

Trauma to the gallbladder is associated with concurrent injuries to the extra hepatic biliary system: A South African experience

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ABSTRACT

Introduction: Gallbladder trauma is a rare injury. This study aimed to describe the significance of these injuries and the appropriate management strategies.

Methods: A retrospective study was undertaken at a major trauma centre in South Africa and included all patients diagnosed with a gallbladder injury between January 2012 and October 2020.

Results: A total of 51 cases were included (88% male, mean age: 38 years), with 44 (86%) penetrating trauma cases [28 stab wounds (SW), 16 sustained gunshot wounds (GSW)]. Of the 7 (13%) blunt trauma cases, five were involved in a motor vehicle crash, and two were injured via assault. All patients underwent laparotomy. Full-thickness gallbladder laceration or perforation was the most common type of injury (84%) and all patients with a gallbladder perforation or laceration had a cholecystectomy at index operation. Two out of 5 patients with a gallbladder contusion were managed conservatively without a cholecystectomy and the remaining three had evidence of gallbladder necrosis which were managed with cholecystectomy. Associated extrahepatic bile duct injuries occurred in 4% of cases, and 18 cases (35%) required intensive care unit (ICU) admission. The overall mortality was 8%.

Conclusion: Gallbladder injury is rare but when encountered implies a significant degree of trauma. Although cholecystectomy is usually definitive, there is an association with other occult extra-hepatic biliary tract injuries. The severity of the associated injuries usually determines patient outcomes.

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Introduction

The anatomical location of the gallbladder (GB) means that it is relatively protected from trauma. As such, injuries to the gallbladder are relatively rare in comparison to injuries to the rest of the hepato-biliary system [1]. Individual surgeons are likely to encounter such injuries infrequently and literature on the topic is sparse [1–3]. Collating clinical experience with these injuries is important as it facilitates the development of best practice guidelines and clinical algorithms. This study uses the large data set accumulated by our regional trauma registry with the aim of describing

the injury profile of patients with gallbladder injuries, and describing the management and outcomes after this injury.

Materials and methods

Clinical setting

The study was based at the Pietermaritzburg Metropolitan Trauma Service (PMTS), Pietermaritzburg, South Africa. The PMTS provides definitive trauma care to the city of Pietermaritzburg, the capital of KwaZulu Natal (KZN) province. PMTS is the largest academic trauma centre in western KZN and is the tertiary trauma referral centre covering a total catchment population of over three million. Over 4000 cases are admitted annually, over 50% of which are penetrating trauma. This is a reflection of the high incidence of interpersonal violence throughout the province. The PMTS main-

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Table 1
Demographics and presenting physiology.

Variable		Blunt trauma (n = 7)	Penetrating trauma (n = 44)	Total (n = 51)	p
Age (years)	Mean (SD)	31.3 (11.3)	29.7 (10.6)	29.9 (10.6)	0.713
Sex	Male (%)	6 (86)	39 (89)	45 (88)	0.608
Physiological variables at presentation					
RR	Mean (SD)	18.3 (3.1)	19.3 (4.6)	19.1 (4.4)	0.588
HR	Mean (SD)	100.7 (18.2)	94.0 (21.9)	94.9 (21.4)	0.444
SBP	Mean (SD)	121.7 (16.3)	123.0 (19.2)	122.8 (18.7)	0.872
Temp	Mean (SD)	36.4 (0.5)	36.3 (0.8)	36.3 (0.7)	0.861
Shock Index	Mean (SD)	0.8 (0.2)	0.8 (0.3)	0.8 (0.3)	0.579
pH	Mean (SD)	7.3 (0.1)	7.3 (0.1)	7.3 (0.1)	0.766
Lactate	Median (IQR)	3.7 (2.5 – 6.2)	3.1 (1.8 – 5.3)	3.3 (1.8 – 5.3)	0.692

RR: respiration rate, HR: heart rate, SBP: systolic blood pressure.

tains a formal regional trauma registry known as the Hybrid Electronic Medical Registry (HEMR) described extensively elsewhere [4].

