Operative Treatment of Hepatic Trauma in Vachira Phuket Hospital

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Descriptive study of an 8-year period, 211 patients with hepatic trauma were studied retrospectively. Most of the patients were male (81.5%). Patients mainly affected were in the third decade of life (46.9%) with an age range of 2 to 65 years old (Mean 26.1 ± 9.8). Fifty four percent resulted from blunt and 46.4% from penetrating injuries. The most common cause of injuries was motorcycle accidents (41.2%). The injuries were graded by the hepatic injury scale (grades I to VI). There were 22 (10.4%), 62 (29.4%), 70 (33.2%), 27 (12.8%), 28 (13.3%) and 2 (0.9%) patients with grade I, II, III, IV, V and VI hepatic injuries, respectively. Forty seven percent of patients were in shock when they first arrived at the emergency room. One hundred and sixty five patients (78.2%) had 375 associated injuries. Seventy three percent of patients had low grade hepatic injuries (grades I to III), the remainder (27%) had high grade hepatic injuries (grades IV to VI). Operative treatment of hepatic injuries varied according to degree of injury. Low grade hepatic injuries amenable to relatively simple operative treatment. Nineteen deaths (12.3%) occurring in this group were attributed to the commonly encountered associated injuries inside and outside the abdomen, which were more frequently seen after blunt trauma (89.5%). High-grade hepatic injuries required major techniques. Thirty four of these patients died (59.6%), death was related to the injury itself (91.2%), which were more frequently seen after blunt trauma (85%). During operation, suture ligature of the bleeding point, or hepatorrhaphy stopped the bleeding in most circumstances. Perihepatic packing was a useful procedure when termination of the operation was considered necessary in order to prevent the development of hypothermia, acidosis and coagulopathy. Perihepatic packing was used for treatment of 73% of high grade hepatic injuries and yielded 65.5% survival rate. The results were 59 patients had complication (morbidity 28%) and 53 patients in the present study died (mortality 25.1%). Thirty one patients (14.7%) died of hepatic cause, whereas 22 patients (10.4%) died of non hepatic causes. Exsanguination and associated head injuries were the major cause of death (83%). Nonsurvivors had a significantly higher shock, blunt injury, associated injury and high grade hepatic injury than survivors ($p < 0.005$). The high mortality and morbidity can be achieved by well regulated motorcycle accident prevention measures and well prehospital care.

Keywords: *Hepatic trauma, Hepatic injury grade, Operative treatment, Perihepatic packing*

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The liver is frequently injured in both blunt and penetrating trauma because of its size and location in the abdominal cavity[1]. Severe hepatic trauma is the major cause of death in abdominal trauma[2-5]. Exsanguination is main problem and most cause of death in hepatic trauma[4,6]. Despite the progress made in the management of trauma patients, mortality rate after hepatic trauma has remained the same[4,7]. Although non-operative management of hepatic trauma has been utilized with increasing popularity during the last decade[8,9,11,12], most major hepatic trauma still require operative treatment[13,14]. In rural hospitals where facilities to manage hepatic trauma are limited, hepatic trauma is managed with operative treatment.

The purpose of the present study was to examine the operative treatment and results of treatment of patients with hepatic trauma, who were

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admitted to Vachira Phuket hospital, Phuket, Thailand from October 1996 to September 2004.Data collection included causes and types of injuries, associated injuries, operative treatment, and results of treatment. The result should be beneficial for further treatment particularly at provincial hospital level.

Material and Method

This was a retrospective study of patients who had hepatic injuries and were admitted to the surgical department, Vachira Phuket Hospital following blunt or penetrating trauma from October 1996 to September 2004, an eight year period. All the hepatic injuries were diagnosed during exploratory laparotomy. Severity of hepatic injury was graded according to Moore et al as shown in Table 1[15]. Grades I to III were graded as low-grade hepatic injuries and grades IV to VI were graded as high-grade hepatic injuries[16]. Following blunt trauma, indications for abdominal exploration included a positive diagnostic peritoneal lavage, abdominal computed tomography (CT) demonstrating intra-abdominal injury, or abdominal tenderness on physical examination. All patients with gunshot wounds to the torso inferior to the nipple line and superior to the inguinal creases underwent abdominal exploration. Stable patients with anterior stab wounds underwent local exploration followed by laparotomy if the anterior fascia was violated. Stable patients with stab wounds to the back or flank were initially observed and serially examined; they received laparotomy if they became unstable or developed abdominal tenderness.

Exploratory laparotomy was carried out through a midline incision which may extend into the chest via median sternotomy or right 7th intercostal space if necessary. Active bleeding from the liver wound was first controlled by Pringle maneuver and packing. Subsequent management depended on severity of hepatic injuries.

