

# Operative management of liver trauma

## A 10-year experience in Riyadh, Saudi Arabia

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### ABSTRACT

**الأهداف:** من أجل تحليل خبرتنا والنتائج من العلاج الجراحي لإصابة الكبد ولاقتراح الطرق التي تحسن من علاج مثل هؤلاء المرضى.

**الطريقة:** أجريت هذه الدراسة على المرضى الذين يعانون من إصابة في الكبد وتم إدخالهم مجمع الملك سعود الطبي - الرياض - المملكة العربية السعودية ما بين الفترة يناير 1997م حتى ديسمبر 2006م. شملت هذه الدراسة المرضى الذين خضعوا للعلاج الجراحي فقط.

**النتائج:** تمت معالجة 64 مريضاً من 138 مريضاً يعاني من إصابة في الكبد جراحياً. كان معظم المرضى من الشباب (متوسط العمر 29.4 عاماً)، الذكور 84%. تعرض 56 مريضاً لإصابة غير حادة. و8 مرضى تعرضوا لإصابة من الدرجة الأولى، و17 مريض من الدرجة الثانية، و21 مريض من الدرجة الثالثة، و12 مريض من الدرجة الرابعة، و6 مرضى من الدرجة الخامسة من إصابات الكبد. كانت خياطة الكبد التقنية الأكثر شيوعاً (عدد=28) يليها وضع كمادة قبل الكبد (عدد=12)، ثم القياسات المرقمية البسيطة (عدد=9) والاستئصال الكبدية غير التشريحية (عدد=8). لم تكن عملية شق البطن علاجية لدى 7 مرضى (11%). بلغت نسبة إصابة الكبد ذات الصلة بالحالة المرضية 19% والوفاة 11%.

**خاتمة:** كانت خياطة الكبد أكثر التقنيات الجراحية شيوعاً والتي تم توظيفها لتوقيف النزيف. تم استعمال وضع الكمادة قبل الكبد لدى المرضى غير المستقرين. في 25% من المرضى الذين يعانون من نزيف إما تعرضوا للتوقف من إصابة الكبد أو احتاجوا فقط إلى قياسات مرقمية بسيطة.

**Objectives:** To analyze our experience and the outcome of operative management of liver trauma, and to suggest ways to improve the management of such patients.

**Methods:** This retrospective study was conducted on patients admitted with liver trauma to King Saud Medical Complex, Riyadh, Kingdom of Saudi Arabia

between January 1997 and December 2006. Only patients who underwent operative management were included in this study.

**Results:** Sixty-four out of 138 patients with liver injury were treated surgically. Most of the patients were young (mean 29.4 years), and male (84%). Fifty-six patients sustained blunt trauma. Eight patients had grade I, 17 had grade II, 21 had grade III, 12 had grade IV, and 6 patients had grade V liver injuries. Hepatorrhaphy (n=28) was the most common surgical technique used followed by perihepatic packing (n=12), simple hemostatic measures (n=9), and non-anatomical hepatic resections (n=8). Laparotomy was non-therapeutic in 7 patients (11%). Liver injury related morbidity was 19%, and mortality was 11%.

**Conclusions:** Hepatorrhaphy was the most common surgical modality employed to control bleeding. Perihepatic packing was used in unstable patients. In 25% of patients, bleeding had either stopped from the injured liver or needed only simple hemostatic measures.

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Operative therapy has been the standard of care for liver injuries from the beginning of century until the early 1990's.<sup>1</sup> Management of liver trauma has changed dramatically during the past 2 decades.<sup>2</sup>

Non-operative management (NOM) has now become the standard of care in clinically stable patients. The majority of the recent studies have documented the low morbidity, and the mortality rates by NOM.<sup>3-10</sup> However, a significant number of patients having extensive liver trauma or other associated intra-abdominal injuries require the operative management (OM). Operative management of liver injuries remains a challenge for the general surgeons.<sup>8</sup> Optimal surgical procedure for these complicated trauma cases is still controversial. These procedures include, simple hemostatic measures, hepatorrhaphy, hepatotomy with direct suture ligation, resectional debridement, anatomical resection, perihepatic packing, atriocaval shunting, and even liver transplantation. The application of these surgical procedures depends on the type of injury, experience and the preference of the operating surgeon.<sup>11</sup> The aim of this study was to analyze our experience and the outcome of OM of liver trauma, with a view to suggest ways to improve the management of such patients.

