High Success With Nonoperative Management of Blunt Hepatic Trauma

The Liver Is a Sturdy Organ

George C. Velmahos, MD; Konstantinos Toutouzas, MD; Randall Radin, MD; Linda Chan, PhD; Peter Rhee, MD; Areti Tillou, MD; Demetrios Demetriades, MD

Hypothesis: Nonoperative management of liver injuries (NOMLI) is highly successful and rarely leads to adverse events.

Design: Prospective observational study.

Setting: High-volume academic level I trauma center.

Patients: For 26 months, 78 consecutive unselected patients with liver injuries were followed up prospectively. In the absence of hemodynamic instability or signs of hollow visceral trauma, NOMLI was offered irrespective of the magnitude of the liver injury.

Main Outcome Measure: Failure of NOMLI, defined as a laparotomy after an initial decision to treat the patient nonoperatively.

Results: Of the 78 patients, 23 (29%) were operated on immediately, but only 12 (15%) for bleeding from the liver. All 12 patients required packing in addition to other maneuvers (hepatorrhaphy [n=8], resection [n=4], and liver isolation [n=1]). Of the remaining 55 patients selected for NOMLI, the method failed in 8 for reasons unrelated to the liver injury: 2 underwent a splenectomy, 1 underwent a nephrectomy, 1 had a small-bowel repair, 1 underwent abdominal decompression for abdominal compartment syndrome, and 3 underwent a non-therapeutic laparotomy. The success rate of NOMLI was 85% (47 of 55 patients), but the liver-specific success rate was 100%. Compared with those in whom NOMLI was successful, patients in whom it failed had a higher Injury Severity Score and underwent more blood transfusions, but they had similar liver injury grades. In total, 66 (85%) of liver injuries did not bleed significantly. No adverse events were attributed to NOMLI.

Conclusions: Nonoperative management of liver injuries is safe and effective regardless of the grade of liver injury. Failure of NOMLI is caused by associated abdominal injuries and not the liver. Fluid and blood requirements, the degree of injury severity, and the presence of other abdominal organ injuries may help predict failure.

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was further divided into 2 groups: those in whom NOMLI succeeded and those in whom NOMLI failed. Failure of NOMLI was defined as the need for an operation after an initial decision was made to treat the patient nonoperatively. Failures of NOMLI were categorized as liver- or nonliver-specific, indicating whether the liver or another organ was responsible for the required delayed operation. The previously mentioned groups were compared in a univariate analysis. The sample size was not adequate for meaningful multivariate analysis. Categorical variables were compared by the 2-tailed χ² test or the Fisher exact test, and continuous variables were compared by the Mann-Whitney rank sum test or an analysis of variance for more than 2 groups. P < .05 was chosen to indicate statistical significance. The study was approved by our institutional review board.

**RESULTS**

**PATIENTS TREATED BY AN IMMEDIATE OPERATION**

Seventy-eight patients were included, 23 (29%) who underwent an immediate operation and 55 (71%) who underwent NOMLI. However, only 12 patients (15%) underwent an emergency operation because of liver bleeding. They had major liver injuries that required drastic interventions, including packing, atypical hepatectomies, and total liver isolation. The remaining 11 patients were operated on because of splenic injuries (n = 3), pancreatic injuries (n = 2), small-bowel or mesenteric lacerations (n = 1), a bladder rupture (n = 1), a diaphragmatic rupture (n = 1), or a central retroperitoneal hematoma (n = 1). These 11 patients had only grade I to III liver lacerations that were not bleeding at the time of the operation. Compared with the patients who underwent NOMLI, patients who underwent an immediate operation had a higher Injury Severity Score, a greater amount of fluid and blood resuscitation, and more associated head and intra-abdominal injuries. They also more frequently had grade III to V liver injuries. They had a higher rate of complications and stayed longer in the hospital, but mortality was not different (Table 2). Liver-related complications developed in 4 patients who underwent an immediate operation, representing an incidence of 17% among all patients who underwent immediate operations or 33% among patients operated on for liver bleeding. These complications included 1 prolonged biliary leak, 1 hemorrhage requiring a subsequent operation, 1 intrahepatic abscess requiring percutaneous drainage, and 1 case of liver necrosis requiring operative debridement.

