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IDENTIFYING PREDICTORS FOR SURGICAL INTERVENTION AND DAMAGE CONTROL PROCEDURES IN MANAGEMENT OF LIVER INJURIES.

Medical Science

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ABSTRACT

Background: The advancement in the management of liver injuries, including the use of non-operative management (NOM), damage control surgery (DCS) has resulted, in improvement of outcomes. This study are to review the outcome of liver injury management and identify the predictors for the need of operation and DCS . **Methods:** This retrospective study include 100 patients for 24 month – 1st Nov 2022 to 31st Oct. 2024 , from the surgery department of Darbhanga Medical college and Hospital , Darbhanga, Bihar. . Data collection included demographic, data, emergency department parameters, detail of liver injuries, and outcome in terms of mortality rate (MR). Stepwise logistic regression was performed to identify mutually independent predictors for the need of OM and DCS. **Results:** One hundred patients with liver injury were identified (72 blunt and 28 penetrating). Sixty Five patients (65.0%) underwent OM due to hemodynamic instability, (40), peritonitis (10), and other indications (18). DCS (perihepatic packing and temporary abdominal closure) was utilised in 17 patients. NOM was attempted in 35 patients (35.0%), 4 of these, subsequently required laparotomy . Overall MR was 5.0%, the MR was significantly higher in OM than in NOM (6.0% vs. 2.9% ; $p < 0.001$). The mutually independent predictors for the need of operation were low Glasgow Coma Score (GCS), penetrating mechanism, tachycardia, and hypotension; while the independent predictors for DCS were high grade (>4) liver injury, tachycardia, and blunt mechanism. **Conclusion:** Overall MR of liver injury patients was 5.0%. NOM carried a low MR and should be, attempted in the absence of hemodynamic instability and peritonitis. Patients with low GCS, penetrating injury, tachycardia, and hypotension were more likely to require operation. DCS should be considered while operating on patients with high grade liver injury, tachycardia, and blunt mechanism.

KEYWORDS

INTRODUCTION

Liver injuries can occur due to both blunt and penetrating trauma, and their management is a critical aspect of trauma care. The liver is highly vascular and capable of considerable bleeding when injured, which can lead to life-threatening hemorrhage.

During the past 40 years, the management of liver injuries has evolved significantly due to the development of angiographic embolisation (AE) and non-operative management (NOM)(1)(2).This has resulted in less operative interventions required in managing liver injuries, especially blunt liver injury patients in which NOM could be performed in 50–80% of the patients and carries successful rate of 88–98% (1)(2). Furthermore, the acceptance of damage control surgery (DCS) techniques has also improved the outcomes of the patients with complex liver injury requiring operation (3).

Furthermore, the acceptance of damage control surgery (DCS) techniques has also improved the outcomes of the patients with complex liver injury requiring operation (3)(4). Recently, the reported mortality rates of liver injury patients ranged from 5 to 52% (1,2,5–7)(8), the higher mortality rates are from the series with more severe liver injuries and higher operative rates (6,7)(9). The objectives of this study are to review the outcome of liver injury management and identify the predictors for the need of operation and DCS.

MATERIALS AND METHODS

Study Design: This retrospective study include patients for 24 month – 1st Nov 2022 to 31st Oct. 2024 , from the surgery department of Darbhanga Medical college and Hospital , Darbhanga, Bihar . This study was conducted after approval from the Ethical Committee of the Institute. Proper statistical analysis was done .

Inclusion Criteria :

1. All patients with blunt and penetrating injury to abdomen of age (between 10 to 80 yr) and any sex which involves liver injury of any grade.
2. Patients with associated non life threatening limb , spine , chest , and head injuries were included
3. Complete medical records and follow-up information

Exclusion Criteria

1. Patients below 10 yr & above 80 yr of age .
2. Patients with associated life threatening limb , spine , chest , and head injuries were excluded .

Methodology

The management of abdominal injury patients in our institution depends mainly on the patient's hemodynamic status, the presence of generalised peritonitis, and the mechanism of injury.

The patients with (1) persistent hypotension (systolic blood pressure <90 mmHg not responding to the initial fluid resuscitation) and/or (2) generalised peritonitis would immediately undergo operative management (OM).

In penetrating trauma, the additional indications for exploratory laparotomy were (1) stab wound (SW) with evisceration, gastrointestinal (GI) bleeding and hematuria and (2) all gunshot wounds (GSWs) through the abdomen other than an isolated GSW to the right upper quadrant. SW patients without indications for operation would undergo serial physical examination. Stable patients with an isolated GSW or SW to the right upper quadrant and stable blunt trauma patients would be considered candidates for NOM and would be sent for computed tomography scan (CT) of the abdomen. The patients with positive CT findings for pancreatic and/or hollow viscus injuries would also undergo OM, while all other patients with liver injury identifying on CT would be managed non-operatively. The diagnosis of liver injury in the present study was made based on either intra-operative findings or CT findings. The severity of liver injuries was graded by the American Association for the Surgery of Trauma-Organ Injury Scale .

