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ORIGINAL ARTICLE

NONOPERATIVE MANAGEMENT OF BLUNT HEPATIC AND SPLENIC INJURIES: A PROSPECTIVE STUDY

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Aim: *Nonoperative management (NOM) of blunt hepatic and splenic trauma in hemodynamically stable patients has become the treatment of choice in most trauma centers. The aim of this prospective study was to define the safety and success rate of NOM of blunt hepatic and splenic trauma within the setting of our Alexandria Main University Hospital.*
Methods: *Nonoperative management criteria included hemodynamic stability and absence of other injuries requiring laparotomy. Patients were closely observed in the surgical ward unless ICU admission was indicated for an associated injury.*
Results: *Forty two consecutive patients with injury to the liver (n=16) and /or spleen (n=33) were included. Associated injuries were present in 34 patients (82%). Ten patients (23.8%) underwent immediate laparotomy. Of the remaining 32 patients, 2 (6.2%) failed NOM with no complications related to the delayed laparotomy. The remaining 30 patients were successfully treated nonoperatively with ICU admission required in only 2 patients. The 30 patients had 35 liver and/or splenic injuries; 2 were grade I, 13 were grade II, 13 were grade III, and 7 were grade IV.*
Conclusion: *The majority of patients with blunt liver and spleen injuries (71.4%) can be successfully and safely managed without laparotomy.*

Keywords: *Abdominal injury, Blunt trauma, liver, spleen.*

INTRODUCTION

Management of hepatic and splenic injuries has evolved over the past 25 years. Prior to that time, a diagnostic peritoneal lavage positive for blood was an indication for exploratory laparotomy. Stimulated by the success of nonoperative management of splenic and hepatic injuries in children who are hemodynamically stable, there has been a trend towards nonoperative management in hemodynamically stable adults with similar injuries.[(1-8)]

Uncertainty still exists about efficacy, patient selection, and details of nonoperative management.[(9)] We hypothesize that NOM of blunt hepatic and splenic injuries is highly successful in hemodynamically stable patients who has no other indications for laparotomy irrespective of the grade of injury, the age of the patient, and the presence of other injuries including head injury. The aim of this prospective study was to define the safety and success rate of this hypothesis within the setting of our Alexandria Main University Hospital.

PATIENTS AND METHODS

All patients with blunt abdominal trauma presented, through the Accident and Emergency Department, to the Hepato-biliary Surgical Unit, Alexandria Main University Hospital during the period from October 15, 2004, through January 15, 2006, were potential study candidates. Hemodynamically unstable patients underwent immediate laparotomy after confirmation of free intra-abdominal fluid by means of ultrasound or diagnostic peritoneal aspiration. Hemodynamically unstable patients were defined as patients who after the initial fluid resuscitation had blood

pressure lower and pulse higher than expected for any individual's age and sex, and accompanied by weak or thready pulses, or cool, pale, clammy skin. Patients who were hemodynamically stable but had diffuse and significant abdominal tenderness were also taken directly to the operating room. All other patients with blunt abdominal trauma had a routine screening abdominal and pelvic ultrasound (U/S) examination. Patients with positive findings on U/S underwent computed tomographic (CT) scan with intravenous contrast of the abdomen and pelvis. The CT scan was initially evaluated for the presence of hepatic and splenic injury, intraperitoneal fluid, and associated injuries that would require laparotomy.

The diagnosis of hepatic and splenic injuries was established either in the operating room or by the CT study. When the diagnosis was made by the CT, all patients were considered for nonoperative treatment. Patients were excluded only if they (1) manifested hemodynamic instability (hypotension, persistent tachycardia or both) that did not promptly respond to fluid infusion, or (2) had or were clinically suspected of having any other injury requiring laparotomy. All patients or their next of kin signed an informed consent.

Patients whose injuries were managed expectantly were closely observed in the regular surgical ward unless ICU admission was indicated for an associated injury. Abdominal examination was frequently repeated. At a minimum, all patients had urinary catheters and had vital signs and urine output monitored hourly. A pulse oximeter was used to continuously monitor the patients' pulse. A central venous catheter was only used in adult patients particularly with severe injuries. Serial hematocrits were drawn every 6 hours for the first 48 hours and thereafter with decreasing frequency. Coagulation profile was performed at least on admission. Abdominal U\S was repeated when indicated because of transfusion requirements (particularly in multiple trauma patients) and at least once before discharge. Patients were not discharged before the free peritoneal fluid, by U\S, became absent or minimal. Abdominal CT scan with intravenous and oral contrasts was repeated in only selected patients when indicated, because of abdominal pain, fever, or other clinical changes. Blood transfusions were given as necessary. Evidence of continuous blood loss (tachycardia, hypotension, or falling hematocrit) or associated intestinal injury was considered as an indication for delayed laparotomy. Diet was advanced as tolerated 24-48 hours after admission. Bed rest was required for 2 days. Following that period progressive mobilization and ambulation of the patients were instituted as would have been prescribed in the absence of hepatic or splenic injury. Patient were discharged after at least 4 days (when ambulatory, tolerating regular diet, has no or minimal free peritoneal fluid by U\S, and has no associated conditions necessitating hospitalization).