Definitive operative treatment of the hepatic injury was classified as simple or major treatment[7]. Simple treatment included topical hemostatic techniques (including local pressure on the liver with laparotomy packs or topical hemostatic agents), electrocautery, and individual suture of superficial bleeding vessels. Simple operative treatment was used almost exclusively for grades I to III injuries. Major operative treatment included omental packing, individual suture of large vessels within hepatic parenchyma, resectional debridement, and gauze packing. Omental packing was used in patients with deep lacerations, stellate fracture and burst injuries.

Shock in the present study was defined as a systolic blood pressure of $\leq$ 90 mmHg when patients first arrived at the emergency room.

Data are presented as percentage or mean $\pm$ SD as appropriate. Statistical significance was considered at $p < 0.05$, with the Chi-square test.

Results

During the 8 year-period, 211 patients were enrolled into the present study. The age ranged from 2 to 65 years (mean 26.1 $\pm$ 9.8). One hundred and seventy two (81.5%) were male and 39 (18.5%) were

Table 1. Liver injury scale (1994 revision)[15]

Grade [a]	Injury Description		ICD-9	AIS-90
I	Hematoma	Subcapsular, < 10% surface area	864.01	2
	Laceration	Capsular tear, < 1 cm parenchymal depth	864.11	2
II	Hematoma	Subcapsular, 10-50% surface area; intraparenchymal, < 10 cm in diameter	864.02	2
	Laceration	1-3 cm parenchymal depth, <10 cm in length	864.12	2
III	Hematoma	Subcapsular, > 50% surface area or expanding; ruptured subcapsular or parenchymal hematoma	864.01	3
		Intraparenchymal hematoma > 10 cm or expanding	864.11	3
	Laceration	> 3 cm parenchymal depth	864.03	4
IV	Laceration	Parenchymal disruption involving 25-75% of hepatic lobe or 1-3 Couinaud's segments within a single lobe	864.13	5
V	Laceration	Parenchymal disruption involving > 75% of hepatic lobe or > 3 Couinaud's segments with in a single lobe	864.04	5
	Vascular	Juxtahepatic venous injuries; i.e., retrohepatic	864.14	5
		Vena cava/central major hepatic veins	864.04	
VI	Vascular	Hepatic avulsion	864.14	6

[a] Advance one grade for multiple injuries, up to grade III

female. Blunt trauma occurred in 113 patients (53.6%) and penetrating trauma in 98 patients (46.4%). Motorcycle accidents, car accidents, and falls or assaults occurred in 41.2%, 7.6% and 4.7%, respectively, of the patients. Of the penetrating injury group, 38.9% were stab wounds, 7.1% were gunshot wounds, and 0.4% were shot gun blasts. Causes and type of injuries including number of patients with shock and number of patients who died are shown in Table 2.

Hepatic injury grading

The severity of liver injury was stratified by the hepatic injury grading system (Table 1). Twenty two patients (10.4%) were grade I, 62 (29.4%) were grade II, 70 (33.2%) were grade III, 27 (12.8%) were grade IV, 28 (13.3%) were grade V and 2 (0.9%) were grade VI (Table 2). Most hepatic injuries (73%) were low-grade hepatic injuries (grades I to III).

Associated Injury

One hundred and sixty five patients (78.2%) had 375 associated injuries. Forty six patients (21.8%) had isolated hepatic trauma. Details of associated injuries and mechanism of injuries are shown in Table 3. The most frequently associated intra-abdominal organ injuries after blunt trauma were the spleen (42.4%), kidney (17%) and small bowel (11.9%). Those most frequent after penetrating injury were the diaphragm (19.8%), stomach (16.7%), colon (11.1%), small bowel (10.3%) and pancreas (9.5%). The most frequently associated extra-abdominal organ injuries after blunt trauma were chest injury, head injury, long bone fractures. Those most frequent after penetrating injury were chest, long bone fracture, spinal fracture. Many of these patients had other abdominal and extra-abdominal injuries in addition to their hepatic injuries. One hundred patients (47.4%) had documented signs and symptoms of hypovolemic shock when admitted to the emergency room (Table 2).

Fractures of the extremities and chest injuries, head injuries were common in extra-abdominal associated injuries. Chest injuries and head injuries were associated with a high mortality rate regardless of the type of hepatic injury (Table 3, 6).

