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Original Research Article

Study of blunt trauma abdomen involving liver injuries based on grade of injury, management: a single centre study

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ABSTRACT

Background: Modern treatment of liver trauma is increasingly non-operative. Advantages of non-operative management include avoidance of non-therapeutic celiotomies and the associated cost and morbidity, fewer intra-abdominal complications compared to operative repair and reduced transfusion risks. It is associated with a low overall morbidity and mortality and does not result in increase in length of the hospital stay. The objectives was to study efficacy of non-operative management of blunt liver injury.
Methods: Seventy patients were studied, out of which 59 were initially given a trial of non-operative management and 11 patients were immediately shifted to the operating room. Of the 59 patients initially considered for non-operative management, 5 of them became unstable hemodynamically and were operated. Any complications arising in patients in non-operative group were managed with the help of interventional radiological procedures.
Results: Total 54 patients were managed successfully without operative intervention which included patients with higher grade of injuries. 11 patients were shifted to surgery on arrival as they did not respond to resuscitation measures. Mortality and morbidity were found to be higher in patients undergoing surgery. Also, number of transfusions required, ICU stay and total number of days in hospital were higher in operated group. High ISS, low BP at admission, higher grade of injury in this study were seen in patients who failed non-operative management.
Conclusions: Non-operative management is the initial management of choice in hemodynamically stable patients, irrespective of the grade of injury and is associated with less mortality and morbidity.

Keywords: Blunt liver injury, Efficacy, Grade of injury, Hemodynamic status

INTRODUCTION

The severity, nature and outcome of road crashes is determined by the impact of the crash, the amount of energy transferred to the host, physiological factors such as age, sex, fragility of body organs, presence of protective devices such as helmets, seat belts, child restraints, nature and speed of vehicle-impacting crash and availability, affordability and accessibility to health care. Rautji and Dogra in a study of 127 autopsy reports noticed that in a majority of cases, exsanguinations (31%) and brain injury (11%) were the major causes of early deaths, while sepsis and multi-organ failure contributed to late deaths (Rautji and Dogra, 2004). The average Injury Severity Score (ISS) for mortality was 37.8 in the series.[1] The abdomen is third most common injured region with surgery required in about 25% cases. Abdominal trauma is responsible for about 7.7% of all

deaths related to trauma. 85% of abdominal traumas are of blunt character. The spleen and liver are the most commonly injured abdominal organs as a result of blunt trauma. The liver is the largest solid abdominal organ with a relatively fixed position, which makes it prone to injury during blunt abdominal trauma.[2]

While small lacerations of the liver substance may be and no doubt are recovered from without operative interference: if the laceration is extensive and vessels of any magnitude are torn, haemorrhage will, owing to the structural arrangement of the liver, go on continuously.[3]

Operative therapy has been the standard of care for liver injuries from the beginning of the century until the early 1990s. The treatment of complex liver injuries remains a challenge for surgeons despite the last decade's advances in diagnostic and therapeutic techniques. This has been based on the dual rationale of haemostasis and bile drainage.[4]

The non-operative treatment for such injuries in hemodynamically stable patients with blunt abdominal trauma admitted with no signs of peritonitis is being progressively more utilized as the initial therapeutic approach in many designated trauma centres. The recognition that 50%-80% of liver injuries stop bleeding spontaneously coupled with better imaging of the injured liver by computed tomography (CT) has led progressively to the acceptance of Non-Operative (NOP) management with a resultant decrease in mortality rates.[5]

Modern treatment of liver trauma is increasingly non-operative. Advantages of non-operative management include avoidance of non-therapeutic celiotomies and the associated cost and morbidity, fewer intra-abdominal complications compared to operative repair and reduced transfusion risks. It is associated with a low overall morbidity and mortality and does not result in increase in length of the hospital stay, need for blood transfusions, and bleeding complications as compared with operative management. Improvement in resuscitation and careful monitoring in high dependency unit coupled with advances in diagnostic tools has helped to make a non-operative policy possible and acceptable.[6]

Present study was carried out to study efficacy of non-operative management of blunt liver injury depending only on the hemodynamic status and irrespective of the grade of injury.

