Nonoperative management of penetrating wounds of the liver

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Submitted

ABSTRACT:

Nonoperative management (NOM) of penetrating liver injuries is infrequently practised. The aim of this study was to assess the safety of selective NOM of penetrating liver injuries.

Patients and Methods: A prospective, protocol-driven study, which included patients with penetrating liver injuries admitted to a level I trauma center, was conducted over a 52- month period. Patients with right-side thoracoabdominal, and right upper quadrant (RUQ) penetrating wounds with or without localized RUQ tenderness underwent contrasted abdominal CT scan evaluation to detect the presence of a liver injury. Patients with confirmed liver injuries were observed with serial clinical examinations. Outcome parameters included need for delayed laparotomy, complications, length of hospital stay and survival.

Results: During the study period, 95 patients (54 gunshot and 41stabbed liver injuries), were selected for nonoperative management. The mean injury severity and PATI scores were, 20 (range 4-50) and 7(range 4-20), respectively. Simple liver injuries (Grades I and II) occurred in 49 (51.6%) patients and complex liver injuries occurred in 46 (48.4%) patients. Associated injuries included 23 (24.2%) kidney, 69 (72.6%) diaphragm, 23 (24.2 %) pulmonary contusion, 42 (66.7%) hemo/pneuomothoraces, and 28 (29.5%) rib fractures. Three patients required delayed laparotomy resulting in successful nonoperative management rate of 96.8%. Complications included: liver abscess (1), biliary fistula (9), retained hemothorax (3), and nosocomial pneumonia (4). The overall median hospital stay was 6 IQR: [4-11] days, with no mortality.

Conclusion: The nonoperative management of appropriately selected patients with penetrating liver injuries is safe and associated with minimal morbidity.

INTRODUCTION

The selective nonoperative management of penetrating abdominal trauma is gradually being embraced by the trauma fraternity. The selective nonoperative management (NOM) of abdominal stab wounds is widely accepted and typically considered the standard of care. Conversely, the NOM of gunshot wounds to the abdomen is slowly gaining momentum in the context of adjunctive use of computerised axial tomographic (CT) scanning in patients without peritonitis or sustained hypotension. Patients selected for nonoperative management of penetrating liver injuries are those who have sustained a penetrating abdominal injury without an immediate indication for an emergency laparotomy, who undergo CT imaging to confirm a liver injury and are managed without a laparotomy. This study attempts to validate the feasibility and safety of the SNOM of penetrating liver injuries.

METHODS

This prospective, local ethics board approved study was conducted in the Trauma Center in Groote Schuur Hospital in Cape Town, South Africa, over a 52-month period (September 2008 – December 2012). All patients presenting with penetrating abdominal trauma were initially assessed and resuscitated along standard guidelines. Indications for emergency laparotomy were: peritonitis (diffuse tenderness, rebound tenderness, guarding, rigidity), hemodynamic instability and patients with associated head and spinal cord injuries. Hemodynamically stable patients without signs of peritonitis with intact sensorium were selected for a trial of nonoperative management. Patients with right-sided thoracoabdominal, and right upper quadrant (RUQ) penetrating injuries with or without localized RUQ tenderness underwent a CT scan with intravenous contrast to identify or exclude a liver injury. All CT scans were performed using a 16-channel scanner with a high-power injection of 100 mL of intravenous contrast at 5mL/sec. Portovenous, arterial and delayed phases were routinely acquired. Patients with confirmed liver injuries were admitted to a high-care observation area for continuous hemodynamic monitoring, 4-hourly hemoglobin estimation and serial clinical examination. After 48 hours in the high-care observation area, once stabilized and tolerating oral diet, patients were transferred to a general trauma surgical ward. At any time, in the event of the development of peritonitis, hemodynamic instability or a significant reduction in hemoglobin requiring more than 2-4 units of blood transfusion in 24 hours, a laparotomy was performed. The injury severity was categorized using the revised trauma score (RTS), injury severity score (ISS) and American Association of Surgery for Trauma (AAST) grading for solid organ injury. Outcome was determined by the need for delayed laparotomy, liver-

related morbidity, length of hospital stay and survival. All patients were followed up 2-weeks from discharge.