The study

All patients diagnosed with a gallbladder injury, between January 2012 and October 2020 were included. Diagnosis of injury was confirmed at laparotomy. Variables reviewed include demographic factors, mechanism of injury, and grade of injury measured by Injury Severity Score (ISS) [5]. Type of injury was graded by American Association for the Surgery of Trauma (AAST) extrahepatic biliary tree injury grades [6]. Ethics approval for the maintenance of this registry has been formally endorsed by the Biomedical Research Ethics Committee (BREC) of the University of KwaZulu Natal (UKZN). Ethics approval to maintain and use this database is provided by the Biomedical Research Ethics Committee of the University of Kwa Zulu-Natal (ref. no. BE207/09 BCA 221/13).

Management of gallbladder injury

A standard trauma laparotomy was performed, and all injuries are managed on their merit. Indications for trauma laparotomy included peritonitis or haemodynamic instability. Damage control principles were applied. Destructive injuries of the gallbladder were managed by cholecystectomy. Complex explorations of the external biliary system were only undertaken if there was obvious biliary leakage into the connective tissue surrounding the biliary triad. However, this was seldom indicated in the acute setting and simple external drainage was usually the only intervention.

Statistical analysis

Statistical analysis was completed using R (version 4.0.3, R Foundation for Statistical Computing, Vienna, Austria) [7]. Normality of data was investigated visually with histograms and Q-Q plots. All normally distributed variables are presented as mean (SD), while non-normally distributed variables as median (IQR). A two-tailed independent t-test was used to compare normally distributed continuous variables, Mann-Whitney U for non-normally distributed continuous variables, and Fisher's exact test for categorical variables. A p-value of <0.05 was taken as statistically significant.

Results

Over the 8-year period, a total of 51 patients sustained a gallbladder injury following trauma. The mean patient age was 29.9 (SD: 10.6) years, and most patients were male (n = 45, 88%). Table 1 shows the demographics and presenting physiology, stratified according to blunt or penetrating mechanisms. Of the 7 pa-

tients (14%) who sustained blunt trauma, 5 were involved in a motor vehicle collision, and 2 were assaulted. Of the 44 patients (86%) sustaining penetrating trauma, 28 sustained a stab wound (SW), whilst 16 sustained a gunshot wound (GSW). Table 2 summarizes the pre-operative imaging the cohort underwent.

Operative management

The operative management of the gallbladder injuries is presented in Fig. 1. All patients underwent laparotomy. A full-thickness gallbladder laceration or perforation was the most common type of injury (84%). Of the 43 patients with a gallbladder perforation or laceration, 42 underwent cholecystectomy at their index operation, while one required a delayed cholecystectomy after an initial primary repair during a damage control procedure. A single patient had a missed gallbladder injury on index laparotomy and subsequently developed necrosis of gallbladder necrosis with bile leak. This was identified at repeat laparotomy and was managed by cholecystectomy. Of the five patients who had a gallbladder contusion, two were managed conservatively without a cholecystectomy. The remaining three with a contusion had evidence of gallbladder necrosis and underwent cholecystectomy. Of the three patients with a partial gallbladder avulsion from the gallbladder bed, all three were managed conservatively without cholecystectomy as the gallbladder was still viable. None of the five patients managed conservatively required a subsequent cholecystectomy. Table 3 summarizes the Injury Severity Scores for the cohort, and the concurrent injuries to the abdomen and other parts of the body are shown in Table 4.

In the patients with gallbladder avulsions, one had a concurrent duodenal haematoma managed conservatively, and one had additional AAST I splenic and AAST II liver injuries. The other patient with gallbladder avulsion had a concurrent AAST VI liver injury who eventually died from renal failure secondary to polytrauma.

There were two cases (4%) of associated extra hepatic biliary tree injury. Case 1 was a thirty-year old man with a SW injury to the gallbladder, intrapancreatic CBD, stomach, and inferior vena cava. He underwent an initial damage control laparotomy, at which the injury was drained. He returned for definitive surgery and died forty days later from multiple organ failure. Case 2 was a twelve-year old boy who sustained blunt trauma. At laparotomy, an injury to the GB and to the nearby segment III hepatic duct injury was identified. Once the nature of the ductal injury had been confirmed via intraoperative cholangiography, the segment III duct was ligated.

