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ORIGINAL ARTICLE

Non-operative management of blunt liver trauma: feasible and safe also in centres with a low trauma incidence

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Abstract

Background and Aims: Non-operative management (NOM) of blunt liver trauma is currently, if possible, the preferred treatment of choice. The present study evaluates the experience of blunt liver injury in adults in a Swedish university hospital.

Material and Methods: Forty-six patients with blunt liver trauma were treated from January 1994 through to December 2004. Patient charts were reviewed retrospectively to examine injury severity score (ISS), liver injury grade, diagnostics, treatment and outcome.

Results: Thirty-five patients (76%) were initially treated non-operatively and 11 (24%) patients had immediate surgery. In four (11%) patients, NOM failed and the patients required surgery 8–72 h after admission. Patients failing non-operative care had a significantly lower systolic blood pressure on admission as compared with patients with successful NOM ($P = 0.001$). Patients immediately operated upon had higher ISS ($P < 0.001$) and were haemodynamically unstable to a greater extent ($P < 0.001$) as compared with patients initially considered for NOM. Operated patients had increased transfusion requirements ($P < 0.001$), longer total hospital stay ($P = 0.011$) and stay in the intensive care unit (ICU) unit ($P < 0.001$) as compared with NOM. One immediately operated and one failed NOM died (total mortality 4%). Seventeen patients in the NOM group were successfully treated without surgery despite the presence of at least one described risk factor.

Conclusions: Most patients with blunt liver trauma can be treated without surgery, and non-operative management may be performed even in the presence of established risk factors.

Keywords

blunt liver trauma, injury severity score, non-operative management, outcome, treatment failure

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Introduction

During the past decades, there has been an overall trend from operative towards conservative treatment in the management of liver trauma.[1–7] Older studies have shown that almost half of the liver injuries actually had ceased to bleed at the time of operation.[5] Furthermore, 'non-therapeutic' surgery is associated with significant morbidity.[1] The introduction and enhancement of the computed tomography (CT) scan has facilitated and improved selection and management of patients treated non-operatively.[5] Non-operative management (NOM) has today become the first treatment of choice when possible in patients with blunt liver trauma.

NOM should only be considered in haemodynamically stable patients lacking signs of other laparotomy-demanding injuries. In the case of surgical intervention, less extensive surgical procedures have to a large extent replaced previous interventions such as formal liver resections.[7] Selective embolization has proven to be a useful complement to surgery in some cases.[8]

Treatment of patients with extensive liver injuries has been recommended to be reserved to specialized centres where liver surgery can readily be performed in case of 'failure' of NOM.[3,8,10] Alternatively, if NOM is failing in a small volume centre, damage control may be performed before referral to a specialized centre for further treatment.[4,7]

Despite the quite extensive amount of publications on NOM in liver trauma, only a minority of reports have originated from low-frequency trauma centres. Sweden is a country with a low incidence of abdominal trauma,[5] though with a tradition of non-operative treatment with a high success rate.[6] These results have led to attempts to also treat patients with more serious injuries without surgery.

The aims of the present study were to review and evaluate our experience of management of traumatic liver injury during a decade, to evaluate if NOM can be safely performed in a setting with low trauma frequency and to determine possible risk factors for failure of NOM.

Material and methods

Lund University Hospital is a partial referral centre for the south of Sweden, primarily serving 270 000 inhabitants and 1.7 million by referral. From January 1994 through to December 2004, 49 adult patients (age > 15 years) were treated at the department of surgery as a result of traumatic liver injury according to the coding registry (ICD-9 codes 864A and 864B, ICD-10 code S361). Penetrating trauma or delay of diagnosis exceeding 24 h were considered exclusion criteria.

All patient charts were reviewed concerning demographics, mechanism of injury, initial management, diagnostic tests, associated injuries, injury severity score (ISS), grade of liver injury, quantity of haemoperitoneum, treatment, blood products received, total length of stay (LOS), days in the intensive care unit (ICU), complications and mortality.