RESULTS

During the study period, 278 patients with penetrating liver injuries were admitted. Of these, 183 (65.8%) had an indication for emergency laparotomy. Table 1 summarizes the management of these 183 liver injuries and of these, 115 (62.8%) patients had no liver-related surgical intervention. Ninety-five patients, (GSW 54, SW 41) with CT confirmed liver injuries were selected for a trial of nonoperative management and form the basis of further analysis for this study. There were 88 men and seven women with a mean age of 27.7 (range 14-88) years. All patients were hemodynamically stable on admission. In addition, 30 of these patients had associated hematuria. Computerized tomography revealed 95 liver and 23 kidney injuries: 72 patients with isolated liver injuries and 23 with combined liver and kidney injuries. The mean RTS and ISS was 7.841 and 19.6 (range 4-34), respectively. The liver and kidney injury grading is shown in Table 2. Simple liver injuries (Grades I and II) occurred in 49 (51.6%) patients and complex liver injuries (Grades III, IV and V) occurred in 46 (48.4%) patients. Associated injuries are listed in Table 3. Right-sided diaphragm injuries were accepted as being present when either lung contusion and/or hemo/pneuomthoraces were diagnosed with a liver injury caused by the same missile trajectory. Three patients with liver gunshot injuries failed abdominal observa-

Table 1. Management of 183 patients with liver injuries undergoing emergency laparotomy

Procedure	Stab	GSW	Total
Definitive packing (damage control)	5	40	45
Drain	16	39	55
Suture	7	16	23
Temporary packing	8	16	24
Nil	10	26	36
Total	46	137	183

Table 2. Liver and kidney injury according to AAST-OIS

	GI		GII		GIII		GIV		GV	
	SW	GSW	SW	GSW	SW	GSW	SW	GSW	SW	GSW
Liver (95)	9	6	19	15	13	19	0	13	0	1
Kidney (23)	0	1	5	3	3	6	3	2	0	0

AAST-OIS, American Association of Surgery for Trauma organ injury scale

Table 3. Associated injuries (same trajectory causing liver injury)

Viscera	SW	GSW
Diaphragm	26	43
Lung contusion	3	20
Hemothorax /pneumothorax	35	60
Rib fractures	4	24
Kidney	11	12

AAST-OIS, American Association of Surgery for Trauma organ injury scale

tion and underwent delayed laparotomy. No hollow-viscus injuries were detected at laparotomy. Table 4 summarizes the indications for surgery and findings at laparotomy. Liver-related complications occurred in 10 (10.5%) patients. There were 9 biliary fistulae: 3 biliary cutaneous fistulae through drains placed at surgery in patients 1, 2 and 3 undergoing delayed laparotomy (see above) and two pleurobiliary fistula in patients undergoing successful nonoperative management (one SW and one GSW). Two intrahepatic culture negative bilomas underwent successful percutaneous drainage. Four patients underwent an endoscopic retrograde cholangiogram for persistent bile leaks (> 50 mL for > 14days) which showed peripheral bile leaks, a sphincterotomy was done and a 10 Fr biliary stent placed. The outcome in these patients was further uneventful apart from a

Table 4. Patients undergoing delayed laparotomy N=3

No.	CT findings	Indication for laparotomy	Delay	Findings / Procedure
1	Grade 2 liver injury	Peritonism & Fever	18 hours	300mL haemperitoneum Diaphragm repair Liver drained Hospital stay 7 days
2	Grade 4 liver and Grade 1 kidney Injuries	Peritonism & Fever	12 hours	300mL haemperitoneum Diaphragm repair Liver drained Hospital stay 13 days
3	Grade 4 liver injury	Bile peritonitis	15 days	Lavage Liver drained Hospital stay 57 days
			48 hours	250 mL blood Liver drained Diaphragm repair