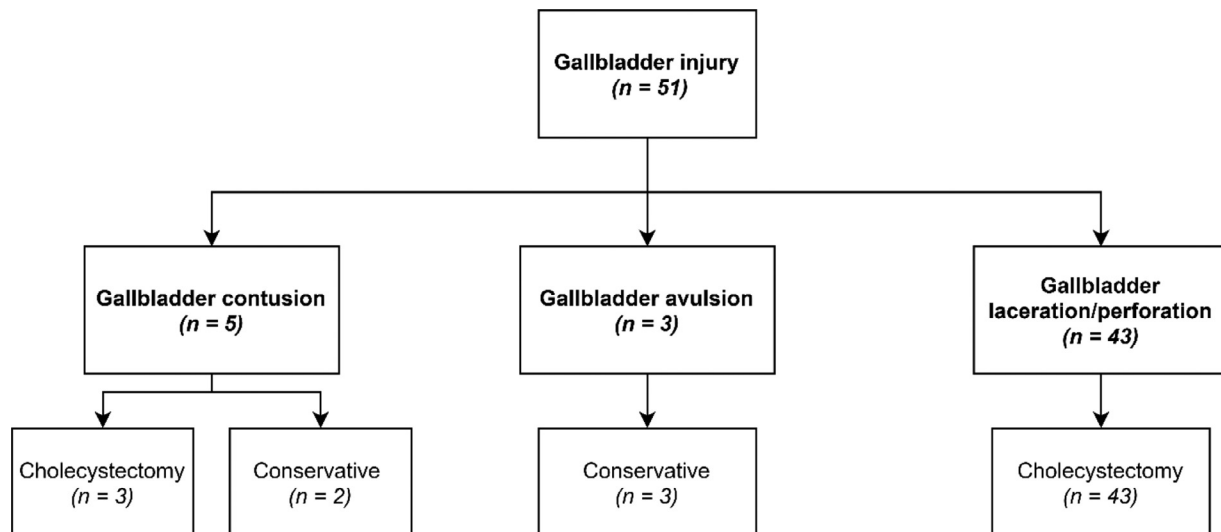
Damage control surgery

A total of 5 (10%) patients required damage control surgery. Details of these patients are provided in Table 5. In one patient who

Table 2
Pre-operative imaging.

Imaging modality		Blunt trauma (n = 7)	Penetrating trauma (n = 44)	Total (n = 51)
Chest X-Ray	(%)	6 (86)	32 (73)	38 (75)
Abdominal X-Ray	(%)	3 (43)	20 (46)	23 (45)
Abdominal FAST scan	(%)	1 (14)	4 (9)	5 (10)
CT scan	(%)	3 (43)	6 (14)	9 (18)

FAST: focused assessment with sonography in trauma, CT: computerized tomography.

**Fig. 1.** Flow chart detailing management of gallbladder injuries.**Table 3**
ISS and grade of injury.

Injury severity variables		Blunt trauma (n = 7)	Penetrating trauma (n = 44)	Total (n = 51)	p
Injury severity score	Median (IQR)	13.0 (9.0 – 29.0)	10.0 (9.0 – 16.0)	11.5 (9.0 – 19.0)	0.617
Abdominal Trauma AIS Score (%)	2	1 (14)	1 (2)	2 (4)	0.205
	3	4 (57)	18 (41)	22 (43)	
	4	0 (0)	10 (23)	10 (20)	
	5	0 (0)	4 (9)	4 (8)	
	Unknown	2 (29)	11 (25)	13 (26)	
AAST Extrahepatic biliary injury grade (%)	I	1 (14)	5 (11)	6 (12)	1.000
	II	6 (86)	38 (86)	44 (86)	
	V	0 (0)	1 (2)	1 (2)	
Type of injury (%)	Gallbladder avulsion	3 (38)	0 (0)	3 (6)	0.002
	Gallbladder contusion	1 (13)	4 (9)	5 (10)	
	Gallbladder laceration	3 (38)	40 (91)	43 (84)	

AIS: abbreviated injury scale, AAST: American Association for the Surgery of Trauma grading system.