**Methods.** This retrospective clinical study was carried out in the Department of General Surgery, King Saud Medical Complex (KSMC), Riyadh, Kingdom of Saudi Arabia over a period of 10 years from January 1997 to December 2006. The KSMC is a large general hospital in Riyadh city, accepting trauma patients. After the approval from Hospital Research and Ethical Committee, medical record of all patients with liver injury was retrieved. Only surgically treated patients were analyzed and included in this study. Clinical data regarding patient demographics, mechanism of injury, hemodynamic status on presentation, diagnostic modality, hepatic injury grade, associated intra-abdominal injuries, operative procedures, extra-abdominal injuries, number of blood transfusion, injury severity, hospital stay, outcome in terms of liver injury related morbidity and mortality and follow up were collected onto a Proforma. Based on operation record liver injuries were graded according to the Organ Injury Scale of the American Association for the Surgery of Trauma.<sup>12</sup> The Injury Severity Score (ISS) was also documented.<sup>13</sup> Patients of penetrating injuries with peritoneal breach were directly taken for surgical intervention. Blunt trauma patients with stable hemodynamics (systolic blood pressure, SBP >100 mm of Hg) on presentation or stabilized soon after initial fluid resuscitation were evaluated for abdominal injury by Computed Tomography Scan (CT scan). They were primarily selected for NOM for liver injury if there was no other indication for laparotomy. If hypotension developed during NOM (Failure of NOM) they were taken for surgical intervention. Diagnostic peritoneal lavage (DPL) was the main evaluation tool in those who

presented with hypotension (SBP<100 mm of Hg) and remained hypotensive even after fluid resuscitation. Only patients with liver injury found either after operation for positive DPL, peritonitis due to trauma, or failed NOM for liver trauma were included this study.

During the operation, one, or more surgical techniques were used to control the bleeding. We have grouped them into 5 categories, which include non-therapeutic, simple hemostatic measures, hepatorrhaphy, non-anatomical liver resection and Peri-hepatic packing. Intervention was considered non therapeutic when no active bleeding from liver injury was found. Superficial lacerations were managed by simple hemostatic measures such as diathermy, Argon beam coagulation, superficial bleeder ligation, or application of oxidized cellulose (Surgicel®). Bleeding from deep lacerations was control by hepatorrhaphy. Hepatorrhaphy was performed by applying deep horizontal mattress stitches with polyglycolic acid suture, number 1 (Vicryl, Ethicon®). Peripheral placed large lacerated segments were resected in non-anatomical fashion. Bleeding from multiple deep lacerations in hemodynamically unstable patients were controlled by perihepatic packing.

Liver related complications were defined as hemorrhage from liver, biloma, biliary fistula, hematemesis, and infected intra-abdominal collection requiring per-cutaneous or open drainage. Data was analyzed by using the Statistical Package for the Social Sciences (SPSS) version 12. Categorical data comparison was made by Fischer Exact test. Numerical (Continuous) variable comparison was made by student T- test. The *p*-value of <0.05 was considered as statistically significant.

**Results.** During the study period 138 patients were admitted with liver trauma, of which 64 patients were treated surgically. This study is based on the analysis of these operated patients (n=64). Majority of patients were young (Mean age 29.4 years), male (n=54). Fifty-six patients sustained blunt trauma. Forty-three patients had associated extra-abdominal injuries, thoracic trauma being the most common (34%). Indications for surgery were positive DPL (n=59), failed NOM (n=3) and peritonitis due to trauma (n=2).

The distribution of patients according to grade is shown in Table 1. Hepatorrhaphy was the most common, surgical procedure employed to control the bleeding. In 16 (25%) patients, 10 of them with isolated liver injury, bleeding from injured liver had either stopped or required simple hemostatic measures. Details of other procedures are outlined in Table 1. Twenty-nine patients had isolated liver injuries, while the rest (n=35) had other concomitant intra-abdominal injuries (Table 2). Injury Severity Score (ISS) and

hospital stay was significantly higher in patients who had associated intra-abdominal injuries compared to the patients with isolated liver trauma (Table 3). Closed system tube drain was employed in 16 (25%) patients. Peri-operative blood transfusion ranged from 2-27 units (median 8 units). The median ISS of these patients was 27 (range, 11-75).