METHODS

A prospective institutional based descriptive study was conducted including all age groups above 12 years of age hospitalized with blunt liver injury. According to previous study, the prevalence of liver injury in blunt abdominal trauma was 5%. Using the sample size formula, the sample size came out to be 76. The study was conducted in MediCiti hospitals, Hyderabad and patients admitted in the Departments of General Surgery and Surgical Gastroenterology from April 4, 2014 to April 31, 2016 were included in this study.

Three distinct groups were defined:

- NOM: Patients initially managed non-operatively,
- SNOM: Successful non-operatively Managed group,
- FNOM: Failure of non-operative Management,
- OM: Immediately operated group.

An informed consent was obtained from all the patients who have met the inclusion criteria and included in this study.

As soon as the patient was received in the emergency department with a history of blunt trauma abdomen, his/her vitals were recorded, Glasgow coma score 7 (GCS) recorded, Injury Severity Score (ISS) and Revised Trauma Score 8 (RTS) calculated and peripheral access was secured. Hemodynamically stable patients were observed and were initially considered for non-operative management.

Unstable patients with systolic blood pressure less than 90mmHg and tachycardia were given crystalloids and blood transfusions of ≥2000ml and their response were recorded.

During initial resuscitation, FAST was performed in the ER for the presence of hemoperitoneum. Unstable patients with FAST positive and who have not responded to resuscitation were shifted for emergency surgery and if isolated liver injury was detected intra-operatively, they were included in OM group.

Patients who were stable with or without resuscitation were shifted to radiology department for CT scanning to confirm the grade of liver injury and to exclude any other abdominal injuries. After excluding other abdominal injuries, they were included in NOM group.

Grading of liver injury was done based on AAST grading.[9]

Routine blood investigations were done for all the patients who included CBP, LFT, RFT, blood grouping and typing, coagulation profile, ABG/VBG, lactate and base excess.

The patients in NOM group were shifted to Intensive Care Unit and closely monitored. Continuous monitoring of vital signs was done. For those patients who were considered for conservative management, repeat Hb was done after 12 hours and 24 hours initially, if there was significant fall in Hb and SBP, they were given blood transfusions and observed. If the patients were stable after transfusions, they were continued with conservative management. However, few patients did not stabilize even after multiple transfusions for who repeat

ultrasonography or CECT were done which were suggestive of expanding hemoperitoneum. These patients underwent delayed surgery and were included in failure of non-operative management group.

Conservatively managed patients were continued in ICU and once they were fully stabilized, they were shifted to surgical wards. Excessive physical activity was restricted. For those patients who were treated conservatively and had developed complications, interventional techniques were tried. After adequate pain control and establishing enteral feeds, they were discharged after performing a repeat scan in required patients.

For operated patients in OM and FNOM groups, appropriate surgery was done to control bleeding, resect necrosed liver tissue and seal major biliary leaks. They were shifted to ICU post-operatively and closely monitored. If required, they were intubated and connected to mechanical ventilator. Serial CBP, RFT, LFT were done to assess the patient's condition. Blood transfusions were given as and when required. When there was a suspicion about persistent worsening of liver function or continuous fall in Hb repeat scans were done. If required they were re-operated.

Complications which were thought to be managed by radiological or endoscopic procedures were managed accordingly. Once they were stable, they were given oral diet and shifted to surgical wards. At the time of discharge repeat scan was done and they were discharged with the advice of regular follow up and restriction of strenuous activities.

Follow up of patients was done for up to 6 months post injury and during follow up LFT, CBP and USG were done as and when needed in required patients.