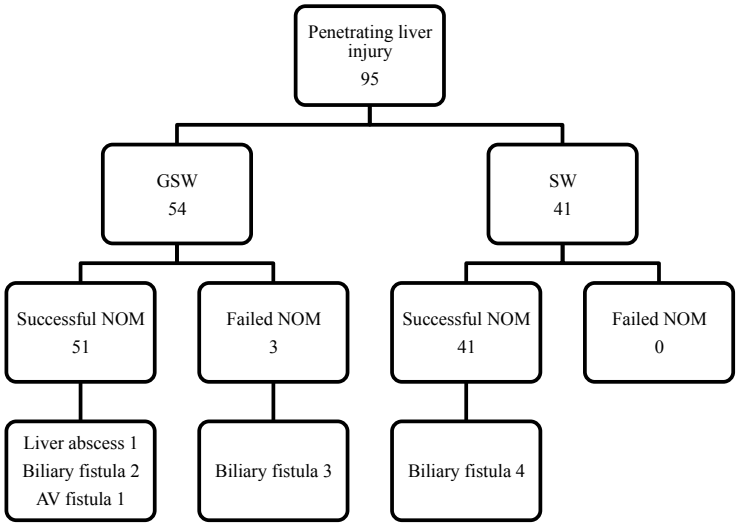

Fig 1. Outcome of patients with penetrating liver injuries managed nonoperatively

prolonged mean 22 day hospital stay. One patient developed a liver abscess treated by ultrasound guided percutaneous drainage. Cultures grew cloxacillin sensitive Staphylococcus aureus. In one GSW patient, admission CT revealed an arterio-venous fistula that underwent immediate successful angioembolisation. Non-liver related complications included 3 right-sided retained or residual hemothoraces that were treated conservatively or with repeat tube thoracostomy. None of these required operative intervention. Four patients developed nosocomial pneumonias or infected lung contusions which were successfully treated with parenteral antibiotics. The overall median hospital stay was 6 IQR: [4-11] days. There were no deaths. A two-week clinical follow-up of 100% had no new complications or patients requiring readmission. Figure 1 summarizes the final outcome of the 95 patients with penetrating liver injuries selected for NOM.

DISCUSSION

The selective nonoperative management of penetrating abdominal trauma has evolved over the last two decades. While clinically evaluable patients with abdominal stab wounds can be safely managed with serial clinical examination[1], the same approach to low-velocity abdominal gunshot wounds has not been readily accepted. There is, however, increasing evidence that the SNOM of abdominal gunshot wounds is practical and safe, and up to one third of all abdominal gunshot wounds can be managed suc-

cessfully nonoperatively[2-8]. The nonoperative management of blunt solid organ injuries is widely accepted with success rates of up to 90%. Conversely, selective nonoperative management of penetrating solid organ injuries, and in particular, penetrating liver injuries has not been widely practised[9-11]. Renz and Feliciano[12] reported the first prospective study on the NOM of liver gunshot injuries. In their series of 13 patients with right-sided thoracoabdominal gunshot wounds, seven patients had CT confirmed liver injuries, with a 100% nonoperative management success rate. Similarly, Chmielewski et al [13], in series of 12 patients with lower right chest gunshot wounds, confirmed eight hepatic injuries (Grades II-III) in those undergoing ultrasound or CT. One patient required delayed laparotomy without any adverse outcome. Ginzburg et al[14] managed 4 patients with liver gunshot injuries successfully nonoperatively. In their retrospective series Demetriades et al [15] proposed the notion that only selected patients with Grade I-III injuries should be managed nonoperatively. In a previous prospective study of SNOM of liver gunshot injuries from our center, increasing injury severity was associated with an increasing rate of complications, however injury grade itself was not shown to be an independent predictor of nonoperative management failure [16]. Overall, of the 313 cases of nonoperatively managed penetrating liver injuries identified in the English literature [11-20], a success rate of greater than 90% has been reported (Table 5). This is comparable to our success rate of 96%. This high success rate could be attributed to the fact that most penetrating injuries to the liver require no treatment[21]. In the current study of 278 penetrating liver injuries, 91/183 (49.7%) of these injuries required no treatment at laparotomy, and 95/278