**PATIENTS TREATED NONOPERATIVELY**

Of the 55 patients initially selected for NOMLI, 8 (15%) of those who underwent NOMLI or 10% of the entire population eventually required an operation 3 to 8 hours after admission (1-5 hours after the CT scan). However, the liver was not the cause of the delayed operation in any of these patients. Therefore, although the general success rate of NOMLI was 85% (47 of 55 patients), the liver-specific success rate was 100%. The reasons for operation in the 8 patients in whom NOMLI failed are described in Table 3. Patients in whom NOMLI failed were different from patients in whom NOMLI succeeded in Injury Severity Score, amount of fluid and blood resuscitation, and the presence of intra-abdominal injuries (Table 4). However, they did not differ on the grade of liver injury, indicating...
that the grade is not a factor for the failure of NOMLI. Specifically, of 3 patients with grade I liver injury, NOMLI did not fail in any of them; of 18 with grade II liver injury, NOMLI failed in 2 (11%); of 18 with grade III liver injury, NOMLI failed in 4 (22%); of 12 with grade IV liver injury, NOMLI failed in 2 (17%); and of 4 with grade V liver injury, NOMLI did not fail in any of them. Twelve patients (22%) underwent angiography following CT, and in 7 (13%) of them, embolization was performed for contrast extravasation. One patient required reembolization because bleeding continued after the initial embolization.

MORBIDITY OF THOSE UNDERGOING NOMLI

The morbidity was high among those in whom NOMLI succeeded (18 [38%] of 47 patients) and among those in whom

<table>
<thead>
<tr>
<th>Table 1. Grades of Liver Injury*</th>
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<tr>
<td>Grade</td>
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<tr>
<td>I</td>
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<td>II</td>
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<td>IV</td>
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*Data from Moore et al.15 Ellipses indicate data not applicable.

<table>
<thead>
<tr>
<th>Table 2. Comparison of Patients With Blunt Hepatic Trauma Who Underwent an Immediate Operation vs Those Who Underwent Initial NOMLI*</th>
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<tbody>
<tr>
<td>Characteristic</td>
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</tr>
<tr>
<td>Age, y†</td>
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<tr>
<td>Injury Severity Score†</td>
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<tr>
<td>Given in the first 6 h†</td>
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<tr>
<td>Blood, U</td>
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<tr>
<td>Blood pressure &lt;90 mm Hg on arrival</td>
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<tr>
<td>Decrease in hematocrit of &gt;20% in the first hour</td>
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<tr>
<td>Head injury</td>
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<tr>
<td>Pelvic injury</td>
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<tr>
<td>Long-bone fracture</td>
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<tr>
<td>Other intra-abdominal injury</td>
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<tr>
<td>Other extra-abdominal injury</td>
</tr>
<tr>
<td>CT grade of liver injury ≥III</td>
</tr>
<tr>
<td>Complications</td>
</tr>
<tr>
<td>Liver-related complications</td>
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<tr>
<td>Hospital stay, d†</td>
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<tr>
<td>Mortality</td>
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*Data are given as number (percentage) of patients unless otherwise indicated.
†Data are given as mean ± SD.