The criteria to include patients in hemodynamically stable group (conservatively managed group):

- Patient without tachycardia (heart rate <100 beats per minute) after resuscitation and analgesia,
- Systolic blood pressure of more than 90mmHg either at admission or after 2litres of crystalloid infusion,
- Absence of respiratory distress,
- Haemoglobin stabilized at ≥8.0gm/dl with or without transfusions.

The criteria to include patients in hemodynamically unstable group (surgically managed group):

- Patients with persistent tachycardia in spite of fluid resuscitation and analgesia,
- Persistent hypotension even after fluid resuscitation (2l crystalloid infusion),
- Haemoglobin with a continuous fall below 8.0 gm/dl even after blood transfusions.

Patients with presence of associated abdominal injuries like hollow viscous, small bowel mesentery, injury to the spleen, kidney, pancreas on CECT abdomen were excluded. Patients less than 12 years of age were not included in this study as this hospital does not deal with pediatric age group of patients.

Statistical analysis was performed by the SPSS program for Windows, version 17.0. Normally distributed continuous variables were compared using ANOVA. If the F-value was significant and variance was homogeneous, Tukeys multiple comparison test was used to assess the differences between the individual groups, otherwise, Tamhane's T2 test was used. The Kruskal Wallis test was used for those variables that were not normally distributed and further comparisons were done using Mann Whitney U test. Categorical variables were analysed using the chi square test. For all statistical tests, a p value less than 0.05 was taken to indicate a significant difference.

RESULTS

Highest number of injuries was reported as a result of RTA (Road Traffic Accident) in all the three groups with 68.6% in SNOM, 80% in FNOM and 81.8% in OM groups, followed by accidental or intentional fall from heights (Table 1).

Time period elapsed from the point of injury to admission varied between minimum of 1 hour to a maximum of 30 hours. This was statistically significant with $p<0.05$. Author have seen a high rate of failure of non-operative management in patients with a delayed presentation to the hospital in this study (Table 2).

Grade I of liver injury was seen in 14 (25.9%) of SNOM patients, whereas it was 0% in FNOM and OM groups. II grade of liver injury was seen in 14 (25.9%) of SNOM patients, whereas it was 0% in FNOM and OM groups. Grade III of liver injury was seen in 13 (24.1%) of SNOM group, 2 (40%) of FNOM group and 3 (27.3%) of OM group.Grade IV liver injury was seen in 13 (24.1%) of SNOM group, 2 (40%) of FNOM group and 6 (54.5%) of OM group. Grade V liver injury was found in 0% of SNOM group 1 (20%) of FNOM group and 2 (18.2%) of OM group. P-value for liver injury grades was not significant statistically with $p=0.075$ for grade I, $p=0.075$ for grade II, $p=0.732$ for grade III, $p=0.117$ for grade IV and $p=0.065$ in grade V (Table 3).

Total number of blood transfusions required in SNOM group was 0.69±1.11 in FNOM it was 5.40±1.34 and in OM it was 8.64±2.25. P-value for total blood transfusions was significant statistically with $p<0.001$ in both SNOM vs. FNOM and NOM vs. OM. Duration of ICU stay in SNOM group was 3.43±1.80 in FNOM group was 4.80±0.84 and in OM group it was 8.82±2.36. Statistically significant p value was obtained ($p<0.05$) when ICU stay was compared among SNOM vs. FNOM

and NOM vs. OM groups. Surgical ward stay in SNOM patients was 5.20±2.20 in FNOM group it was 12.40±1.82 and in OM group it was 11.64±2.25. For ward stay, p value was significant in SNOM vs. FNOM and NOM vs. OM groups. Total number of days spent in the hospital was 8.63±3.89 in SNOM group, 17.20±2.59 in FNOM group and 20.45±3.39 in OM group. P value was significant in SNOM vs. FNOM and NOM vs. OM groups (p<0.001) (Table 4).

Table 1: Comparison between the groups as per mechanism of injury.