Table 2. General characteristic of patients with Hepatic Trauma

Characteristics	Number of patients	%
Total	211	
Sex Male	172	81.5
Female	39	18.5
Mean age ± SD (year)	26.1±9.8	
Age Range (year)	2 to 65	
Causes of injury		
Blunt trauma	113	53.6
Motorcycle accidents	87	41.2
Car accidents	16	7.6
Assault	3	4.7
Fall from height	7	
Penetrating Trauma	98	46.4
Stab wound	82	38.9
Gun shot wound	15	7.1
Shot gun wound	1	0.4
Hepatic injury grade		
Grade I	22	10.4
Grade II	62	29.4
Grade III	70	33.2
Grade IV	27	12.8
Grade V	28	13.3
Grade VI	2	0.9
Patients with shock	100	47.4
Deaths	53	25.1

Operative Treatment

Details of operative treatment are shown in Table 4.

Grade I hepatic injuries

There were 22 patients in this grade. Temporary packing with spontaneous bleeding ceased, electrocautery or hemostatic agent application were performed in 22 patients. Peritoneal drain was placed in 16 patients due to other organ injury.

Grade II hepatic injuries

Twenty three patients in this grade were treated by temporary packing. Liver suture was performed in 41 patients. Surgical adjunct by perihepatic packing in 1 patients. Peritoneal drain was placed in 34 patients. There were 62 patients in this grade.

Grade III hepatic injuries

Deep liver suture was performed in 52 patients in this grade. Hepatomy and individual vessel ligation was performed in 8 patients, Hepatic resection in 4. Pringle maneuver was applied in 15. Surgical adjunts include perihepatic packing in 11 patients. Peritoneal drains were placed in 42 patients. Secondary hepatic procedures were necessary in 10 patients, including perihepatic removal in 10, hematona evacuation in 5 and hepatomy and vessel ligation in 5.

Grade IV hepatic injuries

Deep liver suture was performed in 16 patients.

Table 3. Associated injuries in 165 patients (78.2% of all patients)*

Associated injuries	Mechanism of injury		Number of patients	%
	Blunt	Penetrating		
Extra-abdominal injuries	152	38	190	50.7
Chest (rib fracture, hemothorax, pneumothorax)	30	29	59	15.7
Fracture of upper limbs	28	4	32	8.5
Fracture of lower limbs	30	-	30	8.0
Maxillofacial injuries	25	2	27	7.2
Head injury	29	1	30	8.0
Pelvic fracture	8	-	8	2.2
Spinal fracture	2	2	4	1.1
Intra-abdominal injuries	59	126	185	49.3
Spleen	25	8	33	8.8
Diaphragm	3	25	28	7.5
Stomach	3	21	24	6.4
Small bowel	7	13	20	5.3
Colon	4	14	18	4.8
Kidney	10	10	20	5.3
Pancreas	1	12	13	3.5
Duodenum	-	10	10	2.7
Gall bladder	2	6	8	2.1
Urinary Bladder	3	-	3	
Ovary	1	-	1	
Aorta	-	2	2	2.9
IVC	-	3	3	
Mesenteric vein	-	2	2	
Total	211	164	375	100.0

* Some patients had more than 1 associated injury

Five patients were treated by packing liver wounds with omentum and suture to stop bleeding, other initial hepatic procedures included hepatic resection in 2, perihepatic packing in 20 and peritoneal drain was placed in 10 patients. Pringle maneuver was applied in 8 patients. Secondary hepatic procedures were necessary in 12 patients including perihepatic pack removal in 8, hematoma evacuation in 2, resectional debridement in 2 and suture ligation of bleeding in 4.

Table 4. Operative Treatment of hepatic trauma

Treatment	Hepatic Injury Grade						Total
	I	II	III	IV	V	VI	
Temporary packing*	22	23	23	5	2	-	75
Liver suture	-	41	52	16	12	-	121
Hepatomy and vessel ligation	-	-	8	-	9	1	18
Omental packing	-	-	-	5	-	-	5
Resectional debridement	-	-	-	2	3	-	5
Hepatic resection	-	-	4	2	4	-	10
Hepatic artery ligation	-	-	-	-	1	-	1
Perihepatic packing	-	1	11	20	21	1	54
Peritoneal drain	16	34	42	10	5	-	98
Number of patients	22	62	70	27	28	2	211

* Included spontaneous bleeding ceased, electrocautery and hemostatic agent application

Grade V hepatic injuries

Deep liver suture was performed in 12 patients. Hepatomy and vessel ligation was performed in 9. Other initial and adjunct hepatic procedures were perihepatic packing in 21, hepatic artery ligation in 1, resectional debridement in 3 and hepatic resection in 4. Peritoneal drains were placed in 5.