Twelve (19%) patients developed complications. Two (3%) patients developed biliary fistulae. They were successfully managed by endoscopic retrograde cholangio pancreatography (ERCP), papillotomy, and drainage. Infected peri-hepatic collection (n=3) and liver abscess (n=1) were managed by CT guided percutaneous aspiration and broad-spectrum antibiotics. Three patients developed pulmonary complications. Wound infection in 3 patients was managed with antibiotics and dressing. Mortality rate was 11% (n=7). Three patients died of uncontrolled bleeding during the operation. Others died of multi organ failure (n=3) and pulmonary embolism (n=1). There was no death among patients with grade I and II liver injury. (Table 1). Grade V liver injuries had a significantly higher mortality

compared to grade I-IV ( $p=0.0144$ ). The mean ISS of the survived patients and expired patients was  $21.8\pm 2.4$  and  $47.6\pm 4.4$ . ( $p=0.0001$ ) Follow up of 55 patients (86%) was available (mean  $7.5\pm 2.8$  months, range 3 month-17 months). Only one patient developed incisional hernia.

**Discussion.** Major liver trauma is generally associated with significant morbidity and mortality.<sup>2</sup> Associated injuries, uncontrolled hemorrhage from the liver and subsequent septic complications contribute to its morbidity and mortality.<sup>14</sup> However, the mortality rate from liver trauma has fallen from 66% in World War I to 27% in World War II, to current levels of 10-15%. Better knowledge of liver anatomy, pathophysiology, enhanced resuscitation, better anesthesia, advancement in operative techniques, and intensive care, have all contributed to this improvement.<sup>8</sup> Furthermore, the widespread application of non-operative management has also reduced the rate of morbidity and mortality related to liver trauma and unnecessary surgical approaches.<sup>15</sup>

**Table 1** - Liver injury grade, surgical techniques, and mortality.

Injury grade	No active bleeding (n=7)	Simple hemostatic measures (n=9)	Hepatorrhaphy (n=28)	Non-anatomical liver resection (n=8)	Packing (n=12)	Mortality (procedure) (n=7)
I (n=8)	07	01	-	-	-	-
II (n=17)		08	09	-	-	-
III (n=21)		-	16	04	01	01 (hepatorrhaphy)
IV (n=12)		-	03	02	07	03 (Packing)
V (n=6)		-	-	02	04	03 (Packing)
Total & Percentage (n=64,100%)	(11%)	(14%)	(43%)	(13%)	(19%)	(11%)

**Table 2** - Associated intra-abdominal injuries (n=35, 55%).

Intra-abdominal injuries	Number of Patients	Management
Splenic injuries	8	Splenectomy(6) Splenorhaphy(2)
Pelvic hematoma	7	Non operative
Longitudinal mesenteric tears	6	Ligation of bleeding vessels
Small bowel perforation	4	Primary repair
Perinephric hematoma	3	Non-operative
Colon injuries	3	Primary repair
Pancreatic injury	2	Drainage
Diaphragmatic tear	1	Repair
Shattered kidney	1	Nephrectomy

**Table 3** - Comparison of patients with isolated liver injury and associated intra-abdominal injuries.

Characteristics	Patients with Isolated liver injury	Patients with associated intra-abdominal injuries	P-value
Number of patients	29	35	
Male:female ratio	3.8:1	7.7:1	0.251
Injury severity score	24.9±12.8	36.9±11.8	0.0002
Morbidity (n)	4	8	0.299
Mortality (n)	2	5	0.546
Hospital stay (days)	19.8±12.3	36.9±17.9	0.0004

The recognition of this fact that 50-80% of liver injuries stop bleeding spontaneously, with better imaging of the injured liver by CT scan has led to the acceptance of non-operative management of liver trauma.<sup>16,17</sup> Recent studies suggest that 71-89% of all the patients with blunt liver trauma are treated non-surgically, with a success rate of 85-94%.<sup>1,3-10</sup> Despite this current trend, a significant number of patients still require surgical intervention because of ongoing hemorrhage or associated intra-abdominal injuries.<sup>8</sup> In the present study, 46% of liver trauma patients underwent OM, a higher rate of surgical intervention than many recent studies.<sup>6-10</sup> In 16 patients (25%), bleeding from the injured liver had either already stopped or required simple hemostatic measures at the time of surgery. Moreover, 10 of them had isolated liver injuries. We believe that the number of laparotomies in this subset of patients could have been minimized by more resuscitation to stabilize them. This would have allowed evaluation by CT scan. Patients with minor liver injuries are less likely to undergo OM after CT scan. The other reason, we believe, for the higher rate of surgical intervention in our patients was the non-availability of an expert ultra sonologist in the emergency room for most of the study. In a hypotensive trauma patient, the ultrasound assessment can reasonably exclude major solid organ injury in the abdomen and thus avoid DPL. Most hypotensive patients in this study had assessment by DPL, which can be positive in presence of minor solid organ injury.