NOM protocol in our institution consisted of continuous monitoring of vital signs, serial physical examination, and serial blood tests for hematocrit and amylase every 6 h. DCS was defined as an abbreviated operative intervention performed in liver injury patients including perihepatic packing and temporary abdominal closure. The decision to perform DCS in liver injury patients was made when other simpler maneuvers failed to control the bleeding and when the patient's

physiology became deranged (i.e., when hypothermia, acidosis, and coagulopathy occurred).

Data collection included demographics data, emergency department (ED) parameters (vital signs, trauma scores, hematocrit, and base deficit), detail of liver injuries, type of management, and outcomes in terms of blood component transfusion, complications, Intensive Care Unit (ICU) days, ventilator days, length of stay and mortality. Statistical analysis was done by the Window SPSS program version 17.0 with the statistical significance was set at $p < 0.05$. Univariate analysis was performed with the chi-squared test for comparison of categorical variables, and the Student's t test for comparison of continuous variables.

RESULTS

There were 100 patients with liver injury identified during 1st Nov 2022 to 31st Oct. 2024 (72 blunt and 28 penetrating). Eighty patients (80) were male and 20 were female, the mean age was 32.6 years. Thirty five (35) patients were candidates for NOM (35.0%, NOM group). In the OM group, there were 65 patients (65.0%) operated on initially due to hemodynamic instability (40); peritonitis (10); stab wound with evisceration, GI bleeding, and hematuria (8); gunshot wound through the abdomen (1); and positive CT scan for hollow viscus and/or pancreatic injuries (6).

The demographic data and the ED parameters were shown in Table 1.

Table:1. Demographic Data And Emergency Department (ed) Parameters

	Total (100)	NOM (n=35)	OM (n=65)	*p*-value
Sex				
Male	80 (80.0%)	30(85.7%)	50(76.9%)	0.086
Female	20 (20.0%)	5(14.3%)	15(23.1%)	
Age				
Mean	32.6	31.8	27.6	0.620
Mechanism				
Blunt	72 (72.0%)	28(80.0%)	44(67.7%)	0.018
Penetrating	28 (28.0%)	7(20.0%)	21(32.3%)	
ED Parameters (Mean)				
SBP	112.8	116.2	104.6	0.002
PR	97.6	92.4	102.8	0.003
GCS	11.8	13.9	10.4	0.001
ISS	22.5	15.8	28.0	0.002
RTS	7.8	8.86	6.4	0.019
TRISS	88.4	96.2	82.2	0.001
Hematocrit	34.2	38.0	30.4	0.003

ED: emergency department, SBP: systolic blood pressure, PR: pulse rate, ISS: Injury Severity Score, RTS: Revised Trauma Score, TRISS: Trauma and Injury Severity Score.

The diagnoses of liver injury were made intraoperatively in 60 patients undergoing immediate laparotomy and by CT scan in 40 patients. The details of liver injury were shown in Table 2. The associated intraabdominal injuries were also shown in Table 2. One patients in the NOM group were suspected to have right diaphragmatic injuries from CT finding (diaphragmatic irregularity) and were managed conservatively.

Table 2. The Details Of Liver Injuries

	Total(n=100)	NOM(n=35)	OM(n=65)	p-value
GRADEa				
I	08 (8.0%)	3 (8.6%)	5 (7.7%)	0.654
II	38 (38.0%)	10 (28.6%)	28 (43.1%)	
III	29 (29.0%)	15 (42.8%)	14 (21.6%)	
IV	14 (14.0%)	5 (14.3%)	9 (13.8%)	
V	11 (11.0%)	2 (5.7%)	9 (13.8%)	
ANATOMY				
Left	25(25.0%)	07(20.0%)	18(27.7%)	0.249
Right	63(63.0%)	25(71.4%)	38(58.5%)	
Combined	12(12.0%)	03(8.6%)	09(13.8%)	
Juxtahepatic	06(6.0%)	00(0)	06(9.2%)	
IVC involvement				
Associated Intraabdominal injuries	Diaphragm 14(14.0%) Kidney 9(9.0%) Spleen 10(10.0%) Pancreas 5(5.0%) Stomach 4(4.0%) Duodenum 4(4.0%) Small Bowel 3(3.0%) Colon 8(8.0%) Gall Bladder 3(3.0%) Urinary Bladder 1(1.0%) Abdominal vascular 3(3.0%)	Diaphragm 1(2.9%) Kidney 3(8.6%) Spleen 3(8.6%)	Diaphragm 12(18.5%) Kidney 6(9.2%) Spleen 9(13.8%) Pancreas 5(7.7%) Stomach 3(4.6%) Duodenum 4(6.2%) Small Bowel 3(4.6%) Colon 7(10.7%) Gall Bladder 3(4.6%) Urinary Bladder 1(1.5%) Abdominal vascular 3(4.6%)	0.005 0.027 0.003