All patients with a first intention to treat conservatively according to the patient charts were classified as NOM. Cases where a laparatomy had to be performed later were considered failure of NOM (FNOM). When the initial decision could not safely be established from findings in the patient charts, FNOM was defined as a laparotomy performed more than 6 h after admission. CT scans were reviewed retrospectively and the liver injuries were graded according to the scale of the American Association for the Surgery of Trauma Organ Scaling Committee[11] (Table 1). In the case of surgery, grade was determined by reviewing operative findings. Haemoperitoneum was determined to be minimal[1] if blood was found near the liver, spleen or in Morrison's pouch, moderate[2] if found in the pericolic gutters and extensive[3] if associated blood was present in the pelvis, based on CT findings, according to what has been used by others.[9,12–15] ISS was calculated using the AIS-90 grading scale.[11]

Haemodynamically unstable patients or patients with obvious signs of peritonitis were immediately taken to the operating room (OR), in some cases preceded by diagnostic peritoneal lavage (DPL) or ultrasonography (US). Patients haemodynamically stable upon arrival, or stabilized after initial fluid resuscitation, underwent abdominal CT scan. Stable patients were observed in the ICU, emergency ward or regular surgical ward, depending on clinical condition and extent of liver injury on CT scan. Diet (enteral) and activity (mobilization) was advanced as soon as the clinical condition so permitted. During hospital stay or follow-up, repeated CT scans were not routinely performed, but rather depended on the attending surgeon judging clinical appearance and extent of injury.

Table 1 Liver injury scale (1994 revision) (10)

Grade[a]	Injury description	
I	Haematoma	Subcapsular, <10% surface area
	Laceration	Capsular tear, <1 cm parenchymal depth
II	Haematoma	Subcapsular, 10–50% surface area; intraparenchymal, <10 cm in diameter
	Laceration	1–3 cm parenchymal depth, <10 cm in length
III	Haematoma	Subcapsular, >50% surface area or expanding; Ruptured subcapsular or parenchymal haematoma
		Intraparenchymal haematoma >10 cm or expanding
	Laceration	>3 cm parenchymal depth.
IV	Laceration	Parenchymal disruption involving 25–75% of hepatic lobe or 1–3 Couinaud's segments within a single lobe.
V	Laceration	Parenchymal disruption involving >75% of hepatic lobeor >3 Couinaud's segments within a single lobe.
	Vascular	Juxtahepatic venous injuries; i.e. retrohepatic vena cava/central major hepatic veins.
VI	Vascular	Hepatic avulsion

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

Statistics

Data were analysed using SPSS for Windows version 11.5 (SPSS Inc., Chicago, IL, USA). Statistical comparisons of means and medians were made using the Mann–Whitney *U*-test. Comparisons of proportions were made using χ^2 analysis with Pearson's correlation coefficient or Fisher's exact test when appropriate. Grading correlations was performed using Spearman's rank correlation test. Data are expressed as mean ± SD unless otherwise stated. A value of $P < 0.05$ was considered significant.

Results

Forty-nine patients were treated for traumatic injury of the liver. After excluding one patient because of a diagnostic delay of more than 24 h and two patients because of penetrating trauma, 46 patients were included in the study. The characteristics of the patients are presented in Table 2. Twelve patients were treated during the first 5.5-year period (January 1994 to June 1999) and 34 patients during the last 5.5 years (July 1999 to December 2004), indicating an increasing incidence over time ($P < 0.001$).

Traffic accidents (20 patients; 43%), horse-related accidents (18 patients; 39%) and false in five patients (11%) were the most

Table 2 Comparing grades (AAST grade based on CT and OR findings)