<table>
<thead>
<tr>
<th>Table 3. Data for 8 Patients With Delayed Operations After Initial NOMLI</th>
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<tr>
<td>Patient No. Reason for the Operation Organ Responsible Procedures</td>
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<tr>
<td>1 Decreasing hemoglobin level Spleen Splenectomy</td>
</tr>
<tr>
<td>2 Decreasing hemoglobin level and hypotension Spleen Splenectomy</td>
</tr>
<tr>
<td>3 Persistent abdominal tenderness and small-bowel thickening on CT None Nontherapeutic laparotomy</td>
</tr>
<tr>
<td>4 Abdominal compartment syndrome Renal vessels Nephrectomy</td>
</tr>
<tr>
<td>5 Decreasing hemoglobin level Retroperitoneal hematoma Nontherapeutic laparotomy</td>
</tr>
<tr>
<td>6 Worsening metabolic acidosis Small bowel Enterectomy and diaphragmatic repair</td>
</tr>
<tr>
<td>7 Abdominal compartment syndrome Massive resuscitation for other injuries Abdominal decompression</td>
</tr>
<tr>
<td>8 Small-bowel thickening on CT None Nontherapeutic laparotomy</td>
</tr>
</tbody>
</table>

Abbreviations: CT, computed tomographic; NOMLI, nonoperative management of liver injuries.

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COMMENT

In this prospective study, we document the safety of NOMLI. Clinically significant bleeding from the liver is immediately obvious and usually requires an emergency operation. Delayed bleeding in patients who are treated nonoperatively is unlikely to originate from a liver laceration. The 100% liver-specific success rate of nonoperative management in this series attests to this fact. Even when the policy of nonoperative treatment is aggressively applied to more than two thirds of the patients with liver injuries, as in our study, the likelihood of failure is slim.

During the past 3 decades, nonoperative management of solid visceral organ injuries has revolutionized the way we treat such patients. Its incidence is progressively increasing, because of the higher confidence level that physicians build through experience with this method of treatment and through the advancing technology that ensures continuous and reliable monitoring. Lucas and Ledgerwood documented this changing trend for 30 years. At their institution, NOMLI was used in 0% of patients from 1969 to 1970, but in 31% of patients from 1997 to 1998. Richardson et al examining their institutional trends for 25 years (1975-1999), found that NOMLI was offered to 65% of patients with blunt injuries during the last 4 years of this period compared with 0% during the initial 4 years.

The rates of NOMLI still vary among institutions according to the level of experience, expertise, and resources. In 2 studies, referring to a collective literature review and a multi-institutional trial, NOMLI was applied to 17% to 60% of relevant patients. Some researchers report an aggressive approach, with 82% or 86% of their patients being treated nonoperatively, whereas others remain at a low 6% or a conservative 30%, 40%, or 50%. Another reason for this wide fluctuation of NOMLI rates results from the retrospective nature of most studies. It is difficult to extract from medical record review the true nature of decision making and patient care.

Of the few other prospective studies on adult patients, use a similarly aggressive approach toward NOMLI, like ours. In another 2 studies, half or fewer of the patients with liver injuries are treated by NOMLI. Two more prospective studies use laparoscopy as an adjunct to NOMLI. We do not believe that laparoscopy is an important tool for routine use in such patients. A significant part of the postoperative morbidity is caused by general anesthesia that can hardly be avoided by laparoscopy. The rate of missed associated hollow visceral injuries in patients with liver trauma is substantially low, according to Miller et al, and there is no evidence to suggest that it will decrease by using laparoscopy. The ongoing improvement in CT technology will offer better image quality and fewer missed injuries. The logistical and resource consumption implications of routine laparoscopy are exactly those that NOMLI targets to avoid. Another important shift in our practice relates to the use of deep peritoneal aspiration, as outlined in our algorithm.

Table 4. Comparison of Patients in Whom NOMLI Succeeded vs Those in Whom NOMLI Failed