There are a variety of manoeuvres to stop bleeding ranging from diathermy, fibrin glue, hepatorrhaphy to resection. Diathermy, argon beam and oxidized cellulose (Surgicel®) were used as the main procedure to control bleeding in some patients and as an adjunct to other procedures in others. Fibrin glue was not used during this study period. Hepatorrhaphy has gone out of favor, because of the risk of tissue necrosis, abscess formation, and sepsis. However, many surgeons still believe that it is a simple, quick, and useful operative modality in simple as well as complex liver injuries.<sup>18-21</sup> Sikhondze<sup>21</sup> used suturing in 34.2% of their patients, while Ahmad<sup>18</sup> used this technique in up to 50% of their patients. Hepatorrhaphy was the most common (43%) surgical technique used during this study. Only one hepatorrhaphy patient developed liver abscess. This was successfully managed by aspiration and antibiotics.

During the past decade, peri-hepatic packing has reestablished as an acceptable method of managing liver injuries. The incidence of packing of liver injuries varies from 5-36% in the literature.<sup>18,22,23</sup> Nicol<sup>22</sup> reported 17% of their patients had packing. Richardson<sup>3</sup> reported a significant decrease in the mortality from 52-34.5% in their patients after the use of packing

in major liver trauma. They attributed this decrease in mortality to earlier packing, which resulted in reduced average blood loss of 6.8 units compared to 15 units in their earlier series.<sup>24,25</sup> Peri-hepatic packing was applied in 12 patients (19%) in this study. High mortality (50%) among our peri-hepatic packing patients suggests that this particular modality had been used late and as a desperate manoeuvre in high grade liver trauma. Complex liver injuries are still associated with high mortality (>50%) despite improvements in resuscitation, surgical skill, anesthesia, and intensive care.<sup>8</sup> High grade liver injuries are usually associated with extra and intra-abdominal injuries because of high magnitude of trauma which adds to mortality.

Anatomical resection for liver trauma performed widely during the 1960s, has been a target of criticism because of its high mortality rate.<sup>26</sup> Currently anatomical resections are performed in 2-4% patients with liver trauma and have a mortality rate approaching 50% in most series.<sup>14,20</sup> Recent trends have been toward a minimal surgical procedure such as non-anatomical resection.<sup>27,28</sup> It is rapid and easier than anatomical resection, which can be performed by non-specialized hepatobiliary surgeons. Moreover, it reduces the risk of postoperative sepsis, secondary hemorrhage and bile leakage, compared with anatomical resection.<sup>29,30</sup> Eight (13%) patients had non-anatomical liver resection in this study without any mortality. Two of them developed peri-hepatic collection, which was managed by per-cutaneous aspiration and antibiotics.

Drain or not to drain in minor liver injuries is a debatable issue. In a prospective randomized study, Mullens<sup>31</sup> has found liver related septic complication rate of 8% for both the drainage and no drainage group. A tube drain was used in 16 (25%) patients in this study. We did not find increased septic complication due to drain tube. However, there is now a growing consensus that drainage is not necessary for mild injuries, if there is no bleeding or bile leak.<sup>31,32</sup>

Twelve of our patients (19%) developed complications. Two patients (3%) developed biliary fistulae. The reported incidence of biliary fistulae is 2-8%.<sup>30,33,34</sup> Tsugawa<sup>2</sup> reported 17.2% of his patients developing biliary fistulae after anatomical resection for severe blunt liver trauma. Three (5%) patients in this series developed infected peri-hepatic collection. The reported incidence of this complication is between 7-12%.<sup>30,34,35</sup> However, this incidence increases up to 44% after packing of major liver injuries.<sup>22</sup> Mortality related to liver injuries was 11% in this series. This was directly related to the grade of liver injury and the presence of coexisting injuries. This finding is similar to the other series.<sup>11,18-22</sup>

In conclusion, hepatorrhaphy was the most common surgical modality employed with an acceptable complication rate. Peri-hepatic packing was used as a damage control procedure in unstable patients with extensive liver trauma. Mortality was high among these patients. Bleeding from the injured liver had either already stopped or required simple hemostatic measures at the time of surgery in 25% of our patients. We feel that there is a scope for minimizing the number of laparotomies in this subset of patients. Mortality in liver trauma is directly related to the severity of liver injury and ISS.

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