Table 5. Reported results of the treatment of nonoperative management of penetrating liver injuries

	Mechanism	**Study design**	**N**	**Success**
Author, year	**SW / GSW**			**(%)**
Renz, 1994	GSW	Prospective	7	100
Chmielewski, 1995	GSW	Prospective	8	88
Ginzburg, 1998	GSW	Prospective	4	100
Demetriades, 1999	GSW	Retrospective	16	69
Omoshoro-Jones , 2005	GSW	Prospective	33	97
Pal, 2000	GSW	Case reports	2	100
Shanmuganathan, 2001	GSW	Prospective	9	100
Demetriades, 2006	GSW&SW	Prospective	36	84
DuBose, 2007	GSW	Retrospective	10	90
Navsaria, 2009	GSW	Prospective	63	92
Schnurger, 2011	GSW	Retrospective	30	96
Current series	GSW&SW	Prospective	95	96
TOTAL			**313**	**93**

GSW *gunshot wound,* SW *stab wound*

(34.1%) patients were considered for nonoperative management without laparotomy. Hence, a total of 186/278 (66.9%) of all penetrating liver injuries in this series were managed 'conservatively'. Although seen only once in this study, a contrast 'blush' on CT scan is considered a significant finding of a bleeding, false aneurysm or arteriovenous fistula, and in the hemodynamically stable patient should be followed immediately by angiography and possible embolization to increase the success rate of NOM[19,22]. One of the major concerns regarding the nonoperative management of abdominal gunshots wounds is missing a hollow viscus injury. Although modern imaging performed by experienced radiologists using state of the art modern scanners can demonstrate ongoing hemorrhage and corroborate evidence of hollow viscus injury (free air, free fluid in absence of solid organ injury, localized bowel wall thickening, mesentery stranding, hematoma surrounding hollow viscus), the level of accuracy and sensitivity for diagnosing bowel injuries following penetrating trauma remains a source of concern [22-24]. It is therefore essential that serial clinical examination be used to identify such injuries in patients who are considered for nonoperative management. The complications of liver injury which include rebleeding, bile leaks and infected fluid collections can be managed by interventional radiological and endoscopic techniques. While only one septic liver-related complication occurred, it is possible that the 4 patients treated for nosocomial pneumonias or infected pulmonary contusions with intravenous antibiotics may have masked or had inadvertently treated septic liver-related complications. While outside the scope of this report, all (100%) associated renal injuries were successfully managed nonoperatively. While reports of nonoperatively treated penetrating kidney injuries are few[19, 20, 25, 26,27], this study further provides some evidence that this too is highly feasible, and when associated with liver injuries, does not preclude the NOM of either solid organ. In conclusion , this study demonstrates the efficacy of NOM of penetrating liver injuries in a select group of clinically evaluable, hemodynamically stable patients. Selective CT scanning for right thoracoabdominal and RUQ gunshot wounds with localized tenderness detects liver injuries for NOM. In the current series, 34.2% of all penetrating liver injuries were managed nonoperatively without laparotomy with a 96% success rate, irrespective of severity of injury. A reasonable liver-related complication rate of 10.5% is acceptable. The surgeon must recognize the risks of NOM of penetrating liver injuries and possess the resources (angioembolization, percutaneous interventional techniques, endoscopic interventional cholangiography) to address potential complications. However, SNOM of patients with penetrating abdominal wounds, with or without solid-organ injury, with or without advanced CT technology, is still based largely on the findings from serial clinical examinations.

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