Of the 35 patients in NOM group, 31 (88.6%) underwent successful NOM, while the other 4 patients (11.4%) required subsequent laparotomy due to delayed hemorrhage(3) and development of peritonitis on serial examination(1). Among the 3 patients with delayed hemorrhage, 2 had active bleeding from liver injuries and 1 had active bleeding from a kidney injury. One patients who developed peritonitis on serial examination received non therapeutic laparotomy (no hollow viscus/pancreatic injuries found). Six of 07 patients with severe liver injuries (grade 4 and 5) in the NOM group were successfully managed nonoperatively. NOM was also carried out successfully in 2 patients sustaining penetrating injuries (1 SWs and 1 GSWs to the right upper quadrant). Only one patient died in the NOM group due to sudden cardiac arrest (mortality rate 2.3%).

In the OM group, the patients had significantly higher penetrating mechanism, pulse rate, Injury Severity Score (ISS); and significantly lower systolic blood pressure, Glasgow Coma Score (GCS), Revised Trauma Score (RTS), Trauma and Injury Severity Score (TRISS), hematocrit p;than in the NOM group (Table 1). As shown in Table 3, the OM group patients also requires more blood product transfusions; had longer ICU days than the NOM group . The overall mortality rate was 5.0%, the mortality rate was significantly higher in the OM group than in the NOM group (6.0% vs. 2.9%, $p < 0.001$).

DCS (perihepatic packing and temporary abdominal closure) was utilised in 17 patients in the OM group. 2 patients died (multi organ failure in 1 and severe head injury in 1) before packing removal and abdominal closure could be achieved, while 15 patients survived to receive packing removal and abdominal closure. Abdominal closure techniques used in the present study included absorbable mesh closure in 11 , delayed primary fascial closure in 1, and component separation in 3 . Two patients suffered multiple organ failure and subsequently deceased after receiving abdominal closure, resulting in the mortality rate of 23.5% in the DCS patients.

Table 3 : Outcomes Of Liver Injury Patients.

	Total (n=100)	NOM (n= 35)	OM (n=65)	p-value
Blood transfusion				
PRC	20	09	11	<0.001
FFP	06	02	04	<0.001
Platelets	03	00	03	<0.001
Complications				
Liver related Other	14(14.0%) 15(15.0%)	3(8.6%) 4(11.4%)	11(16.9%) 11(16.9%)	
ICU Days (Median IQR)	0 (0-4)	0(0)	1 (0-5)	<0.001
Length of Stays (Median IQR)	10(6-21)	11(8-16)	9.5(4-24)	
Mortality	05(5.0%)	01(2.9%)	04(6.2%)	<0.001

PRC: Packed Red blood Cells, FFP: Fresh Frozen Plasma, ICU: Intensive Care Unit, LOS: Length of stay, IQR: interquartile range .

Table 4. Mutually independent predictors of the need for operation.

Step	Variable	Adjusted OR (95% CI)	p-value
1	GCS<13	42.46 (5.7-314.2)	<0.001
2	Penetrating mechanism	9.06 (3.1-26.2) 2.95	<0.001
3	PR ≥ 100	(1.6-5.74)	<0.001
4	SBP ≤ 90	4.72 (1.8-12.5)	0.022

The multivariable analysis demonstrated that the mutually independent predictors for the need of operative management were GCS < 13 (p < 0.001, OR 42.46), penetrating mechanism (p < 0.001, OR 9.06), tachycardia (p < 0.001, OR 2.95) and hypotension (p = 0.022, OR 4.72)(Table 4). The univariable analysis showed that the patients who needed DCS had more blunt mechanism, lower systolic blood pressure, higher pulse rate, higher ISS, lower TRISS, and higher numbers of severe liver injuries (grade 4) than those who did not undergo DCS (Table 5). The mutually independent predictors for DCS demonstrated by a multivariable analysis were high grade (4) liver injury (p < 0.001, OR 6.92), tachycardia (p = 0.014, OR 3.92), and blunt mechanism (p = 0.037, OR 6.38) as shown in Table 6.