Patients were seen in the outpatient clinic 1 week after discharge and U/S of the abdomen was repeated. After the first follow-up visit, daily activity was permitted with the exception of any activity that would produce sudden jostling or blow to the liver or spleen. Follow-up U/S was also repeated at varying time during outpatient follow-up. Follow-up CT scan was not done routinely but only in few selected patients with the most severe hepatic and splenic injuries to document the healing.

The CT scans performed at the time of admission were interpreted by the attending general surgeon and the radiology resident on duty for the emergency department. Subsequently, these scans were graded by the consultant radiologist who was blinded to the clinical events. The American Association for the Surgery of Trauma (AAST) Organ Injury Scale[10] was assigned to all splenic and hepatic injuries based on CT scans or operative findings in patients who underwent immediate laparotomy Tables 1,2.

Data collected included patients' demographics, mechanism of injury, physiologic condition on admission, Injury Severity Score (ISS), associated intra-abdominal and extra-abdominal injuries, hepatic and splenic injuries severity grading, transfusion requirements, operative findings, hospital course including morbidity, mortality, need for ICU admission, and length of hospital stay, and length of follow-up and incidence of late complications in the NOM group. Associated injuries were defined as injuries with Abbreviated Injury Scale (AIS) of 2 or greater.

The AIS is an anatomical scoring system, in which injuries are ranked on a scale of 1 to 6, with 1 being minor, 5 severe, and 6 a nonsurvivable injury. The Injury Severity Score (ISS) provides an overall score for patients with multiple injuries. Each injury is assigned an AIS and is allocated to one of six body regions (Head, Face, Chest, Abdomen, Extremities (including Pelvis), External). Only the highest AIS score in each body region is used. The 3 most severely injured body regions have their score squared and added together to produce the ISS score.

Two groups were identified:

1. The nonoperative group included patients who were successfully treated expectantly without surgery.
2. The operative group included patients who required laparotomy whether immediately or after failure of NOM.

Statistical analysis was carried out using the Student's t-test and Chi-square test. In case of sparse data, the Fisher's

exact probability was used as indicated. A P-value of less than 0.05 was considered significant.

RESULTS

The total study population consisted of 42 consecutive patients with blunt splenic and\or hepatic injuries; 26 patients (61.9%) had splenic injury, 9 patients (21.4%) had hepatic injury, and 7 patients (16.7%) had both splenic and hepatic injuries. The patients were 32 males (76.2%) and 10 females (23.8%). Their age ranged between 2 and 56 years with a mean of 20.2 ± 13.3. Motor vehicle crash was the most common mechanism of injury (42.9%) followed by fall from height (31%) and then pedestrian struck by a vehicle (9.5%) Table 3. The mean Injury Severity Score was 22.5 ± 11.6 (range 4-57). Associated injuries were common, occurring in 34 patients (82%). Orthopedic injuries occurred in half of the patients (52.4%), followed by thoracic (40.5%), head (26.2%) and other intra-abdominal (14.3%) injuries. Ten patients (23.8%) underwent immediate laparotomy while 32 patients (76.2%) were considered for NOM.

