuries.

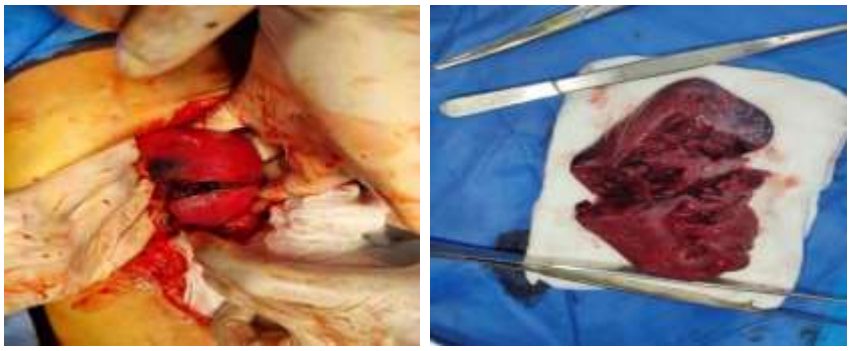
Table 5: Associated organ injuries among the studied patients; (N= 40):

	Frequency	Percent
None	30	75.0
Liver injury	1	10.0
Hemothorax	2	5.0
Rib fracture	3	7.5
Skull fissure fracture	1	2.5
Total	40	100.0

As shown in table (6), the initial management of all cases was aiming for stabilization. Thirty two cases (80%) continued conservatively while eight patients (20%) underwent splenectomy due to failure of resuscitation as shown in **figures (5 and 6)**.

Table 6: Initial management among the studied participants; (N= 40):

	Frequency	Percent
Non- operative	32	80.0
Operative	8	20.0
Total	40	100.0



Figs. (5 and 6) : A patient with splenic injury grade **V** managed operatively

As shown in table (7), The results of follow-up for the 32 patients who were managed conservatively revealed that 29 of them had shown initial improvement, while the other three cases had longer time of instability: elevated heart rate, decreased blood pressure, increased Shock index, two of these three patients returned to stable state after resuscitation, and the third one did not respond to resuscitation, his shock index was 1.1 and HB was 8.5g\dL , and CT with I.V contrast showed grade III splenic injury, during follow up shock index became 1.8, HB became 7 g\dL despite repeated blood transfusion these criteria indicated failure of NOM according to **ATOMAC** and **APSA** guidelines, and patient finally underwent abdominal exploration. Intra-operatively, there was moderate abdominal collection, and splenic parenchymal laceration reaching hilar vessels that represent grade IV splenic injury despite that CT showed grade III splenic injury, splenectomy was done then formal exploration revealed no other solid organ injuries or viscus injury.

Table 7: Follow up after initial management among the studied participants:

	Frequency	**Percent**
Still stable and improving	29	90.6%
Deteriorated but responded to resuscitation	2	6.25%
Deteriorated but did not responded to resuscitation	1	3.1%

As shown in table (8), regarding the final management among the studied cases, most of cases were managed conservatively (NOM) (31 cases =77.5%), while nine patients (22.5%) underwent operations, eight patients of them in the initial management and one patient during the follow up based on Injury Severity Score (ISS) and Shock Index (SI).

Table 8: Final management among the studied participants; (N= 40):

	Frequency	**Percent**
Non- operative	31	77.5%
Operative	9	22.5%
Total	40	100.0%

As shown in table (9), most of patients who underwent splenectomy on final management needed blood transfusion, however 4 cases only who were managed conservatively, needed blood transfusion during resuscitation.

Table 9: Association between blood transfusion during the course of management and the final management; (N= 40):

	N	Blood transfusion one time	Repeated blood transfusion	total	percent
Non-operative	31	3	1	4	12.9%
operative	9	3	5	8	88.8%

As shown in table (10) regarding Injury Severity Score (ISS), most of the patients who were unstable and did not respond to initial resuscitation and managed operatively were with high score in ISS.

Table 10: Relation between ISS of splenic injury and the final management (N= 40):

ISS	Operative	Non-operative
1-8 (minor)	-	21
9-15 (moderate)	-	7
16-24 (serious)	1	3
25-49 (severe)	5	-
50-74 (critical)	2	-
75 (maximum)	1	-

ISS: Injury severity score

As shown in table (11), regarding shock index (SI), most of patients who were unstable and did not respond to resuscitation and initially underwent splenectomy were with high shock index while patients with normal range of shock index were initially managed non-operatively; all of them had shown improvement of shock index except one patient showed increasing shock index and finally was managed operatively.

Table 11: Relation between Shock index (SI) of patients with splenic injury and final management (N= 40)

Age	< 6 years		7-12 years		>13 years	
SI	**<1.2**	**>1.2**	**<1**	**>1**	**<0.9**	**>0.9**
Operative	-	3		3		2
Non-operative	5	-	17		9	-
Non-operative turned to operative	-	1	-	-	-	-

SI: Shock index

As shown in table (12), all patients who were managed conservatively survived, where as among the patients who were managed operatively, 9 patients survived and one patient died.