Mode of injury	SNOM	FNOM	OM	P value
	Frequency (%)	Frequency (%)	Frequency (%)	
Assault	0 (0.0%)	0 (0.0%)	1 (9.1%)	0.248
Fall	15 (27.8%)	1 (20.0%)	1 (9.1%)	
Hit by rod	2 (3.7%)	0 (0.0%)	0 (0.0%)	
RTA	37 (68.6%)	4 (80.0%)	9 (81.8%)	
Total	54 (100%)	5 (100%)	11 (100%)	

Table 2: Comparison between the groups as per admission time.

		SNOM	FNOM	OM	P Value	SNOM v/s FNOM	NOM v/s OM
Admission time (hrs)	Mean±SD	4.80±4.32	9.40±11.61	2.82±1.60	0.046	0.109	0.148
	Median	4.00	5.00	3.00			
	Min-Max	1-30	2-30	1-6			

Table 3: Comparison between the groups as per grading of liver injury.

Grade of liver injury	SNOM	FNOM	OM	p value
	Frequency (%)	Frequency (%)	Frequency (%)	
I	14 (25.9%)	0 (0.0%)	0 (0.0%)	0.075
II	14 (25.9%)	0 (0.0%)	0 (0.0%)	0.075
III	13 (24.1%)	2 (40%)	3 (27.3%)	0.732
IV	13 (24.1%)	2 (40%)	6 (54.5%)	0.117
V	0 (0.0%)	1 (20.0%)	2 (18.2%)	0.065
Total	54 (100%)	5 (100%)	11 (100%)	

Table 4: Comparison between the groups as per outcomes in SNOM, FNOM and OM groups.

Parameters	SNOM			FNOM			OM			P value	SNOM vs FNOM	NOM vs OM
	Mean ±SD	Median	Min-Max	Mean ±SD	Median	Min-Max	Mean ±SD	Median	Min-Max			
No. of transfusions required	0.69 ±1.11	0.00	0-4	5.40 ±1.34	6.00	4-7	8.64 ±2.25	8.00	6-12	<0.001	<0.001	<0.001
Duration of ICU stay	3.43 ±1.80	3.00	1-8	4.80 ±0.84	5.00	4-6	8.82 ±2.36	8.00	6-13	<0.001	0.045	<0.001
Ward stay	5.20 ±2.20	4.00	2-11	12.40 ±1.82	12.00	10-15	11.64 ±2.25	11.00	9-17	<0.001	<0.001	<0.001
Total hospital stays	8.63 ±3.89	7.00	4-18	17.20 ±2.59	17.00	14-21	20.45 ±3.39	20.00	15-25	<0.001	<0.001	<0.001

No complications were seen in 40 (74.1%) of SNOM group, 2 (40.0%) of FNOM group and 3 (27.3%) of OM group with statistically significant p value of 0.006. 3 (5.6%) of SNOM patients, 0% of FNOM patients and 1 (9.1%) of OM patients developed liver abscess during the hospital stay which was insignificant statistically (p=0.764). Biliary fistula was seen in 1 (9.1%) of OM group, 1 (20.0%) of FNOM group and 0% of SNOM group patients which was statistically significant with

p=0.015. Bile leak was a complication in 5 (9.3%) of SNOM patients, 1 (20.0%) of FNOM patients and 1 (9.1%) of OM patients with p=0.741 which was insignificant. Biloma had occurred in 4 (7.4%) of SNOM patients, 0% of FNOM and OM patients with no significance (p=0.533). Bleeding was a complication in 3 (27.3%) of OM group and none of the patients in SNOM and FNOM group had bleeding which was significant statistically with p<0.001. Hematoma was seen in 2 (3.7%) of SNOM patients and 0% of FNOM and OM group with no statistical significance (p=0.737). Liver necrosis was seen only in 1(20%) of FNOM group with significant p value (<0.001). Septic shock with MODS was seen in 2 (18.2%) of OM patients with p<0.004 which was significant (Table 5).

Table 5: Comparison between the groups as per liver related complications.