The nonoperative group: Thirty patients (18 spleen, 7 liver, and 5 both liver and spleen) were successfully treated nonoperatively. This number represents 71.4% of the total study population and 93.8 % of the 32 patients who were selected for NOM. The mean age of this group was 18.7 ± 13.3 years (range 2-50). Table 4. shows the injury grade distribution of hepatic and splenic injuries (n = 35). Grades II and III were the most common each representing 37%, followed by grade IV (20 %), and then grade I (6 %). Associated injuries were present in 24 patients (75%). One or more bone fractures existed in 16 patients, chest injury in 12, head injury in 8, and renal injury in 2 patients. The mean Injury Severity Score in this group was 19.8±10. ICU admission was required in only 2 patients because of an associated head injury in one patient and chest injury in the second. CT of abdomen was repeated in only 2 patients to exclude a suspected intestinal injury. On the other hand, repeat U/S was carried out in all patients at least once before discharge. Mean hospital stay was 9.6 ± 4.4 days. Patients were followed-up for a mean period of 8.8 ± 4.9 months (range 2-17). All patients had a follow-up U/S one week after discharge and at variable time during follow-up. The mean time to the second post-discharge U/S was 16.1 ± 3.8 weeks (range 8-23 weeks). There were no complications related the NOM of hepatic and splenic injuries in this group and there were no mortalities. A late post-discharge CT scan to document healing was done in 2 patients with grade IV splenic injury and 2 patients with grade III hepatic injury (Figs. 1).

Operative management group: The laparotomy group consisted of 12 patients. Ten patients (6 spleen, 2 liver, and 2 both liver and spleen) underwent immediate operation, while 2 patients had a delayed laparotomy due to failure of an initial period of nonoperative management. The causes of immediate laparotomy are shown in Table 5. Five patients were hemodynamically unstable. A CT-diagnosed grade IV kidney injury with extravasation was the cause in one patient, while three patients underwent immediate laparotomy because they were suspected to have intestinal injury by CT (one) or on clinical examination (two). One patient was hemodynamically stable with no indication for laparotomy consistent with those delineated by the protocol. Surgery was done at the discretion of the attending surgeon. One patient developed biloma and external biliary fistula after laparotomy for a grade V liver injury. He was treated by percutaneous drainage and endoscopic sphincterotomy. There were 3 deaths in this group of patients; two because of multi-organ failure (following exanguinating hemorrhage) and one due to an associated chest injury. A delayed laparotomy was required in only 2 patients out of the 32 who were selected for NOM. Both had a grade III splenic injury. The first was a 56-year–old patient who underwent laparotomy after 4 days of initial NOM due to a falling hematocrit. The second delayed laparotomy was carried out after 40 hours in a 35-year-old male patient due to persistent tachycardia, decreasing urine output, and falling CVP. Laparotomy in the latter revealed, in addition to the splenic injury, a mesenteric tear with a devitalized segment of small intestine that required limited resection. The delayed laparotomy had no adverse effects in either patient.

Group comparison: Table 6. shows that, Compared with the 30 patients who had a successful NOM, patients in the laparotomy group (n = 12) had a significantly (p = 0.015) higher ISS (29.2 vs. 19.8), and a significantly (p = 0.046) higher incidence of associated intra-abdominal injuries (33% vs. 7%). A significantly (P = 0.004) higher proportion of this group was admitted to the ICU (6 of 12, 50%) compared with those managed non-operatively (2 of 30, 7%) and they significantly (P = 0.008) required more blood transfusion (4.5 vs. 1.8 unit). The hospital stay was longer and severe liver and spleen injuries (AAST grade III or more) had a higher incidence in the laparotomy group but the difference was statistically insignificant. The 2 groups were also statistically similar in sex, age, and incidence of extra-abdominal injuries.

Table 1 Spleen injury scale.[10]

Grade*	Injury type	Description of injury
I	Haematoma	Subcapsular, <10% surface area
	Laceration	Capsular tear, <1cm parenchymal depth
II	Haematoma	Subcapsular, 10%-50% surface area; intraparenchymal, <5 cm in diameter
	Laceration	Capsular tear, 1-3cm parenchymal depth that does not involve a trabecular vessel
III	Haematoma	Subcapsular, >50% surface area or expanding; ruptured subcapsular or parenchymal Haematoma; intraparenchymal Haematoma > 5 cm or expanding
	Laceration	>3 cm parenchymal depth or involving trabecular vessels
IV	Laceration	Laceration involving segmental or hilar vessels producing major devascularisation (>25% of spleen)
V	Laceration	Completely shattered spleen
	Vascular	Hilar vascular injury with devascularised spleen

*Advance one grade for multiple injuries up to grade III.