Grade VI Hepatic injuries

There were 2 patients in this grade. Both of them died in the operating room before any specific treatment was performed. The cause of death was exsanguination. Perihepatic packing was performed in 1 and hepatomy and vessel ligation in 1 patient.

In 25 patients, all of them with grade I, or grade II injuries, the hepatic lacerations had ceased bleeding at the time of operation.

Operative treatment was analyzed according to low grade and high grade hepatic injuries. Treatment of 134 low grade hepatic injuries (73% of total) included temporary packing (Electrocautary, hemostatic agent) in 68, or suture (superficial vessels) in 93. High grade hepatic injuries (27%) treatment involved omental pacing in 5, hepatic resection in 10, resectional debriement in 5, sutures (larger vessels within hepatic parenchyma) in 28, hepatomy and vessel ligation in 18, hepatic artery ligation in 1 and gauze packing in 42. Peritoneal drains were closed suction drainages.

Perihepatic packing was performed in 54 patients, 42 of them (73.7%) had high grade hepatic injuries and the remaining 12 had low grade hepatic injuries with severe injuries in other intra-abdominal organs. Perihepatic packing was considered when the bleeding from the liver wound could not be stopped effectively by surgical means, all of them had massive blood loss and blood transfusion. The packing was done with a large roll of gauze which was removed 48 to 72 hours later when the patients were hemodynamically stable and coagulopathy had been corrected. Fifteen patients died, and yielded a 65.5% survival rate. Overview of the outcome according to type of operative treatment is reported in Table 4, 5 and 6.

Postoperative hepatic complications

One hundred and fifty two patients (72%) recovered after repair of their injuries without postoperative complications, 59 (28%) had one or more postoperative complication. Complications in low grade hepatic injuries were related to associated injuries and in high grade hepatic injuries were related to the hepatic injury itself. The most frequent postoperative hepatic complications were coagulopathy, late hemorrhage, sepsis, pulmornary insufficiency (ARDS) and renal failure as shown in Table 5.

Table 5. Postoperative complication in 59 patients (28%)

Complication	Hepatic Injury Grade						Total
	I	II	III	IV	V	VI	
Wound infection	1	2	4	4	1	-	12
Coagulopathy	-	2	3	9	7	2	23
Late hemorrhage	-	-	-	2	4	-	6
Abdominal abscess	-	-	1	1	1	-	3
Sepsis	-	1	-	3	1	-	5
Liver failure	-	-	-	1	1	-	2
Renal failure	-	-	2	5	-	-	7
Bile leak	-	-	-	1	-	-	1
ARDS	-	-	-	2	2	-	4
	1	5	10	27	17	2	63

* Some patients had more than 1 complication

Mortality

There were 53 deaths among the 211 cases reviewed for an overall mortality of 25.1%, 22 of those were not liver related (10.4%), in the remaining 31 deaths (14.7%), liver injury was the contributory

Table 6. Mortality

Grading of Hepatic Injury	Number of Patients	Mechanism of Injury		Cause of Death	Liver Death	Associated Injuries	Hepatic Resection
		Blunt	Penetrating				
Low-grade	154 (19)	68 (17)	86 (2)		-		-
I	22 (2)	13 (2)	9	Head injury (2)	-	E	-
II	62 (9)	29 (9)	33	Head injury (4)	-	E	-
				Exsanguination (4)	-	E & I	-
				Sepsis (1)	-	E & I	-
III	70 (8)	26 (6)	44 (2)	Head injury (2)	-	E	-
				Exsanguination (4)	-	I	-
				Acute Renal failure (1)	-	E & I	yes(1)
				Sepsis (1)	-	E & I	-
High-grade	57 (34)	45 (29)	12 (5)		yes		-
IV	27 (14)	22 (14)	5	Exsanguination (8)	yes	E & I	yes(1)
				Head injury (1)	-	E	-
				Sepsis (3)	yes	E & I	-
				Renal failure (2)	-	E	-
V	28 (18)	22 (14)	6 (4)	Exsanguination (17)	yes	E & I	yes(3)
				Sepsis (1)	yes	E & I	-
VI	2 (2)	1 (1)	1 (1)	Exsanguination (2)	yes	E & I	-
Total	211 (53)	113 (46)	98 (7)	53	31		

( ) = Deaths, E = Extra-Abdominal injuries, I = Intra-Abdominal injuries

factor. The mechanism of injury in the deaths were blunt in 46 (86.8%) and peretrating in 7 (13.2%). Thus, the overall mortality rate for the entire population associated with penetreating wounds was 3.3% compared to 21.8% for blunt injuries. Of the 31 deaths directly related to liver injury, 11 had grade IV injuries, 18 had grade V and 2 had grade VI. 9 of the 22 non-liver-related deaths were due primarily to closed head injury, 8 were due to exsanguination (2 from the chest, 2 maxillofacial, 2 kidney, 2 fracture pelvic) 4 were due to sepsis and multiple–organ failure. 1 was due to associated major vascular injury. Non-liver death occurred in low grade hepatic injury but liver related death occurred in high grade hepatic injuries.

