Original Paper

Evaluation of the Healing time of Non-operatively Managed Liver Injuries

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ABBREVIATIONS: InterQuartile Range (IQR); Computed Tomography (CT); Ultrasound (US); Organ Injury Scale (OIS)

ABSTRACT

Background/Aims: Post discharge prescriptions and follow-up protocols after non-operative treatment of blunt liver injuries are still controversial. The aim of this study was to detail the evolution of the hepatic injuries considering their different patterns and severity grades, stated by the Liver Injury Scale.

Methodology: Analysis of a database concerning 79 consecutive patients submitted to ultrasound follow-up until complete recovery of liver injury.

Results: All patients had an uncomplicated course and the liver restoration was demonstrated between 3 and 300 days after the trauma. The median healing time of hematomas increased with the grading ($p<0.001$): 6 days (IQR=6.75), 45.5 days (IQR=91) and 108 days (IQR=89) for I, II and III grade lesions, respectively. Similarly behaved the lacerations and 29 days (IQR=14.25), 34 days (IQR=43.5) and 77.5 days (IQR=83.5) was the median healing time of II, III and IV grade lesions, statistical significance emerging only comparing II to IV grade lacerations ($p<0.035$). Considering the different lesion patterns within the same severity grade, the liver restoration was more prompt after lacerations ($p<0.001$).

Conclusions: These data suggest that medical prescriptions and follow-up protocols can be tailored considering the lesion characteristics.

INTRODUCTION

The non-operative management of blunt liver injuries is a standard method of care for hemodynamically stable patients (1). Since the early eighties the indications to this type of treatment have been progressively standardized (2-10), the different complications described (6,10,11) and the lesion's evolution illustrated in the main steps (12,13).

A still controversial issue concerns the post discharge prescriptions and the follow-up protocols. It is known that in the great majority of cases the complete restoration of the liver parenchyma is achieved within 3-6 months after the trauma (2,3,6,7). Notwithstanding, we consider that a better knowledge of the healing time of the different lesions, considering their pattern (laceration or hematoma) and severity (grading), could be useful in order to improve the appropriateness of medical prescriptions and the organization of follow-up protocols.

For this reason, the data concerning 79 consecutive patients submitted to ultrasound (US) follow-up was reviewed and the healing time of the different liver injuries was detailed, showing that different lesions display different healing time and that not only the lesion severity but also the lesion pattern influences the time to healing.

METHODOLOGY

From January 1992 through December 2004, 170 consecutive patients with blunt hepatic trauma were admitted at the Emergency Department of Institution. Eighty-one patients required an immediate laparotomy and 91 were submitted to the non-operative management of the liver injury. The conservative approach was successful in 86 cases (94.5%); 4 patients required a delayed celiotomy and 1 died due to concomitant cerebral lesions.

This study was conducted through the analysis of a database concerning 79 patients that pursued a clinical and US follow-up until the liver restoration was instrumentally documented; 7 patients refused the follow-up for travel distances.

The study group comprised 48 men and 31 women; their mean age was 35 years (range 16-92). The mode of injuries was similar to those reported in other papers, road accidents and falls being responsible for 84% and 12% of cases, respectively.

At admission, hemodynamic stability was evident in 61 patients (77.2%); in 18 cases it was achieved after resuscitation. The mean Trauma Score was 14.1 (10-16), the mean Injury Severity Score was 13.9 (4-41).

At admission the hepatic lesions were assessed by Computed tomography (CT) with intravenous contrast in 72 cases and by abdominal US scanning in 7 patients sustaining minor trauma. Accordingly to the Organ Injury Scale (OIS) for hepatic injuries (14) 8 (10.1%) grade I, 36 (45.6%) grade II, 29 (36.7%) grade

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TABLE 1 Major Associated Injuries Observed in 45 Patients

HEAD/SPINE: Head/facial fracture/s	12
Spine fracture/s	8
THORAX: Hemo/pneumothorax	14
Cage fracture/s	36
ABDOMEN: Splenic injury	6
Renal injury	8
Pancreas injury	4
Others	6
ORTHOPEDIC: Pelvic fracture/s	12
Long bone fracture/s	18
TOTAL	124

III and 6 (7.6%) grade IV hepatic lesions were recorded. For this particular study, when multiple hepatic lesions coexisted, only the most important one was considered and the OIS upgrading prescription for multiple liver injuries was not followed.

Hemoperitoneum was present in 48 patients and exceeded 500cc in 13 cases. In 45 patients (56.9%) 124 major injuries were associated to the liver trauma **(Table 1)**. Forty patients (50.6%) were monitored in intensive care unit settings (ICU); **Table 2** lists the duration of hospital and ICU stay and the general and liver-related transfusional requirements, the latter extrapolated accordingly to Croce *et al.* (7).

All patients were submitted to a clinical and US follow-up until the complete recovery of the liver parenchyma was demonstrated. This was defined as complete "*restitutio ad integrum*" (echographic normalization of the liver parenchyma) or echographic evidence of hepatic scar at the lesion site.