Table 2 Liver injury scale.[10]

Grade*	Injury type	Description of injury
I	Haematoma	Subcapsular, <10% surface area
	Laceration	Capsular tear, <1cm parenchymal depth
II	Haematoma	Subcapsular, 10% to 50% surface area: intraparenchymal <10 cm in diameter
	Laceration	Capsular tear 1-3 parenchymal depth, <10 cm in length
III	Haematoma	Subcapsular, >50% surface area or expanding; ruptured subcapsular or parenchymal Haematoma; intraparenchymal Haematoma > 10 cm or expanding
	Laceration	> 3 cm parenchymal depth
IV	Laceration	Parenchymal disruption involving 25% to 75% hepatic lobe or 1-3 Couinaud's segments within a single lobe.
V	Laceration	Parenchymal disruption involving >75% of hepatic lobe or >3 Couinaud's segments within a single lobe
	Vascular	Juxtahepatic venous injuries; i.e., retrohepatic vena cava/central major hepatic veins
VI	Vascular	Hepatic avulsion

*Advance one grade for multiple injuries up to grade III.

Table 3. The mechanisms of injury.

Mechanism	Number	(%)
Motor vehicle crash	18	42.9
Fall from height	13	31.0
Pedestrian struck	4	9.5
Train accident	2	4.8
Motor cycle accident	1	2.4
Sport injury	1	2.4
Others	3	7.1

Table 4. Computed tomography grading of hepatic and splenic injuries in the NOM group.

Injury grade	Hepatic	Splenic	Total
I	1	1	2
II	5	8	13
III	6	7	13
IV	-	7	7
Total	12	23	35

Table 5. Causes of immediate laparotomy (n=10).

Cause	Number
Hemodynamic instability	5
Suspected intestinal injury	3
Associated renal injury	1
Surgeon's discretion	1

Table 6. Characteristics of various patient groups.

Patient variable	Nonoperative	Operative	p
Number of patients	30	12	NA
Mean ISS score	19.8	29.2	0.015
Mean age (years)	18.7	23.9	0.257
Mean hospital stay (days)	9.6	16.8	0.398
Mean blood transfusion (units)	1.8	4.5	0.008
Sex (male/female)	23/7	9/3	1.0
Severe organ injury*, No (%)	17 (57)	10 (83)	0.158
ICU admission, No (%)	2 (7)	6 (50)	0.004
Children (<15 years), No (%)	13 (43)	3 (25)	0.316
Associated abdominal injury, No (%)	2 (7)	4 (33)	0.046
Associated chest injury, No (%)	12 (40)	5 (42)	1.0
Associated head injury, No (%)	8 (27)	3 (25)	1.0
Associated skeletal injury, No (%)	16 (53)	6 (50)	1.0

*AAST grade III or more.

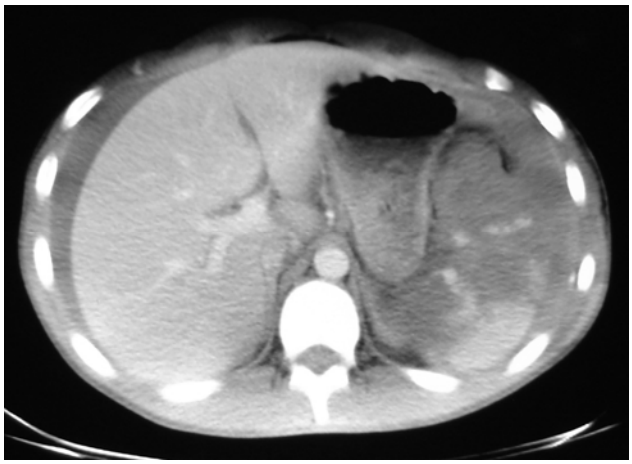

Fig 1a. Extensive splenic lacertion (grade IV) with significant hemoperitoneumin a 19-year-old male that was managed conservatively with no complications.

Fig 2b. Follow-up computed tomography shows complete healing after 16 weeks.

DISCUSSION

While a growing number of reports support NOM in hemodynamically stable patients with blunt hepatic and splenic trauma, there still exists uncertainty about efficacy, patient selection and details of management. In addition, most of those reports are retrospective with their inherent limitations. In the current study, 42 consecutive patients with blunt liver or spleen injury were evaluated prospectively. The decision to operate was solely based on the hemodynamic status of the patient. We have held that hemodynamic instability is the only absolute contraindication to NOM and have extended NOM to all stable patients with blunt liver and spleen injuries unless there was other significant abdominal injury that required operation. Based on these criteria, 10 patients (23.8%) required emergent laparotomy and 32 patients (76.2%) were candidates for NOM. Of these, 93.8% did not require laparotomy and 6.2% failed NOM therapy with no mortality and no complications related to the delayed laparotomy. These results compare favorably to the results from other studies using a nonoperative approach to blunt splenic and hepatic trauma and support the policy of expanding the selection criteria for nonoperative management. The 71.4 % of total study population successfully managed nonoperatively in the present study is among the largest reported. Despite expanding traditional selection criteria, our NOM success rate of 93.8% is among the best reported.[6,7,11-17]