Table 4
Concurrent injuries.

	Blunt trauma (n = 7)	Penetrating trauma (n = 44)	Total
Head/neck (%)	0 (0)	3 (7)	3 (6)
Face (%)	2 (29)	2 (5)	4 (8)
Thorax (%)	2 (29)	13 (30)	15 (29)
Extremities (%)	2 (29)	6 (14)	8 (16)
Other abdominal injury (%)			
Diaphragm	1 (14)	9 (21)	10 (20)
Spleen	1 (14)	0 (0)	1 (2)
Liver	5 (71)	33 (75)	38 (75)
Pancreas	0 (0)	7 (16)	7 (14)
Stomach	1 (14)	3 (7)	4 (8)
Duodenum	0 (0)	13 (30)	13 (26)
Small bowel	1 (14)	11 (25)	12 (24)
Colon	1 (14)	7 (16)	8 (16)
Rectum	1 (14)	13 (30)	14 (28)
Kidney	0 (0)	1 (2)	1 (2)
Ureter	0 (0)	1 (2)	1 (2)
Abdominal vasculature	0 (0)	4 (9)	4 (8)
Any abdominal injury	7 (100)	43 (98)	50 (98)

Data presented as frequency (%).

Table 5
Patients requiring damage control surgery.

	Areas injured	Mechanism	Management and complications	Outcome
1	Bilateral hemopneumothorax, diaphragm, stomach, colon, right kidney, bilateral liver lobes and gallbladder laceration. Severe faecal contamination and 1000 ml hemoperitoneum.	High velocity firearm	Systemic inflammatory response syndrome.	Survived
2	Injuries to liver, kidney and perforations of ascending and transverse colon and gallbladder.	Spear	3x reoperations for organ repair/anastomosis and washout	Survived
3	Liver lacerations, gallbladder and small bowel perforations	Low velocity firearm	Septic shock. Outcome unknown as patient transferred due to lack of ICU beds.	Transferred
4	Transverse and ascending colon, duodenal, and multiple small bowel perforations. Gallbladder perforation. Multiple liver lacerations	High velocity firearm	After DCS, 2x abdominal operations, one for organ repair/anastomosis, one for abdominal closure. Retained hemothorax. Abdominal wound site sepsis.	Survived
5	Bilateral diaphragm injuries, gastric through-and-through injuries, shattered head of pancreas, through and through liver injuries, gallbladder perforations, destructive injuries to D1/D2 regions of duodenum, multiple SB injuries	Low velocity firearm	3x relaparotomies for repair breakdowns. Other complications included acute kidney injury, anastomotic leak	Survived

Table 6
Postoperative outcomes.

Operative outcomes		Blunt trauma (n = 7)	Penetrating trauma (n = 44)	Total (n = 51)	p
Cholecystectomy	(%)	4 (57)	42 (96)	46 (90)	0.015
Intensive care admission	(%)	3 (43)	15 (34)	18 (35)	0.310
Clavien-Dindo classification of post-operative complications (%)	None	5 (71)	23 (52)	28 (55)	0.754
	I	0 (0)	2 (5)	2 (4)	
	II	1 (14)	10 (23)	11 (22)	
	III	0 (0)	3 (7)	3 (6)	
	IV	0 (0)	4 (9)	4 (8)	
Length of stay (days)	Median (IQR)	10.0 (5.0 – 11.0)	10.0 (6.0 – 20.0)	10.0 (6.0 – 20.0)	0.589
In hospital-mortality	(%)	1 (14)	3 (7)	4 (8)	0.538

RR: respiration rate, HR: heart rate, SBP: systolic blood pressure, AIS: abbreviated injury scale, AAST: American Association for the Surgery of Trauma grading system, FAST: focused assessment with sonography in trauma, CT: computerized tomography, ICU: intensive care unit, LOS: length of stay.

was stabbed with a spear, a gallbladder laceration was repaired. At repeat laparotomy a cholecystectomy was performed.