Table 12: The mortality rate among the participated patients through the course of the management, (N= 40):

	Operative	Non-operative	percent
Survival	8	31	97.5%
Mortality	1	-	2.5%

4. Discussion:

Our study revealed that the most common mode of trauma was RTA (58.1%), then FFH (38.7%), which in agreement with the study by **Osifo et al.,** in his study showed that traffic accidents were the mode of trauma in 50% of the cases then fall from height. (**6**). Also, **Gad et al.** found that RTA was the cause in 55% of cases then fall from height (35%). **(7)**.

According to **Hsieh et al.,**we cannot predict failure of treatment according to the amount of free fluid seen in the abdominal US. **(12)**.

In our study, 10 cases had moderate collection; all of them were successfully treated non-operatively, this result with an agreement with the study by **Osman M. et al.,** in which, 11 cases (17.7%) had moderate amounts of free fluid in the abdomen and managed conservatively. **(13)**.

In our study three patients of forty (7.5%) were of grade I and eleven patients (27.5%) were of grade II all of them were successfully treated non-operatively ,while seventeen patients (42.5%) were of grade III, one patient was initially needed operative intervention and another one had needed splenectomy due to failure of NOM over 6 hours , the other fifteen patient had successfully treated non-operatively, Seven patients(17.5%) was diagnosed as grade IV, five of them were had needed operative intervention, while two patients were stabilized and continued conservatively , while all of patients with grade V needed operative intervention.

These results denote that lower grades (I-III) have the highest rate of success non-operative management which compares to previous results as **Cirocchi et al.** who compared 7 cases treated conservatively to 6 cases who managed operatively. Two cases managed non-operatively had grade I, four cases had a grade II and one case had a grade III. There was one failure case in non-operative management **(14)**. and also with a result of **Osman et al.** who study 62 patients of blunt abdominal trauma treated conservatively, grade I was noted in 12 patients, grade II in 27 patients, grade III in 17 patients, and grade IV in 6 patients. **(13)**.

In our study, most of Patients who underwent splenectomy on final management (eight patients of nine patients; 88.8%) needed blood transfusion, and did not respond to repeated

transfusion however 4 cases (12.9%) who were managed conservatively needed blood transfusion during resuscitation.

This result was in agreement with the result of **Gad et al** As in his study 100% of cases who were managed operatively needed transfusion of blood **(7)**.

In our study, forty patients participated, of them, twenty-one patients presented vitally stable and were managed non-operatively, while nine patients were unstable but responded to resuscitation and were successfully managed non-operatively. This result compares favorably with other studies. As in **Gad et al** study, 85% of cases were stable and were managed non-operatively, Two cases became unstable and had been operated. Twenty cases were unstable and were managed operatively **(7)**, and in the study of **Jamaladeen et al.,** 94% of cases had been successful managed conservatively and there was failure in two cases (6%). **(9)**

In our study, eight patients were managed operatively initially due to failure of resuscitation and had high score in Injury Severity Score (ISS), three of them had associated organ injuries with ISS more than 30 which indicates severe injury, all of these patients persisted unstable despite of resuscitation, with high shock index, and when FAST was repeated had shown increasing intra-abdominal collection and CBC was showed HB drop despite of blood transfusion.

In our cases with low grade injury and stable initially (grade I and II) period of follow up and hospital stay was around one week, but in cases with high grade who was unstable and turned to stable follow up and hospital stay had extended to 14 days as in the study of **Yu-Cheng Su et al.** in which 80% of cases had needed observation about 14 days. **(15)**

According to **Stylianos et al.,** there was a high risk to discharge patients to home with intra-abdominal collection which needed some time to resolve. **(16)**

This is in concordance with our cases follow up which had shown that the mean duration of hospital stay for patients treated conservatively was relatively higher than those who needed operative intervention.

According to mortality in our study, only one patient who was managed operatively died, this patient presented to us with disturbed conscious level and was vitally unstable with Shock Index 2.3 and Injury Severity Score was 75, he had associated injuries as skull fracture and lung contusion with hemothorax , failure of resuscitation by crystalloids fluids and repeated blood transfusion, the patient was managed operatively and splenectomy was done, but unfortunately, the patient arrested intra-operatively and failed CPR. This result agrees with the result of **Gad et al**., as in his study there was one mortality case among operative group due to intra cranial hemorrhage **(7)**. **And** in the study of **Osifo et al.,** there was one mortality recorded in patients who were operated upon. **(6)**

5. Conclusion:

Blunt abdominal trauma patients in pediatric age needs proper assessment as regards clinical picture, radiological and laboratory findings.

Primary survey and secondary survey with close monitoring for this type of patients are needed for proper decision whether to select non-operative management (NOM) or to operate.

NOM is possible in most of these cases; operative decision is not considered a failure but an alternative for the best outcome.

Declarations

Ethics approval and consent to participate

The study was approved by the Faculty of Medicine Beni-Suef University Research Ethics Committee (FM-BSU REC) dated 3/12/2023. Approval No.: FMBSUREC/03122023/Abd-Elaal. As well as an informed consent was taken from all cases before participation in this study.

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