During the hospital stay, 15 patients affected by severe (III and IV grade) liver injuries and/or associated lesions of other abdominal parenchymas were submitted to 17 control CT during the first 72 hours, as established by local protocols, and to US controls thereafter; 64 patients were monitored by US alone. Each patient received from 1-6 control US scans (mean 2.7) during the hospitalization. Imaging controls were more frequent as OIS grading raised and all the injuries graded III and IV received at least 4 instrumental controls before discharge.

Post-discharge controls were scheduled every 2-6 weeks, depending on the evolution trend. In fact, evolving lesions were submitted to closer controls while stable injuries were controlled every 4-6 weeks. Each patient received from 1-5 US scans (mean 2.3).

All US scans were performed by experienced radiologists using 3.5-MHz probes. The liver parenchyma was evaluated through the anterior and lateral abdominal wall and the intercostal spaces; the color-Doppler was routinely employed.

The time to healing of the hepatic injuries of different grades was evaluated. Furthermore, the lesion patterns were separately considered, hematoma or laceration, and the time to healing of different lesions presenting the same severity grade and that of similar lesions of different severity grades was compared.

Considering the wide time spread of the study, all the economical considerations were drawn on the basis of the 2003 outpatient rates of the different imaging techniques, expressed in Euro, in the hospital.

Statistical Methods

Results are presented as median and InterQuartile Range (IQR) given the skewed distribution of the parameters analyzed. To compare the healing time in relation to the severity and the different pattern of the lesions, the Kruskal-Wallis test was applied with adjustment for multiple comparisons and an ANOVA applied to the ranked measures. To perform the analysis the freeware statistical package "R language" was used. A p-value of <0.05 was considered significant.

RESULTS

All patients had a favorable and uncomplicated course, unaffected by the associated lesions whose evolution was also favorable. The median healing time of the 79 liver injuries was 45 days (IQR=74.5) and was documented between 3 and 300 days after the trauma, in 17 cases during the hospital stay.

A healing time of 6 days (IQR=6.75), 38.5 days (IQR=43.25), 70 days (IQR=72) and 77.5 days (IQR=83.5) was calculated respectively for I, II, III and IV grade lesions; a statistical significance ($p<0.001$) was present only comparing I grade to IV grade lesions.

When considering the different lesion patterns, the 53 hepatic hematomas required a longer time to healing than the 26 hepatic lacerations: 55 days (IQR=94) and 35 days (IQR=41.75), respectively, but this difference had not a statistical relevance ($p=0.21$).

The time to healing of hematomas increased accordingly to their grading ($p<0.01$): 6 days (IQR=6.75), 45.5 days (IQR=91) and 108 days (IQR=89) was respectively the healing time of I, II and III grade hematomas **(Figure 1)**.

The time to healing of lacerations increased in accordance to the lesions' grading and 29 days (IQR=14.25), 34 days (IQR=43.5) and 77.5 days (IQR=83.5) was respectively the healing time of II, III and IV grade lacerations but a statistical significance

TABLE 2 Hospital, Intensive Care Unit Stay, and Transfusional Requirements

Grade (n° of pts)	Hospital stay mean (range)	ICU stay pts/mean stay	Transfusions pts/total units	Liver-related transfusions pts/total units
I (8)	9 (3-30)	2/9	0/0	0/0
II (36)	15 (3-60)	13/6.7	6/34	2/7
III (29)	15.5 (2-42)	19/5.0	9/20	3/5
IV (6)	19 (12-24)	6/4.8	3/10	2/4

Pts: patients.

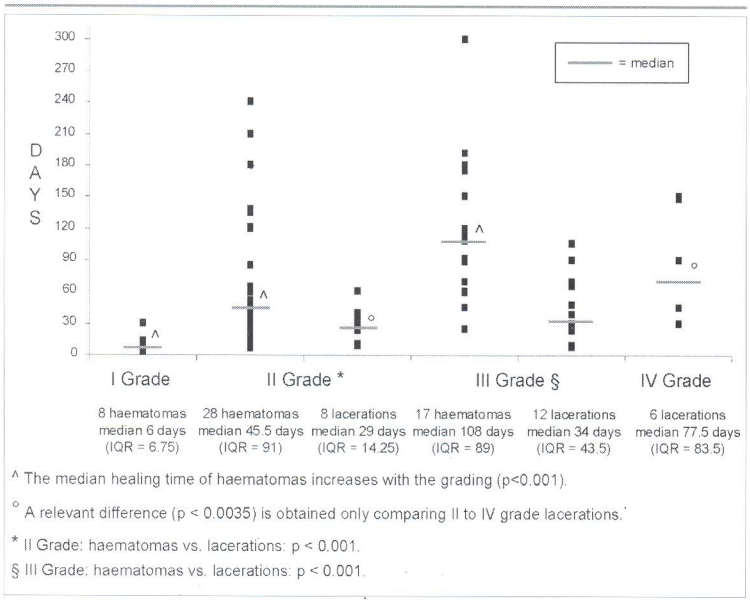

FIGURE 1 Healing time of 79 liver injuries, considering their severity and pattern.