Table 5. Univariate Analysis Of Factors Associated With The Need Of DCS.

	OM group (n= 65)	No DCS (n= 48)	DCS (n= 17)	p-value
Sex				
Male	50(76.9%)	38(79.2%)	12(70.6%)	0.494
Female	15(23.1%)	10(20.8%)	5(29.4%)	
Age (Mean)	27.6	27.2	31.6	0.689
Mechanism				
Blunt	44(67.7%)	30(62.5%)	14(82.4%)	<0.001
Penetrating	21(32.3%)	18(37.5%)	3(17.6%)	
ED Parameters (Mean)				
SBP	104.6	108.2	96.4	0.038 0.027
PR	102.8	96.4 11.8	110.2	0.080
GCS	10.4	24.6 6.9	10.2	<0.001
ISS	28.0 6.4	86.4	36.6	
RTS	82.2	31.8	5.8	
TRISS	30.4		75.4	
Hematocrit			29.6	
Grade ≥ 4	18(27.7%)	08(16.7%)	10(58.8%)	<0.001

Table 6. Mutually Independent Predictors Of The Need For DCS.

Step	Variable	Adjusted OR (95% CI)	P-value
1	Grade ≥ 4	6.92 (3.2-15.1)	<0.001
2	PR ≥ 100	3.92 (17-19.2)	0.014
3	Blunt mechanism	6.38 (2.5-16.3)	0.037

DISCUSSION

The increase in evidences has resulted in the increased use of NOM in liver injuries, especially in blunt trauma which yielded high success rates (88–98%)(1,2,5,10). The application of NOM has also been expanded to penetrating abdominal trauma, in which NOM could be performed in 33% of penetrating liver injury patients with a success rate of 86% in one series. CT scan of the abdomen is crucial when considering NOM in liver injury patients, since it helps grade the liver injuries and identify associated intraabdominal organ injuries (11). In the present study, the patients were considered candidates for NOM when they were hemodynamically stable and had no peritonitis nor other indications for surgery. With both penetrating (28.0%) and blunt (72.0%) mechanisms in our series, NOM could be carried out in 35.0% of the liver injury patients . The low NOM rate in the present study may be explained by a higher proportion of the hemodynamically unstable patients in our series (44% overall and 44% in blunt injury) since significant proportion of the patients (36%) had been referred from other hospitals to our institution due to the high severity of injuries. The severe liver injury (grade 4 and 5) per se is not considered a contraindication for NOM as demonstrated in the present study (success rate of NOM was 91.7% in severe liver injury patients) and in the previous reports(12). The success rate of NOM in this study was 88.6%, which is comparable with other studies.

Several studies have proposed the factors associated with the need for operation and failure of NOM including increasing age, male sex, hypotension, low GCS, high ISS, low TRISS, low initial platelet count, high fluid requirement, and concomitant abdominal trauma (5). In the present study, the authors identified low GCS, penetrating mechanism, tachycardia, and hypotension as mutually independent predictors for the need of operation. These parameters are in agreement with the previous studies.

Since the introduction of Damage Control in the early 1980s, it has been generally accepted that patients with severe injury and physiologic derangements (i.e. ,hypothermia, acidosis, coagulopathy) are likely to benefit from DCS (11). As mentioned before, the decision to perform DCS in our institution was made intraoperatively when other simpler maneuvers failed to control the bleeding and when the patient's physiology became deranged. In the present study, the mutually independent predictors for DCS were high grade (≥4) liver injury, tachycardia, and blunt mechanism. Although our blunt liver injury patients were less likely to require operation, when they did they tended to need more DCS (32 % of blunt injury patients) than in those with penetrating injury (14%). This may be explained by higher grade of liver injury in blunt injury patients than in penetrating injury patients in the OM group. Nevertheless, the lack of the intraoperative physiologic parameters (i.e., coagulogram, blood pH, and body temperature) and the retrospective nature of the present study making our analysis arguable and a prospective study should be performed on this subject, particularly in the liver injury patients, to clarify the issue.

CONCLUSION

The management of liver injuries requires a multidisciplinary approach, i.e. a combination of NOM, OM by surgeons. Since the NOM carries lower mortality rate, it should be attempted in hemodynamically stable patients without other indications for surgery. The patients with low GCS, penetrating mechanism, tachycardia and hypotension are more likely to undergo surgery; while those with high grade liver injury, tachycardia, and blunt mechanism are more likely to require DCS. When operating on the severe liver injury patients, the surgeons should be familiar with the concept and techniques of DCS in order to provide the best possible outcome.

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