	Grade I (n = 9)	Grade II (n = 21)	Grade III (n = 7)	Grade IV (n = 6)	Grade V (n = 3)	Correlation coefficient (r_s)
Treatment						
S-NOM	6 (67%)	15 (71%)	6 (86%)	4 (67%)	0	[a]
OM	3 (33%)	3 (14%)	1 (14%)	2 (33%)	2 (67%)	[a]
FNOM	0	3 (14%)	0	0	1 (33%)	[a]
Demographics						
Age	41 ± 24	33 ± 17	33 ± 17	26 ± 12	23 ± 12	NS
Male	2 (22%)	13 (62%)	1 (14%)	2 (33%)	0	[a]
Haemodynamics in the ER						
First sBT	122 ± 32	125 ± 26	122 ± 26	118 ± 22	90 ± 10	NS
Instability	1 (11%)	5 (24%)	1 (14%)	2 (33%)	2 (67%)	[a]
Extent of damage						
ISS	14 ± 11	14 ± 14	13 ± 3	25 ± 11	37 ± 7	0.4**
Haemoperitoneum[b]	0.5 (0–3)	1 (0–3)	3 (1–3)	3 (2.5–3)	3 (3–3)	0.4**
Hospital stay						
ICU days	1 ± 3	4 ± 7	3 ± 2	6 ± 5	6 ± 4	NS
SW days	9 ± 7	13 ± 13	19 ± 14	20 ± 6	43 ± 48	0.4**
Total LOS	10 ± 6	17 ± 19	23 ± 16	26 ± 10	49 ± 50	0.4**
Transfusion requirements						
Patients receiving B-Tx	4 (44%)	5 (24%)	3 (43%)	5 (83%)	3 (100%)	[a]
Blood Tx	1 ± 1	9 ± 19	8 ± 19	8 ± 9	41 ± 24	0.4*
Outcome						
Complications	0	8 (38%)	4 (57%)	4 (67%)	3 (100%)	[a]
Mortality	0	1 (5%)	0	0	1 (33%)	[a]

ER, emergency room; sBP, systolic blood-pressure; ISS, injury severity score; ICU, intensive care unit; SW, surgical ward; LOS, length of stay; Tx, transfusion requirements; B-Tx, blood transfusion requirements.
*Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).
***Correlation is significant at the 0.001 level (2-tailed). NS, not significant.
[a]Test could not be performed as the variable is in nominal scale.
[b]Numbers presented as mean ± SD, number of patients (% of total) or median (interquartile range).

common causes. Four-wheel motor vehicle injuries accounted for 24% of the total trauma incidence.

The distribution of haemoperitoneum on acute CT scan was: large (52%), moderate (2%), small (12%) and absent (33%). Median grade (on acute CT) was three with the following distribution: grade I (30%), grade II (50%), grade III (17%), grade IV (14%) and grade V (7%).

Thirty-six patients (78% of the total number of patients) had a total of 199 associated injuries, of which 100 were fractures. Abdominal injuries were seen in 30% of patients including splenic injury in 17% and intestinal injury in 9%.

Eleven (24%) patients had immediate surgery. Liver resection was performed twice, packing was performed three times, local haemostasis was sufficient three times and in three cases no liver surgery was performed. Simultaneous splenectomy was performed six times. Thirty-five patients (76%) had initial non-operative treatment. Of these, four patients failed the NOM and required delayed surgery, giving a failure rate of 11%. Reasons for failure were continuous bleeding in two cases (transfusion requirements of 17 and 5 units prior to surgery, operation being performed 12 and 8 h after admission, respectively), hollow viscous injury (HVI), initially missed on CT scan, in one case and bile leakage in one case. Perihepatic packing was performed in both cases with continuous bleeding, cholecystectomy was performed in the bile leakage case and no liver associated surgery was executed in the case of missed HVI.

Continued bleeding occurred five times (14%). Three cases were treated successfully with continued 'active' expectance alone; in one of these a liquefied haematoma was punctured later on. Surgery was performed in two cases (FNOM).

SNOM versus FNOM

Differences between successful non-operative management (SNOM), failure of non-operative management (FNOM) and immediate operative management (OM) are presented in Table 3.

Table 3 SNOM versus FNOM versus OM: demographics, severity of injury, treatment and outcome