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Patients in Whom NOMLI Succeeded (n = 47)</th>
<th>Patients in Whom NOMLI Failed (n = 8)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, y†</td>
<td>35 ± 18</td>
<td>30 ± 16</td>
<td>.54</td>
</tr>
<tr>
<td>Injury Severity Score†</td>
<td>18 ± 10</td>
<td>24 ± 8</td>
<td>.03</td>
</tr>
<tr>
<td>Given in the first 6 h†</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crystalloids, mL</td>
<td>2210 ± 1363</td>
<td>5515 ± 4636</td>
<td>.02</td>
</tr>
<tr>
<td>Blood</td>
<td>0.8 ± 1.6</td>
<td>3.1 ± 2.5</td>
<td>.003</td>
</tr>
<tr>
<td>Blood pressure &lt; 90 mm Hg on arrival</td>
<td>15 (32)</td>
<td>1 (12)</td>
<td>.41</td>
</tr>
<tr>
<td>Decrease in hematocrit of &gt; 20% in the first hour</td>
<td>9 (19)</td>
<td>3 (38)</td>
<td>.35</td>
</tr>
<tr>
<td>Head injury</td>
<td>6 (13)</td>
<td>0</td>
<td>.58</td>
</tr>
<tr>
<td>Pelvic injury</td>
<td>8 (17)</td>
<td>3 (38)</td>
<td>.33</td>
</tr>
<tr>
<td>Long-bone fracture</td>
<td>16 (34)</td>
<td>2 (25)</td>
<td>.89</td>
</tr>
<tr>
<td>Other intra-abdominal injury</td>
<td>6 (13)</td>
<td>7 (88)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Other extra-abdominal injury</td>
<td>18 (38)</td>
<td>4 (50)</td>
<td>.70</td>
</tr>
<tr>
<td>CT grade of liver injury ≥ III</td>
<td>28 (60)</td>
<td>6 (75)</td>
<td>.69</td>
</tr>
<tr>
<td>Complications</td>
<td>18 (38)</td>
<td>5 (62)</td>
<td>.13</td>
</tr>
<tr>
<td>Hospital stay, d†</td>
<td>13 ± 13</td>
<td>35 ± 36</td>
<td>.003</td>
</tr>
<tr>
<td>Mortality</td>
<td>6 (13)</td>
<td>1 (12)</td>
<td>.99</td>
</tr>
</tbody>
</table>

Abbreviations: CT, computed tomographic; NOMLI, nonoperative management of liver injuries.

*Data are given as number (percentage) of patients unless otherwise indicated.
†Data are given as mean ± SD.
(Figure). In the era of CT, patients who are hemodynamically stable undergo CT, and DPL is avoided altogether. For patients with ongoing hemodynamic instability that cannot be explained by other sources, negative emergency ultrasonographic results may be potentially misleading. In these patients, DPL is needed. However, if the cause of hemodynamic instability lies within the abdomen, much free blood should be found. A simple aspirate is (according to our experience) sensitive in diagnosing large amounts of hemoperitoneum and avoids the technical problems and time loss related with the full lavage. Therefore, we use almost exclusively a deep peritoneal aspirate, and not DPL.

The success rate of NOMLI is high in all studies, and is usually reported to exceed 80%. It was 85% in our study. Delayed abdominal explorations for failed NOMLI reveal active liver bleeding only in a few patients. Malhotra et al reported that NOMLI failed in 3% of patients because of delayed liver bleeding, and Pachter et al found a 3.5% failure rate with delayed bleeding. The liver-related failure rate of NOMLI was 0% in our study. With so few patients in whom NOMLI fails, predictors of failure are difficult to determine statistically (as discussed by Malhotra et al). Although patients in whom NOMLI failed had a higher Injury Severity Score and greater volumes of initial fluid resuscitation and blood transfusion, the statistically independent nature of these variables in predicting failure cannot be established. Possibly, a meta-analysis of the existing literature would be the only means to accrue enough patients for meaningful multivariate analysis of independent predictors of the failure of NOMLI.

Head injury and CT grade of liver injury were not different between patients in whom NOMLI succeeded and those in whom it failed. The lack of relationship between neurologic impairment and the ability to treat patients nonoperatively has been documented in many studies. Hemodynamic stability, an absent or correcting metabolic deficit, and an abdominal CT scan without indications of significant associated organ injuries are sufficient to treat patients by NOMLI, even if the result of the clinical examination is suboptimal because of traumatic neurologic trauma, or high-grade liver injuries should not be a contraindication to NOMLI. The need to operate should be governed only by the presence of hemodynamic instability or frank peritonitis. Even if harmful to surgical pride, we should accept that the best way of treating the liver is by not touching it.