Causes of death were exsanguination in 35 patients (66% of death), severe head injuries in 9 patients (17% of death), sepsis in 6 patients (11.3%) and multiple organ failure in 3 patients (5.7%) The details of the mortality and the cause of death in relation to the mechanism of injury are shown in Table 6 and 7.

Six (2.8%) patients died in the operating room because of massive bleeding, 5 patients from liver injuries and 1 patient from chest injury (massive hemothorax).

Forty-four percent of low-grade hepatic injuries were caused by blunt injury and 56% by penetrating. Seventy-nine percent of high-grade hepatic injuries were blunt and 21% were penetrating.

In low-grade hepatic injuries, the mortality rate (12.3%) was related to associated injuries, which were more frequently seen after blunt trauma (89.5%)

In high-grade hepatic injuries, the mortality rate (59.6%) was related to the injury itself (91.2%), which was more frequently seen after blunt trauma (85%) too.

Factors related to mortality

Statistical analysis using X^2 test found that patients who died had a significantly higher shock, blunt injury, associated injuries and high grade hepatic injuries compared to patients who survived ($p < 0.005$) (Table 7).

Table 7. Factors Related to Mortality

Factors	Non survivors	Surviors	p
Shock	73.6%	38.6%	<0.005
Blunt injury	86.8%	42.2%	<0.005
Associated injury	100.0%	70.9%	<0.005
High grade hepatic injury	64.2%	14.6%	<0.005

Excluding patients who died, the hospital stay ranged from 1 to 74 days (Mean 13.6 $\pm$ 12.3).

Discussion

In the present, most hepatic injuries which are diagnosed by abdominal CTscan can be treated nonoperatively[15,17]. The classic criteria for non-operative treatment of hepatic injuries includes hemodynamic stability, normal mental status, absence of a clear indication for laparotomy such as peritoneal signs, low-grade hepatic injuries (grade I to III), and transfusion requirements less than 2 units of blood[16]. The overall reported success of nonoperative treatment of blunt hepatic injuries is greater than 90% in most series[17,18]. Broken down by injury grade, the success rate of nonoperative treatment for injuries grade I to III approaches 95%, whereas for injuries grade IV and V, the success rate decreases to 75% to 80%[16]. With the use of angiography and super-selective embolization in patients with persistent bleeding, the success rate may be higher[9,11,12,19]. However, hepatic trauma is mainly served by operative treatment[13,14], especially in Thailand. Because of patients with persistent bleeding, associated abdominal organ injuries and limited facilities, nonoperative treatment is not appropriate for hepatic trauma.

The principles of operative treatment of hepatic trauma are the same, regardless of the severity of injury. They involve control of bleeding, removal of devitalized tissue and establishment of adequate drainage[16]. Most liver injuries can be properly managed with simple procedures[3,4,20], control of profuse bleeding from deep hepatic lacerations remains a formidable challenge for trauma surgeons.

The morbidity and mortality rates associated with hepatic injuries vary significantly depending on the mechanism of injury. Recent reports of hepatic injuries demonstrate disparate mortality rates range from 1.2% to 31%[3,21-23]. Those with low rates generally result from a preponderance of patients sustaining penetrating injury (1.2% and 10.5%)[3,21] Higher mortality rates are reported when the experience is heavily weighted with blunt injury (29% and 31%)[22,23]. In the present study illustrates that point with a 3.3% mortality rate from penetrating injury and 21.8% rate from blunt trauma. Blunt injury accounted for 53.6% of the populations, but 86.8% of the deaths (Table 2, 6). Death from penetrating injuries is generally in two phases: early deaths from hemorrhage and

hypovolemic shock from either the liver or associated major vascular injuries, and late deaths from sepsis and multiple-organ failure[24,25]. Death associated with blunt injury also occurs in early and late phases; but the causative factors differ from penetrating injury. Early deaths occur from hemorrhage associated major hepatic trauma and they die from brain injury. The late phase of deaths occur from closed head injury and sepsis with multiple organ failure. In the present report, 41.5% of deaths were not liver related and 58.5% were associated with the hepatic injury. While closed head injury was responsible for 40.9% of the non-liver-related deaths, all of the liver-related deaths were due to hemorrhage and sepsis, regardless of mechanism of injury (Table 6). Indeed efforts to reduce liver injury-related morbidity must be directed at expeditions hemostasis and to reducing infections complications.