	SNOM (n = 31)	FNOM (n = 4)	OM (n = 11)	Total (n = 46)
Patient factors				
Age	35 ± 21	24 ± 9	31 ± 17	33 ± 19
Male	12 (39%)	1 (25%)	5 (46%)	18 (39%)
Haemodynamics in the ER				
Admission sBP[a,c,d,e]	134 ± 19	99 ± 16	93 ± 21	120 ± 27
Instability[b,c,d,e]	1 (3%)	1 (25%)	9 (82%)	11 (24%)
Investigations				
Acute CT performed[c,d,e]	31 (100%)	4 (100%)	7 (64%)	42 (91%)
Findings on acute CT-scan				
Grade no.	2 (2–3)	2.5 (0.5–3)	1.5 (0–4)	2 (2–3)
≥Grade III	10 (32%)	2 (50%)	4 (57%)	16 (38%)
Amount HP[‡]	1 (0–3)	3 (3–3)	3 (1.75)	3 (0–3)
Large HP[a]	14 (45%)	4 (100%)	4 (57%)	22 (52%)
Extent of damage				
Associated injuries[c,d]	22 (71%)	3 (75%)	11 (100%)	36 (78%)
Interventions*[c,d,e]	6 (19%)	2 (50%)	8 (73%)	16 (35%)
Abdominal injuries[b,c,d,e]	3 (10%)	1 (25%)	10 (91%)	14 (30%)
ISS[b,c,d,e]	12 ± 9	14 ± 14	32 ± 13	17 ± 13
ISS > 15[b,c,d,e]	6 (19%)	1 (25%)	10 (91%)	17 (37%)
Hospital stay				
ICU days[c,d,e]	2 ± 4	4 ± 2	8 ± 7	4 ± 5
SW days[c,d]	12 ± 9	14 ± 11	29 ± 27	16 ± 17
Total LOS[c,d,e]	14 ± 12	17 ± 11	38 ± 31	20 ± 20
Transfusion requirements				
Patients receiving Tx[c,d,e]	8 (26%)	2 (50%)	10 (91%)	20 (43%)
Blood Tx[c,d,e]	1 ± 2	20 ± 30	28 ± 24	9 ± 18
Outcome				
Complications[c,e]	9 (29%)	3 (75%)	7 (64%)	19 (41%)
Interventions*[c,e]	3 (10%)	3 (75%)	5 (46%)	11 (24%)
Mortality[a,e]	0 (0%)	1 (25%)	1 (9%)	2 (4%)

ER, emergency room; sBP, systolic blood pressure; HP, haemoperitoneum; ISS, injury severity score; ICU, intensive care unit; SW, surgical ward; LOS, length of stay; Tx, transfusion requirements.
[a]Significant SNOM vs. FNOM, $P < 0.05$.
[b]Significant FNOM vs. OM.
[c]Significant SNOM vs. OM $P < 0.05$.
[d]Significant NOM vs. OM $P < 0.05$.
[e]Significant SNOM vs. FNOM + OM $P < 0.05$.
*Associated injuries/complications demanding some kind of intervention.
[‡]Numbers presented as mean ± SD, number of patients (% of total) or median (interquartile range).

In patients where surgery had to be performed (FNOM) later, the systolic blood pressure at admission ($P = 0.005$), the proportion of patients with a large haemoperitoneum ($P = 0.039$) and mortality ($P = 0.005$) was higher, as compared with patients with 'successful' non-operative management (SNOM).

NOM versus OM

Comparing all patients initially selected for non-operative management to those immediately operated on, overall the NOM group was more stable in the emergency room ($P < 0.001$) and systolic blood pressure at admission was higher ($P < 0.001$). The NOM group had lower ISS ($P < 0.001$) and less patients had an ISS exceeding 15 ($P < 0.001$), associated injuries ($P = 0.045$), associated injuries demanding interventions ($P = 0.002$) and associated intra-abdominal injuries ($P < 0.001$). Correspondingly, NOM patients spent less total days in hospital ($P = 0.011$), as well as in the surgical ward ($P = 0.033$) and the ICU ($P < 0.001$), respectively. Patients immediately operated upon (OM) had greater transfusion requirements ($P < 0.001$) and a larger proportion received blood products ($P < 0.001$).

FNOM versus OM

Haemodynamic instability was more common among patients who were immediately operated on ($P = 0.039$). ISS was higher in the OM group ($P = 0.04$), a greater proportion had an ISS exceeding 15 ($P = 0.011$) and associated intra-abdominal injuries ($P < 0.001$). Outcome measures were comparable in the two groups. Patients that failed non-operative management (FNOM) spent less days in hospital, the surgical ward and the ICU, although differences did not reach statistical significance.