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Corresponding author: George C. Velmahos, MD, Division of Trauma and Critical Care, Department of Surgery, Los Angeles County—USC Healthcare Network, 1200 N State St, Room 9900, Los Angeles, CA 90033 (e-mail: velmahos@usc.edu).

REFERENCES


DISCUSSION

Scott Norwood, MD, Tyler Tex: Dr Velmahos and his colleagues have presented a prospective observational study on the nonoperative management of blunt liver injuries. Their hypothesis is that nonoperative management of blunt liver injuries is usually successful, safe, and rarely leads to adverse outcome in those patients who present to the emergency department hemodynamically stable. Their study of 55 patients initially treated nonoperatively suggests that this hypothesis is true. I congratulate the authors on another fine study and would emphasize that they have contributed significantly by providing prospective evidence on the safety of NOMLI, which really should at this point in time be considered the standard of care in the stable patient.

We continue to learn more about these and other injuries as our experience with nonoperative management increases. However, we are also identifying new pitfalls as we gain this experience. I have several questions for the authors. (1) To push the envelope a little further, do you envision certain liver injuries that might even present early on in a hemodynamically stable patient in which you might see a small intraparenchymal arterial blush and treat this patient by observation without arteriography? (2) In your population of blunt trauma patients, what is the prevalence of extrahepatic biliary injuries, including gallbladder rupture? Our experience is that this is uncommon, but we recently saw a patient with a grade IV injury with a simultaneous gallbladder rupture who developed severe bile peritonitis and ARDS [acute respiratory distress syndrome] 36 hours postinjury. (3) Could you comment a bit more on how you used diagnostic peritoneal aspiration in your clinical decision making? Donald Trunkey, MD, Portland, Ore: Dr Velmahos, there is a mistake in your title; this should be titled “The Appropriate Management of Liver Injuries.” I would not refer to the nonoperative part of it at all.

You stated in your preface that there are more blunt trauma patients and that there is more nonoperative management. I disagree. It is important for an old geezer like me to point out the error that you have made here in regards to the history. Prior to 1965, we did not make the diagnosis of liver injury very often. The reason is because we relied on distention, pain, hemodynamic instability, and sometimes paracentesis and culdocentesis, which were notoriously wrong. And, in fact, from your own institution, Dr Rosoff pointed out that 50% of patients with significant hemoperitoneum were not diagnosed. Another study at the same time by Olson at the University of Michigan pointed out that there were a number of patients who were found to have liver injuries at autopsy, but not necessarily significant injuries. More recently, Richardson, in a 25-year study, showed that blunt injuries appeared to increase relative to penetrating. In point of fact, what he was doing is just making the diagnosis either with DPL, CT scan, or other diagnostic studies which are clearly more accurate.

Now let us get to your paper, because I think it is critical. In 1970, there were 2 large studies, one from Houston and one from Dallas, that showed that only 5% of liver injuries total were operated on for a resection or where a resectional debridement was carried out. That is precisely what it is in your paper. And you have excellent results. But what they did not have in 1970 was the advantage of Couinaud's descriptions of the anatomy and our experience now with isolation of the liver. So, the real issue now for the surgeon is which ones need operative management and, then, how do you plan your strategy in regards to damage control, arteriogram, and operative resection?

In your 55 patients that were managed nonoperatively, there were 8 failures. If you subtract these patients, there were 47 patients managed nonoperatively, which is about 50%. I would argue that these patients are the ones we did not diagnose 30 years ago. In my own personal series of 74 liver injuries, I operated on one third of these, not for their liver injury but for other associated intra-abdominal injuries. In your series, it seemed to me it was a little bit low. This is important because I either repaired or took out an organ in 19 instances. Are we missing injuries to the small bowel or other organs?

The last comment that I would make is that in our experience, if you do manage them nonoperatively, there is a higher incidence of hematobilia and myelomas. Did you have any in your series?