Most hepatic injuries were caused by blunt trauma occurring during accidents involving motorized vehicles and stab wound to the liver (Table 2). As reported by other authors[26-28] hepatic injuries are frequently associated with serious injuries to other organs located inside or outside the abdomen. When mortality occurs in patients with low grade hepatic injury (grades I to III), it is almost always caused by the associated injuries and not by the injury to the liver (10.4%). However, the mortality directly attributable to the hepatic injury, which was 14.7% in the present series, occurred only in patients with high grade hepatic injury (grades IV to VI) (Table 6). It is not surprising that the presence of shock at the time these patients were admitted to the emergency room was associated with a much higher mortality than these admitted without hypovolemic shock (Table7).

In the present study, the prevalence of low grade hepatic injury (grades I to III) was 73% and the prevalence of high grade hepatic injuries (grades IV to VI) was 27% (Table 2).

In low grade hepatic injury, the fact that 25 of the 211 patients had a hepatic laceration that was not bleeding at the time of laparotomy suggest that some minor hepatic lacerations, if they are the only injury, may not require operation. Obviously, it is very difficult to select preoperatively, the patients with low grade hepatic injuries that are going to stop bleeding spontaneously and virtually impossible to be certain that the signs of peritoneal irritation are not caused by injury to another intra-abdoninal organ in need of surgical repair. Under the right circumstances, a number of patients with low grade hepatic injuries can be managed without operation.

For the liver wounds with active bleeding at the time of exploratory laparotomy, suture ligature of the bleeding artery or suturing the liver wound (hepatorrhaphy) was the only treatment required.

Mortality in low grade hepatic injuries was mainly caused by associated injuries such as head, chest or other serious intra abdominal injuries rather than liver injury per se (Table 6).

The aim of treatment when dealing with a bleeding liver wound is to stop the bleeding as quickly as possible without further jeopardizing the viability of the injured liver. Direct suturing of the bleeding artery, suture approximation of liver wound edge (hepatorrhaphy), hepatic artery ligation, omental packing of the liver wound, resectional debridement, anatomical hepatic resection and perihepatic packing[29] are the procedures currently used. The procedure of choice depends on the nature of the liver wound, surgeons experience and patients condition.

In the present study most arterial bleeding from the liver wounds was successfully treated by suture ligation of the bleeding points (Table 4). When active bleeding from the liver wound is encountered during exploratory laparotomy, inflow occlusive of the liver should be performed by clamping the hepatoduodenal ligament with a vascular clamp (Pringle maneuver). If the bleeding ceases, the sources of bleeding are from branches of the hepatic artery or tributaries of the portal vein. If the bleeding continues, the sources of bleeding are from the hepatic veins or retrohepatic vena cava[30,31]. Direct suturing of the bleeding vessels is recommended when the bleeding is from the branches of the hepatic artery or tributaries of the portal vein[4]. The disrupted bile ducts are also ligated. When one lobe or segment of the liver is severely damaged, debridement of the devitalized liver tissue concomitant with suture ligature of the bleeding vessels (resectional debridement) is advocated[32-34].

When a deep liver wound with continuous venous bleeding is concountered, packing the wound with vascularized omentum and reenforcing the wound edge together with a few sutures is a useful procedure[35]. Omentum has been used to fill large defects in the liver. Omentum provides an excellent source of macrophages and that it fills a potential dead space with viable tissue[36]. In the present report, the authors have successfully treated 5 patients with grade IV hepatic injury by omental packing without any com-

plication. Hepatic artery ligation was performed in 1 case of grade V hepatic injury. Most sources of venous hemorrhage within the liver can be managed with parenchymal sutures, and even injuries of the retro hepatic vena cava and hepatic veins have been successfully tamponaded by closing the hepatic parenchyma over the bleeding vessel[36].

Anatomical hepatic resection in severe hepatic trauma is currently seldom performed and is replaced by resectional debridement. In a collective review of more than 5,000 cases of hepatic trauma, the incedence of hepatic resection was only 7.5 percent, but the procedure had a mortalily rate of 52 percent[37]. In the present study 4 out of 6 (66.7%) high grade hepatic injuries who had anatomical hepatic resection died (Table 4, 6). Six patients with high grade hepatic injuries died in the operating room because of massive bleeding. All of them arrived at the emergency room in the shock stage, caused from blunt trauma. In the present study, 5 patients with grade V hepatic injuries survived. All of them were treated by resectional debridement, direct suture repair of the torn hepatic vein and inferior vena cava and perihepatic packing. Perihepatic packing is capable of controlling hemorrhage from most hepatic injuries, and it has the advantage of freeing the surgeon's hands[38].