Liver related complications	SNOM	FNOM	OM	P value
	Frequency (%)	Frequency (%)	Frequency (%)	
Nil	40 (74.1%)	2 (40.0%)	3 (27.3%)	0.006
Liver abscess	3 (5.6%)	0 (0.0%)	1 (9.1%)	0.764
Biliary fistula	0 (0.0%)	1 (20.0%)	1 (9.1%)	0.015
Bile leak	5 (9.3%)	1 (20.0%)	1 (9.1%)	0.741
Biloma	4 (7.4%)	0 (0.0%)	0 (0.0%)	0.533
Bleeding	0 (0.0%)	0 (0.0%)	3 (27.3%)	<0.001
Hematoma	2 (3.7%)	0 (0.0%)	0 (0.0%)	0.737
Liver necrosis	0 (0.0%)	1 (20.0%)	0 (0.0%)	0.001
Septic shock with mods	0 (0.0%)	0 (0.0%)	2 (18.2%)	0.004
Total	54 (100%)	5 (100%)	11 (100%)	

Table 6: Comparison between the groups as per mortality.

Mortality (death)	SNOM	FNOM	OM	P value
	Frequency (%)	Frequency (%)	Frequency (%)	
No	54 (100%)	4 (80.0%)	8 (72.7%)	0.001
Yes	0 (0.0%)	1 (20.0%)	3 (27.3%)	
Total	54 (100%)	5 (100%)	11 (100%)	

Table 7: Comparison between the groups as per follow up complications.

Follow up complications	SNOM	FNOM	OM	P value
	Frequency (%)	Frequency (%)	Frequency (%)	
Nil	53 (98.1%)	4 (100%)	8 (100%)	0.860
Pseudo aneurysm	1 (1.9%)	0 (0.0%)	0 (0.0%)	
Total	54 (100%)	4 (100%)	8(100%)	

Mortality was seen in none of the SNOM group but 1 (20%) in FNOM and 3 (27.3%) in OM group died. P value for mortality was significant with p<0.001 (Table 6). No follow up complications were seen in 53 (98.1%) of SNOM group, 4 (100%) of FNOM group and 8 (100%) of OM group. Pseudo aneurysm was seen in one patient (1.9%) of SNOM group. There was no statistical significance when follow up complications were considered with p=0.860 (Table 7).

DISCUSSION

Grade I of liver injury was seen in 14 (25.9%) of SNOM patients, whereas it was 0% of FNOM patients. II grade of liver injury was seen in 14 (25.9%) of SNOM patients, whereas it was 0% of FNOM patients. Grade III of liver injury was seen in 13 (24.1%) of SNOM group, 2 (40%) of FNOM group. Grade IV liver injury was seen in 13 (24.1%) of SNOM group, 2 (40%) of FNOM group. Grade V liver injury was found in 0% of SNOM group 1 (20%) of FNOM group. There was no statistical significance of number of patients managed in SNOM and FNOM groups showing that even higher-grade injuries can be managed non-operatively. Similar results were seen in several previous studies.[10,11]

No complications were seen in 40 (74.1%) of SNOM group, 2 (40.0%) of FNOM group and p=0.006 which was significant. A total of 14 patients developed complications in SNOM group out of which 3 (5.6%) had

liver abscess, 5 (9.3%) had peripheral bile leaks, 4 (7.4%) had biloma and 2 (3.7%) had hematomas. In FNOM group, 3 patients had complications- 1 (20.0%) had biliary fistula, 1 (20.0%) had bile leak and 1 (20.0%) had liver necrosis. Even though individual p values were insignificant, the patients in whom there were no complications was significantly different which implies that a smaller number of complications are seen in SNOM group. This result was consistent with the result of Hommes M et al.[11]

None of the patients managed non-operatively died in this study, whereas 1 (20.0%) patient in FNOM died as a result of liver necrosis. P value was significant when mortality was compared (<0.001). Mortality among SNOM and FNOM was significant also in a study by Norman G et al.[12]

Follow up complications were seen in none of the FNOM group but one patient in SNOM of Grade IV developed pseudo aneurysm which was conservatively managed by angio-embolization and the patient was stable in next follow up visits. Follow up complications were not significant in this study.