My final question to you is, in an academic health center such as yours, how are you teaching your residents to do liver surgery? Most academic health centers expose their residents to trauma cases or to patients on the transplant or hepatobiliary service. Now the transplant and the hepatobiliary services often have fellows, and the general surgery residents are excluded. I would ask you how do you get your residents to have appropriate experience and competency in the management of patients with liver disease or liver injuries? Currently, the American Board of Surgery only requires 4 cases to get certified. I would argue that does not make a surgeon competent in liver surgery.

R. Stephen Smith, MD, Wichita, Kan: Were you concerned about the development of abdominal compartment syndrome? At least one previous report has shown that if nonoperative management is offered to patients with grade III to V injuries, then the incidence of abdominal compartment syndrome can be as high as 75%. Did you measure intra-abdominal pressures in these patients?

Secondly, how many of the patients actually required angiography with embolization?

Thirdly, did you have a transfusion threshold at which you would abandon the nonoperative approach? If your hypothesis is correct and the liver rarely bleeds, it seems that if you had to transfuse with more than 1 or 2 U then this was probably secondary to an associated injury, so did you have a threshold at which this indicated a need for operation? In those patients, did you operate or did you return to the angiography suite?

Finally, where did you observe the patients? Were they all observed in the ICU [intensive care unit] or, for patients with lesser injuries, were these patients observed on the ward?
Dr Trunkey, thank you for your comments. You mentioned that actually there are not more liver injuries today compared to previous years. Maybe the better documentation and trauma registries, as you mentioned, are the reason for the increased recorded number of liver injuries. Maybe it is a true increase due to a higher number of motor vehicular accidents and more patients reaching the hospital alive because of improved prehospital care. Lucas and Ledgerwood have also reported such an increase and cited the reasons that we just discussed.

Regarding the strategy of liver management: it varied from damage control, to simple or complex surgical techniques, to angiographic embolization, to nonoperative management. How many associated injuries are there? Are we missing some? We are not missing injuries, but we may be delaying definitive management in unusual cases. The prevalence of associated hollow visceral injuries is about 3%. With improving CT technology, we will diagnose them better and earlier.

We do not see biloma and hemobilia frequently in patients who are managed nonoperatively. We see it more frequently in those who are operated on and have major procedures. How do we teach the young surgeons to do liver trauma? That is, I am afraid, a very difficult-to-answer question. Our primary purpose is to have an alive patient, even if it costs some surgical experience to young surgeons. Unavoidably, by nonoperative management, we increase the chances that young surgeons will not be exposed to all the complexities of surgical management of liver injuries. Elective surgery is part of the answer to that, as might be training in inanimate models, computer simulation, and whatever else the future may bring.

Dr Smith, you mentioned abdominal compartment syndrome and you are right, although it may not be as high as 70%. It occurs during the effort of resuscitating patients who have multiple other injuries associated with the liver injury. The liver should not be resuscitated. Either it bleeds or it does not bleed. If it bleeds, it belongs to the operating room. If it does not bleed, you observe. But there are many other injuries (pelvic fractures, extremity fractures, thoracic injuries, soft tissue trauma) that need resuscitation, and these patients may develop intraperitoneal hypertension.

How many did we embolize? We used angiographic embolization in 17% of patients. We are pretty aggressive and liberal with angiographic embolization, but do not do it routinely for certain grades.

We do not have a transfusion threshold. Usually, if the patient needs more than 2 U of blood transfusion, we start becoming nervous, but again, remember that these patients with average Injury Severity Scores of above 20 have multiple other injuries and, therefore, may need transfusions which are not related to the liver.

Do we observe them in the ICU or the ward? Typically, for grade III and above, the patient is admitted to a highly monitored environment like an ICU.