(p<0.0035) was present only comparing II to IV grade lacerations **(Figure 1)**.

A significant difference (p<0.001) in the time to healing was appreciated when different lesion patterns coexisted in the same severity degree (II and III grade), but it was not detected an interaction between these 2 parameters **(Figure 1)**.

At the rates for the year 2003, the cost of the post-discharge instrumental evaluations would have figured €51,13 for each US study of the upper abdomen (liver, spleen, pancreas and kidneys) and €164,75 for the same CT study (with and without contrast media).

DISCUSSION

This study shows that the lesion severity and the lesion pattern influences the time to healing of non-operatively managed liver injuries.

As expected, the larger the traumatic lesion, the longer is the period required for the complete echographic recovery of the liver parenchyma but, interestingly, a clear relationship also exists between the lesion's pattern and the median time to healing, lacerations recovering faster than hematomas. Moreover, lacerations showed a more homogeneous healing time than haematomas.

The different behavior of lacerations may be considered a consequence of the drainage of the liquid components and necrotic debris through the capsular tear leading to a prompt approximation of the wound margins. Whereas in case of closed lesion, or if the capsular tear is proportionally inadequate, like in the case of broken intraparenchymal hematomas, the healing process includes the resorption and organization of the mentioned components. Consequently, an additional period, proportional to the hematoma's dimensions, is required to achieve the parenchymal restoration.

The healing time recorded within each group of lesions was quite heterogeneous. This can be explained considering the differences among the lesions included in each OIS class and the biologic differences among the enrolled patients. The influence of an imperfect accuracy of the CT staging performed at admission can not be excluded, even if the diagnostic inaccuracy rate of 84% reported by Croce and co-workers in 1991 (15) should have been greatly reduced by the new generations of scanners.

The possibility to foresee the time to healing on the basis of the initial pattern and grading of the liver injury is of critical value in the everyday clinical practice, considering the different discharge prescriptions and follow-up protocols reported in the literature. A prudential limitation of the physical activity with prohibition of contact sports or heavy duties for the duration of 3-6 months is generally prescribed, as it is known that within this period of time the complete restoration of the liver parenchyma is achieved in the great majority of cases and that only in case of severe injuries residual lesions have been sporadically reported after 1 or 2 years. Notwithstanding, Carrillo *et al.* (10) limit this period to few weeks also in case of severe injuries, advocating experimental evaluations concerning wound-breaking strength (13). In the same way, some Authors (3,5) recommend a CT follow-up until complete recovery of the liver injury, others (8) limit instrumental controls to the first month, while the spreading behavior is to reserve control imaging to clinically selected cases (16,17), considering the limited therapeutical value of routine instrumental follow-up (18-22), confirmed also in our experience.

Probably, the safest attitude lies somewhere between the above extremes and the best prescription and follow-up should be tailored to the single patient and lesion. The patients in this study could freely resume their habitual life-style after discharge, the only preclusions being heavy or dangerous duties and sports until the instrumental demonstration of the parenchymal recovery, as far as permitted by associated lesions. In fact, severe skeletal fractures influenced the clinical course in 45 cases and the liver injury itself was the deterrent to the resumption of full activity only in 33/79 patients (41.7%).

Considering that the patient's compliance and the economical impact are the main limitations to a prolonged surveillance program, the ultrasound monitoring of the liver injury was adopted, as suggested by Knudson and Maull (9). This proved effective in documenting the progressive recovery of the injured liver and well accepted by the patients whose compliance to the proposed follow-up schedule was close to 90% (60/67 patients discharged with evidence of parenchymal injury). Although senior radiologists performed all US scans in order to compensate the intrinsic limitations of the method (dynamic and operator-dependent evaluation), a cost reduction of 67.5% was observed *vs.* a similar CT protocol. Moreover, a CT follow-up, although objective, is often con-

sidered excessive both by physicians and patients, whose disaffection is stated by compliance rates lower than 60% in the mentioned series (3,5,8).

This data shows that on the basis of the liver OIS it is possible to tailor the period of physical limitation and preconize the optimal timing of the follow-up. In fact, it seems reasonable to schedule the first post-discharge ultrasound control *circa* the median healing time; this would demonstrate the liver recovery in about 50% of cases **(Figure 1)** and suggest a correct scheduling for further controls, in this way achieving the maximal safety without excessive limitations and costs.

CONCLUSIONS

The data suggest that a clear relationship exists between the grade and pattern of a liver injury and its time to healing. Upon this basis, it is possible to tailor the period of physical limitation and recognize the optimal timing of the follow-up schedule, leading to a safe resumption of the habitual life style and to a positive impact on health-care expenses.

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