Perihepatic packing is performed by using roll gauze packed around the injured liver. Temporary packing has been used, particularly in patients with hypothermia, coagulopathy, and severe acidosis with severe injuries in other intra-abdominal organs. Usually, these patients are taken to the intensive care unit for rewarming and resuscitation. Reexploration for packing removal is performed (after the coagulopathy, acidosis and hypothermia were corrected) within 48 to 72 hours after the initial operation[39,40]. The use of gauze packing in the bleeding patients resulted in a 30% incidence of perihepatic abscess and a 29% mortality rate[7]. In the present study, perihepatic packing was used in 73.7% of high grade hepatic injuries with a 65.5% survival rate. In some circumtances (26.3%) this procedure can be done in low grade hepatic injuries (Table 4). When hypothermia, accidosis and coagulopathy develop from extra-abdominal injuries such as massive bleeding from severe chest injuries, maxillofacial injuries and open fractures. Early use of perihepatic packing when or before hypothermia, acidosis and coagulopathy develop has been shown to improve survival[41-45]. A 34% survival rate was reported when perihepatic packing was used as an adjunct to other measures to control bleeding[7]. In some rural hospitals where facilities to manage high grade hepatic injuries are limited, perihepatic packing may be done and the patients transfered to trauma centers for further definitive management[46].

The most prevalent postoperative complication in the present 211 patients who survived the initial operation was coagulopathy (Table 5), which was corrected by vitamin K and fresh frozen plasma[4]. Intra abdominal sepsis is a serious complication following hepatic trauma. Factors associated with an increased incidence of intra abdominal sepsis are splenectomy, liver packing, severe liver injury, massive blood transfusion, colon injury and open (penrose) drainage of the abdomen[35]. In the present study, the authors used closed suction drainage. Several prospective and retrospective studies have clearly demonstrated that the use of penrose or sump drains is associated with a greater risk of intra-abdominal sepsis when compared to those treated with closed suction drains or no drains[36]. Drains are not necessary for minor lacerations. 3 of 5 patients who had intra abdominal sepsis in the present study died in spite of aggressive drainage and antimicrobial therapy.

In low grade hepatic injuries, mortality rate was related to associated extra or intra abdominal injuries, which were more frequently seen after blunt trauma, the major cause of death was head injury, non liver related death.

In high grade hepatic injuries, death was related to the injury itself, which was frequently seen after blunt trauma too. The cause of death was exsanguination, liver related death (Table 6).

Conclusion

Two hundred and eleven patients with hepatic trauma were retrospectively studied. The majority were male (81.5%) and aged 20-29 years (49.6%). Forty one percent of the injuries were caused by motorcycle accidents. Seventy eight percent of patients had associated injuries and 47.4% were in shock on arrival. Most hepatic injuries (73%) were low grade hepatic injuries (Grades I to III) which were treated by simple operative treatment. During operation, suture ligation of the bleeding points or hepatorrhaphy stopped the bleeding in most circumstances. Hepatic artery ligation was seldom performed. Omental packing of the liver wounds was an effective procedure. Hepatic resections were performed with a relatively high mortality rate. Perihepatic packing was performed in 73% of high grade

hepatic injury, and yielded a 65.5% survival rate. Perihepatic packing was a useful procedure, when termination of the operation was considered necessary in order to prevent the development of hypothermia, acidosis and coagulopathy. Routine closed suction drainage is recommended for high grade hepatic injury. The morbidity rate was 28% and the mortality rate was 25.1%. With a 3.3% mortility rate from penetrating injuries which occurred in patients with low grade hepatic injuries, 21.8% mortality rate from blunt injuries occurred in patients with high grade hepatic injuries. The causes of death were bleeding (66%), severe head injuries (17%), sepsis (11.3%) and multiple organ failure (5.7%). The high morbidity and mortality of hepatic trauma can be achieved by well regulated, prevention measures of mortorcycle accidents (Helmeted, Drink prohibited) and good prehospital care (EMS).