Mild hemoperitoneum on USG was seen in 35 (59.3%) of NOM group, moderate amount of hemoperitoneum was detected in 11 (18.6%) of NOM group. All the OM patients had massive hemoperitoneum (100%) and 13 (22%) of NOM had massive hemoperitoneum. There was a significant difference in the amount of hemoperitoneum in NOM and OM groups. Similar results regarding amount of blood in peritoneum were observed by van der Wilden GM et al, in their study.[13]

Grade I liver injuries were seen in 14 (23.7%) of NOM group, grade II was seen in 14 (23.7%) of NOM group. Grade III was seen in 15 (25.4%) of NOM and 3 (27.3%) of OM group. Grade IV was seen in 15 (25.4%) of NOM and 6 (54.5%) of OM group. Grade V liver injury was seen in 1 (1.7%) of NOM group and 2 (18.2%) of OM group. Distribution of grades among NOM and OM was found to be insignificant. Total number of blood transfusions required in SNOM group was 0.69±1.11, in FNOM it was 5.40±1.34 and in OM it was 8.64±2.25. This was significant with p <0.001. Several studies have shown similar results with respect to total number of transfusions required.[11,12]

Duration of ICU stay in SNOM group was 3.43±1.80, in FNOM group was 4.80±0.84 and in OM group it was 8.82±2.36 which was significant. This result was similar to the result observed in a study by van der Wilden GM et al.[13]

Surgical ward stay in SNOM patients was 5.20±2.20, in FNOM group it was 12.40±1.82 and in OM group it was 11.64±2.25. This was statistically significant between NOM and OM groups with similar results observed in a study by Norrman G et al.[12]

Total number of days in the hospital was 8.63±3.89 in SNOM group, 17.20±2.59 in FNOM group and 20.45±3.39 in OM group. This was also significant. This was in consistence with results obtained by Velmahos GC et al, in their study.[10]

No liver related complications were seen in 42 (71.2%) of NOM group whereas 3 (27.3%) in OM group had no complications. Liver abscess was seen in 3 (5.1%) of NOM group and 1 (9.1%) of OM group. Biliary fistula was seen in 1 (1.7%) of NOM group and 1 (9.1%) of OM group. Bile leak was seen in 6 (10.2%) of NOM group and 1 (9.1%) of OM group. Biloma was seen in 4 (6.8%) of NOM group and none of OM patients. Bleeding was seen in 3 (27.3%) of OM group. Hematoma was seen in 2 (3.4%) of NOM group. Necrosis of a segment of liver was seen in 1 (1.7%) of NOM group. Shock due to sepsis was seen in 2 (18.2%) of OM group. Overall 17 (28.9%) of NOM and 8 (72.7%) of OM patients developed complications with significant p value. Complications related to liver showed significant p values in studies by Zago TM et al, and by van der Wilden GM et al.[13,14]

Mortality in NOM group was 1.7% (1 patient) and in OM group it was 27.3% (3 patients) which was significant. Studies by many authors have shown similar results.[11,13,14]

Follow up complications among survivors were seen in 1 (1.7%) of NOM group and none of the survivors of OM group. This was however insignificant statistically.

CONCLUSION

It is the hemodynamic status at admission and after adequate resuscitation which was the major criteria in deciding the plan of management. Grade of liver injury was not the deciding factor for the plan of management as authors were able to manage higher grade of liver injuries also successfully non-operatively. Outcomes like total number of blood transfusions required, duration of ICU stay, ward stay, total hospital stay and liver related complications were less in successful non-operative group compared to failed non-operative and operative groups which was statistically significant. Failure group had significantly higher ISS, lower BP, higher liver enzyme levels, more requirements of crystalloid and blood transfusions at admission. These could be considered predictors of failure as per this study.

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