Dr Borzotta, failure as a definition is wrong and I agree with that. This is my problem with all of the retrospective studies. None of us records in the chart: "I managed the patient nonoperatively but I failed." That is why when you try to define failure retrospectively from chart reviews, you can never find the right answer. This is why we are doing this study prospectively. Conceptually, I agree with you. We should find a better word than failure. I would not advocate routine ERCP. It is too invasive, time-consuming, and health care resources-consuming. It should only be done very selectively for prolonged biliary leaks or strong suspicion of proximal biliary duct injuries.

And finally, Dr Cocanour, if I understood the question—and forgive me if I did not—we used drains routinely following all operations for liver injury. We do not routinely perform a laparoscopic or open operation just to drain blood, although we are flirting with this issue daily on rounds.

Anthony P. Borzotta, MD, Cincinnati, Ohio: Have a comment and then a question. The comment has to do with your term “failure” in nonoperative management. I would suggest that conceptually you are converting from one mode of management to another, ie, from nonoperative to operative management. As surgeons we would all agree that occasionally a patient does need us to intervene physically, internally, in their care. I am reminded of the review done at the EAST [Eastern Association for the Surgery of Trauma], which looked at nonoperative management of the spleen and reported a handful of patients who expired from hemorrhage with known spleen injuries in level I trauma centers. I wonder if cognitively the idea that you are going to fail at something prohibits you from moving to the next level of care.

My question has to do with biliary complications. When we reported our experience at the Western Trauma Association, about a third of patients with class III, IV, or V injuries had biliary complications, bilomas, or bile peritonitis. We have been moving toward the routine use of ERCP [endoscopic retrograde cholangiopancreatography] on injury day 3 or 4 to stent the duct and preclude these complications. Your remarks on that, please?

Christine Cocanour, MD, Houston, Tex: This paper supports my own biases. We have also noted a number of biliary problems following nonoperative management. Is the reason that you did not have any failures of nonoperative management is because instead of bile leaks being treated with operation, they underwent percutaneous drainage? Would early operative intervention allow a more thorough cleansing of bile from the abdomen, as some of my partners are now beginning to advocate as they feel operatively placed drains are superior to late percutaneous drainage?

Claude H. Organ, Jr, MD, Oakland, Calif: Did you include in your conclusions a statement that the grade V injuries were safe for observation?

Dr Velmahos: Let me address your question first, Dr Organ. In the absence of hemodynamic instability, attempts to repair surgically grade V liver lacerations may end up with a dead patient. It is not usual for such retrohepatic vena cava lacerations to be self-tamponaded. The worst decision is to disturb the hematoma by heroic maneuvers like liver isolation or other complex surgical techniques. These should be used only if the patient is hemodynamically unstable. If the patient is stable, and the CT scan diagnoses a large grade V liver laceration with a retrohepatic vena cava hematoma, the best way to deal with it is expectantly.

Let me run quickly through the answers. Dr Norwood, you asked whether we envision managing small blushes to the liver parenchyma. We do not have a transfusion threshold. Usually, if the patient needs more than 2 U of blood transfusion, we start becoming nervous, but again, remember that these patients with average Injury Severity Scores of above 20 have multiple other injuries and, therefore, may need transfusions which are not related to the liver.

Do we observe them in the ICU or the ward? Typically, for grade III and above, the patient is admitted to a highly monitored environment like an ICU.

Extrahepatic biliary injuries—we did not have any in this study yet. However, the study is still open and extrahepatic biliary injuries—even if very rare after blunt trauma—may occur with the accrual of more patients. With regard to the use of DPA [ diagnostic peritoneal aspiration], as opposed to the well-known standard of care, DPL, for the diagnosis of abdominal bleeding: We have moved away from the lavage part of the DPL. If the patient is hemodynamically stable, the patient should have a CT scan that gives far more specific information than the DPL. If the patient is hemodynamically unstable due to abdominal bleeding, there should be at least a couple of liters of blood in this abdomen to create hemodynamic instability. Therefore, simple aspiration will produce blood, and you do not have to do the time-consuming part of DPL, which is infusing fluid, retrieving the aspirate, and sending it for red blood cell count. So, in the new era of helical CT scan, we have moved away from DPL and towards DPA.

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