When stratifying patients according to grade, NOM dominated in low grade and OM was over-represented in high-grade injuries, as outlined in Table 2. When comparing high-grade injuries (Grades III-V) with low-grade (Grades I-II), there was no significant difference in treatment strategy (Table 4). ISS and quantity of haemoperitoneum correlated positively with grade of injury. Days in the surgical ward and total number of days in hospital also correlated positively with increasing grade of injury. Patients with high-grade injuries had higher ISS ($P = 0.003$), a larger degree of haemoperitoneum ($P = 0.013$), were more prone to develop complications ($P = 0.006$) and received more transfusions ($P = 0.012$) (Table 5).

Two (4%) patients in the study died. One patient, immediately operated on, died because of a major head injury. One patient, stabilized after initial resuscitation, was initially managed without surgery. CT showed a grade V liver injury and as a result of continuous bleeding she had a laparatomy with perihepatic packing performed 12 h after admission. Bleeding stopped after successful additional angiography and coiling. Relaparatomy was performed the day after because of abdominal distension but no signs of intra-abdominal bleeding were found. The patient died post-operatively as a result of deterioration and cardiovascular failure.

Imaging after discharge, CT or US, was accomplished in 26 patients. In-hospital imaging was not reviewed. In 20 patients no radiological follow-up was performed, of which none developed hepatic complications. None of the routinely performed CT scans or ultrasonographies showed any signs of complications.

Table 4 Low grade (AAST grade I and II, based on CT and OR findings) versus high grade (AAST grade III, IV and IV) injuries

	Low grade injuries (*n* = 30)	High grade injuries (*n* = 16)	*P*-value
Treatment			
SNOM	21 (70%)	10 (63%)	NS
OM	6 (20%)	5 (31%)	NS
FNOM	3 (10%)	1 (6%)	NS
Demographics			
Age	36 ± 21	28 ± 14	NS
Male	15 (50%)	3 (19%)	0.039
Haemodynamics in the ER			
First sBT	124 ± 28	113 ± 24	NS
Instability	6 (20%)	5 (31%)	NS
Extent of damage			
ISS	14 ± 13	22 ± 12	0.003
Haemoperitoneum[a]	1 (0–3)	3 (1–3)	0.013
Hospital stay			
ICU days	3 ± 6	5 ± 4	0.01
SW days	12 ± 12	24 ± 22	0.008
Total LOS	15 ± 17	29 ± 24	0.007
Transfusion requirements			
Patients receiving Tx	9 (30%)	11 (69%)	0.012
Total Tx	6 ± 16	14 ± 21	0.014
Outcome			
Complications	8 (27%)	11 (69%)	0.006
Mortality	1 (3%)	1 (6%)	NS

ER, emergency room; sBP, systolic blood-pressure; ISS, injury severity score; ICU, intensive care unit; SW, surgical ward; LOS, length of stay; Tx, transfusion requirements. NS, not significant.
[a]Numbers presented as mean ± SD, number of patients (% of total) or median (interquartile range).

Discussion

Several large series on NOM have been published, predominantly from specialized high-volume American centres, where 70–180 liver traumas are managed annually.[3,10,12,13] Less is known about outcome from centres with low frequency of liver trauma on the applicability and safety of non-operative treatment of liver trauma.

Main potential disadvantages of non-operative care in the management of blunt liver trauma could be delayed bleeding and

Table 5 Successful NOM in patients with potential risk-factors of FNOM

	No of patients
Neurological impairment[a] (2, 8, 9, 29).	4
Liver-related transfusion requirement >4 units (4, 9, 27).	1
High injury severity score (ISS)[b] (31).	6
≥Grade 4[c] (21, 24).	4
Large haemoperitoneum[c] (9, 21, 32).	14
Pooling of contrast[c] (9, 33).	2
Periportal tracking[c] (34).	2
Total number of patients	17/35

NOM, non-operative management; FNOM, failure of non-operative management.
[a]In this study defined as either GCS ≤ 14 on arrival or under the influence of alcohol or other drugs.
[b]In this study defined as an ISS > 15.
[c]As found on acute CT-scan.