Clinical outcomes

In total, fourteen patients (28%) underwent at least one repeat laparotomy. Two patients underwent repeat laparotomy for wound dehiscence. Two patients underwent planned repeat laparotomy after an initial exploratory laparotomy. A single patient had a cystic duct bile leak post cholecystectomy and required subsequent ERCP with sphincterotomy and stenting. The biliary leakage resolved after this. One patient developed an anastomotic leak necessitating a repeat laparotomy. The remaining 8 patients underwent repeat laparotomy for ongoing intra-abdominal sepsis.

In total, 18 patients (35%) required ICU admission. A total of 4 patients died (8%). Out of the 4 patients who died, one patient died from Multiple organ dysfunction syndrome (MODS), two from sepsis (from colonic and urinary sources) and one from renal failure secondary to major polytrauma including gallbladder avulsion and AAST VI liver injury as mentioned above. No patients died from complications directly related to biliary tree or gallbladder injuries.

Other complications included the following: there were 4 cases of postoperative pneumonia, 4 cases of acute kidney injury, 4 cases of postoperative sepsis, 3 cases of superficial wound site infection, 2 cases of a urinary tract infection, 1 retained haemothorax, 1 case of wound dehiscence, 1 duodenal fistula, 1 hepato-biliary fistula, and 1 case of delirium. Grade of post-operative complications are summarized in Table 6, with some patients developing more than one complication. There were no other cholecystectomy related complications (e.g. iatrogenic bile duct injury).

Discussion

Although the protected position of the gallbladder makes it unusual for it to be injured by external trauma, it may in fact be injured in both penetrating and blunt trauma. Penetrating mechanisms are far more common than blunt ones in our environment and in international literature [1,2,8]. Both mechanisms imply significant force and are associated with other injuries both in and outside of the abdomen, reflected in the relatively high median ISS in both cohorts.

There are several differences between the two mechanisms of injury. Blunt trauma is most likely to cause either a contusion or an avulsion of the gallbladder, whilst penetrating trauma results in a laceration. Although simple stab wounds to the gallbladder can be repaired [3], as reported from our parent institution (King Edward VIII Hospital, Durban, South Africa) over three decades ago [9], more recent authors advocate cholecystectomy as the definitive management of this injury [2,10]. One patient in this cohort had a failed primary repair which required a subsequent cholecystectomy. Index cholecystectomy may prevent the need for subsequent reoperations in patients with gallbladder injuries from penetrating mechanisms. Notably, blunt trauma is more likely to cause either an avulsion or contusion of the gallbladder and there is room for conservative treatment in this subset of patients. It is important to exclude other injuries to the extra-hepatic biliary system in this subset [3,11].

The outcome of patients with gallbladder injuries is predominantly determined by the severity of the associated injuries. The most commonly associated intra-abdominal organ that is injured is the liver for both penetrating and blunt mechanisms, as has been reported in other series [9,10]. There may also be injuries to the

pancreaticoduodenal complex [1,8,11]. These injuries are complex to manage and may take priority over the gallbladder injury. Importantly, some injuries to the extra-hepatic biliary system may be difficult to identify and define at initial operation or at damage control surgery. These so-called occult injuries must be actively excluded either by post-operative imaging or by a more detailed exploration of the biliary tract at subsequent laparotomy.

This study has several limitations, predominantly due to its retrospective nature. While this study provides the largest series of gallbladder injuries to date [2,3,9,10,12], evidence regarding these rare injuries is still predominantly based on single centre retrospective observational studies with small sample sizes and limited statistical power.

Conclusion

Gallbladder injury is rare but when encountered implies a significant degree of trauma. Cholecystectomy is usually definitive, and outcomes are often determined by associated injuries rather than the gallbladder injury itself. Occult injuries to other parts of the extra-hepatic biliary tract are not uncommon and due care must be taken to identify such injuries.

Declaration of Competing Interest

There are no funding sources or conflicts of interest to declare from any authors

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21/03/2021.

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