The majority of patients (51%) suffered multiple injuries. ISS was significantly higher in the operative group reflecting more severe injuries and explaining the 25% mortality in this group. The mortality rate in the operative group was similar to that reported by others.[4,16] We found a greater proportion of operative management group to have sustained other intra-abdominal injuries associated with the hepatic or splenic injury. Similar observation was noted by others.[4,16] On the other hand, there was no difference in distribution of extra abdominal injuries including head injuries between the operative and nonoperative management groups. Sartorelli et al.[18] found that the success of NOM of abdominal solid organs injuries in patients with a heterogeneous array of additional injuries was not different than that seen for patients with isolated abdominal solid organs injuries. Another study by Coburn et al.[19] on multiply injured pediatric and adolescent patients with splenic and hepatic trauma found no difference between operative and nonoperative management groups in morbidity, mortality or ICU length of stay. Archer et al.[20] documented that there were no significant differences in morbidity, mortality, failure of treatment, or missed visceral injuries in comparable groups of patients with or without neurologic injuries managed nonoperatively.

Thirty percent of the immediate laparotomy patients (3 patients) underwent operation due to a suspected hollow viscus injury. All were negative for bowel injury at exploration. This reflects our overestimation of abdominal signs and anxiety, particularly in the early part of the study, about the possibility of missing small bowel injuries. The issue of missing intestinal injuries is a major concern in NOM of blunt abdominal trauma. Diagnosis is often

difficult and initial examination can be misleading. In their review of complex hepatic injuries, Pachter and Feliciano[21] emphasized that despite an accuracy rate of 97-99% in detecting associated intra-abdominal injuries, the CT scan is not infallible. The incidence of truly missed intra-abdominal injury ranges from 0.5%[6] to 12%[22] when abdominal CT is used. In the present study, we had a single case of missed mesenteric injury associated with intestinal ischemia, representing 3.1% of the initially nonoperatively managed patients. There was no morbidity related to the delayed laparotomy in this patient. This confirms the conclusion of others that missed intra-abdominal injuries occur infrequently and shouldn't be a cause for denying NOM.[8,12,17,23] With close supervision and frequent physical and laboratory examinations, patients who fail nonoperative treatment can be detected and treated appropriately with no added morbidity or mortality.

A high CT organ injury grade has been identified in many reports as a predictor of failure.[17,24] In contrast, other studies have shown that injury grade cannot be used to predict operative or nonoperative management, because of limited correlation between tomographic grades of injury and either the need for laparotomy[16,25,26] or the demonstrated anatomic grades of injury at laparotomy.[27] In the present series, the incidence of severe injuries (AAST grade III and higher) was not statistically different between the operative and nonoperative management groups. It is both the author experience and the current clinical consensus that it is the hemodynamic stability rather than the extent of organ injury that should determine whether or not a patient is managed without operation.

Concern continues to exist that NOM of blunt injuries would require ICU stay and prolonged hospitalization that would strain limited resources. The relatively short hospital stay (average 9 days) and the fact that only 2 patients in the NOM group (6.7%) required ICU admission in our experience obviate this concern. Recent reports document that both ICU stay and total hospitalization in operatively managed patients exceeded those in patients managed nonoperatively.[16,28] As comfort with NOM increased, Karen et al.[12] were able to decrease stay in the ICU and to manage patients without any ICU care with increasing frequency. Thompson and Holland[2] were able to manage 73% of their nonoperatively treated children with blunt splenic injury outside ICU compared to 17% in the operatively managed group.

Follow-up CT scanning was once an integral part of the approach to managing patients with blunt splenic and liver injuries nonoperatively. Repeat CT scanning is currently limited to very specific circumstances.[29] In the present series, repeat CT scan was done in only 2 patients on clinical indication, but we found follow-up abdominal U/S valuable particularly in multiply injured patients requiring repeated blood transfusions. A decreasing or stable amount of hemoperitoneum in such patient is reassuring. In addition, it is a cheap study and readily available in our hospital. Moreover, we used it as a guide for patients' discharge. Patients were not discharged before their hemoperitoneum became absent or minimal.

In conclusion, the majority of patients with liver and spleen injuries from blunt trauma (71.4%) can be successfully and safely managed without laparotomy. The decision to treat nonoperatively can be solely made on the basis of hemodynamic stability when patients are closely monitored, not necessarily in ICU, and in the absence of other indications for laparotomy.

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