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การผ่าตัดรักษาบาดเจ็บที่ตับในโรงพยาบาลวชิระภูเก็ต

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ในช่วงเวลา 8 ปี ตั้งแต่ ตุลาคม 2539 ถึงกันยายน 2547 ได้ทำการศึกษาย้อนหลังผู้ป่วยบาดเจ็บที่ตับที่ผ่าตัดรักษาในโรงพยาบาลวชิระภูเก็ต จำนวน 211 ราย ส่วนใหญ่ (81.5%) เป็นผู้ชาย ผู้ป่วยมีอายุระหว่าง 2 ถึง 65 ปี (เฉลี่ย 26.1 $\pm$ 9.8 ปี) พบมาก (46.9%) อยู่ในช่วงอายุ 20-29 ปี ได้รับบาดเจ็บแบบกระแทก 113 ราย (53.6%) และแบบทะลุทะลวง 98 ราย (46.4%) สาเหตุของการบาดเจ็บส่วนใหญ่ (41.2%) เป็นอุบัติเหตุรถจักรยานยนต์ ผู้ป่วยร้อยละ 47.4 อยู่ในภาวะช็อก เมื่อแรกรับที่ห้องฉุกเฉิน และผู้ป่วย 165 ราย (78.2%) มีการบาดเจ็บร่วมต่ออวัยวะอื่น 375 แห่ง การบาดเจ็บที่ตับแบ่งตามความรุนแรงเป็น 6 Grades ผู้ป่วย 22 ราย (10.4%) มีการบาดเจ็บที่ตับแบบ Grade I, 62 ราย (29.4%) แบบ Grade II, 70 ราย (33.2%) แบบ Grade III, 27 ราย (12.8%) แบบ Grade IV, 28 ราย (13.3%) แบบ Grade V และ 2 ราย(0.9%) แบบ Grade VI บาดเจ็บที่ตับส่วนใหญ่ (73%) เป็นบาดเจ็บ Low Grade (Grades I ถึง III)ที่เหลือ (27%) เป็นบาดเจ็บ High-grade (Grades IV ถึง VI) การผ่าตัดรักษาบาดเจ็บที่ตับทำได้หลายวิธีขึ้นอยู่กับความรุนแรงของการบาดเจ็บที่ตับ ในกลุ่มบาดเจ็บที่ตับ Low-Grade การผ่าตัดรักษาใช้วิธีเย็บซ่อมตับธรรมดา ในกลุ่มนี้ผู้ป่วยตาย 19 ราย (12.3%) ซึ่งมีความสัมพันธ์กับการบาดเจ็บร่วมในและนอกช่องท้องและส่วนใหญ่ (89.5%) มีสาเหตุจากบาดเจ็บแบบกระแทก ส่วนในกลุ่มบาดเจ็บที่ตับ High-Grade การผ่าตัดรักษาใช้วิธียุ่งยากและซับซ้อนขึ้น ผู้ป่วยในกลุ่มนี้ตาย 34 ราย (59.6%) การตายในกลุ่มนี้สัมพันธ์กับการบาดเจ็บที่ตับ (91.2%) และสัมพันธ์กับการบาดเจ็บแบบกระแทก (85%) การผ่าตัดส่วนใหญ่ทำการเย็บหยุดจุดเลือดออก การเย็บเนื้อตับเข้าหากัน การทำ Perihepatic packing มีประโยชน์มากในกลุ่มบาดเจ็บ High Grade เพื่อป้องกันการเกิดภาวะ Hypothermia, Acidosis และ Coagulophthy ทำ Perihepatic packing ร้อยละ 73.7 ของการรักษาในกลุ่มบาดเจ็บ High Grade มีอัตรารอดร้อยละ 65.5 ผลการรักษาพบว่า ผู้ป่วย 59ราย (28%) มีภาวะแทรกซ้อนเกิดขึ้นส่วนใหญ่เป็น coagulopathy แต่ไม่รุนแรงและ ผู้ป่วยตายทั้งหมด 53 ราย อัตราตายร้อยละ 25.1 มีสาเหตุตายจากตับ 31 ราย (14.7%) ไม่ใช่จากตับ 22 ราย (10.4%) ส่วนใหญ่ (83%) การตายเกิดจากเสียเลือดมากและบาดเจ็บรุนแรงที่ศีรษะ ผู้ป่วยที่ตายมีภาวะช็อก, High grade hepatic injury, Associated Injury, บาดเจ็บแบบกระแทก มากกว่าผู้ป่วยที่รอดชีวิตอย่างมีนัยสำคัญ ($p < 0.005$) สามารถลดอัตราตายลงได้หากมีการควบคุม, ป้องกันอุบัติเหตุจากรถจักรยานยนต์ (เมาไม่ขับ, สวมหมวกนิรภัย) และ Prehospital care ที่ดีลดภาวะช็อกก่อนถึงโรงพยาบาล เช่นมีศูนย์ EMS รับส่งผู้ป่วยที่เกิดเหตุ