missed associated injuries that require surgical intervention, including HVI. These unfortunate situations may result in obvious negative affects on outcome and can even be potentially life-threatening. However, while delayed or continued bleeding in splenic trauma often presents as a sudden circulatory collapse, failure in liver trauma has been described as a frequently more gradual process with decreasing haemoglobin concentrations and increased transfusion requirements, suggesting that this at least sometimes may provide sufficient time to take the patient to surgery before an obsolete situation is a fact.[14] There has also been concerns that transfusion requirements would be greater and patients would need longer observation time if immediate surgery is not performed, although later studies have shown this to be without solid evidence.[1,2,13,15]

One (2%) HVI was missed on initial CT scan, an injury that required concomitant surgery. Missed HVI is very rare, as reported in international literature (0%–0.9%), but must be considered in case of an alarming abdominal presentation.[1,15–17] Our case of initially misdiagnosed HVI was discovered on final examination and could readily be managed 16 h after admission without any obvious harm to the patient.

Some authors suggest that liver-related transfusions of no more than 4 units can be allowed before surgery must be seriously considered[4,8,18] and many consider surgery mandatory for grade V injuries.[1,7,15,19] It may very well be that this would have been the best for this particular patient in our study. There were two additional grade V injuries in the present study, in which immediate surgery was performed in both.

In our study, transfusions were less frequently required, average transfusion requirements were lower, complications more rare, total LOS shorter and days in the ICU less in patients initially treated without surgery as compared with patients in the OM group. This was undoubtedly affected by the fact that patients in the OM group were more severely injured, illustrated by lower systolic blood pressure at admission, higher ISS and frequency of associated injuries, why comparison of these different groups is not possible. However, NOM does not seem to affect outcome in a negative way as far as can be noted.

The FNOM group did not significantly differ in outcome from the SNOM group or OM group, where lack of significance is most probably explained by the low number of patients. When it comes to total LOS and days in the ICU, the FNOM group was similar to the SNOM group, probably as a result of a similar extent of associated injuries. When it comes to transfusion requirements, complications and mortality, the FNOM group was more like the patients where immediate surgery was performed.

Only patients haemodynamically stable at admission or stabilized after initial resuscitation with no associated injuries demanding laparatomy, based on clinical and radiological findings, should be considered for non-operative management.[2,7,8,20] A large number of parameters have been suggested to predict failure of non-operative treatment. The most common are (i) neurological impairment that limits the reliability of physical examinations,[2,3,21,22] a liver-related transfusion requirement that exceeds 4 units,[4,8,18] (ii) high ISS,[23] radiological findings such as (iii) grade (according to the American Association for the Surgery of Trauma (AAST) grading-scale[11]),[1,9,15,23] (iv) quantity of haemoperitoneum,[9,19,24] (v) signs of active extravasation, the so called 'pooling of contrast', defined as a hyperdense well-circumscribed intra-parenchymal contrast collection[15,25] and (vi) periportal tracking.[8,26]

In the present study, all patients where immediate surgery was performed (OM group) had peritoneal irritation, haemodynamic instability or signs of other laparatomy-demanding injury on CT scan. None of the risk factors mentioned above excluded patients from NOM, as long as they were clinically and haemodynamically stable. With this strategy, 76% of the patients were initially managed without surgery with a success rate of 89%. Altogether 17 (49% of all patients in the SNOM group) patients with identified risk factors were treated successfully without surgery.

The patient that failed NOM and subsequently died had five of these seven risk factors discussed above (transfusion requirements >4 units prior to surgery, ISS 34, grade V, large haemoperitoneum and pooling of contrast). The other three had two (transfusion requirements of 5 units prior to surgery and large haemoperitoneum), two (periportal tracking and large haemoperitoneum) and one (large haemoperitoneum) risk factors, respectively. This indicates that the presence of risk factors should increase caution and that the lack of significance could depend on the small patient material.

Two parameters significantly differed between patients successfully treated without surgery and patients where surgery had to be performed later on. Systolic blood pressure at admission was lower in patients that failed NOM ($P = 0.001$) and presence of large amounts of haemoperitoneum was more frequent ($P = 0.039$). The material is, however, again to small to draw any safe conclusions.

In conclusion, most patients with blunt liver injury can be managed non-operatively, and this type of treatment can be applied even in selected patients with defined risk factors.

Conflicts of interest

None declared.

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