Safety of Early Mobilization of Patients With Blunt Solid Organ Injuries

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Background: Many surgeons believe that early mobilization of patients with blunt solid organ injuries increases the risk of delayed hemorrhage.

Objective: To determine whether there is an association between the day of mobilization and rates of delayed hemorrhage from blunt solid organ injuries.

Design: Retrospective cohort study. Univariate and multivariate analyses were performed to determine the association of mobilization with delayed hemorrhage of a solid organ requiring laparotomy.

Setting: Level I trauma center.

Patients: Adults with blunt renal, hepatic, or splenic injuries were identified from a trauma registry.

Main Outcome Measures: Medical records were used to determine the day of mobilization and to identify patients with delayed hemorrhage requiring laparotomy.

Results: Four hundred fifty-four patients with blunt solid organ injuries were admitted to the hospital for nonoperative management. Failure rates of nonoperative management were 4.0%, 1.0%, and 7.1% for renal, hepatic, and splenic injuries, respectively. No patients with renal or hepatic injuries failed secondary to delayed hemorrhage. Ten patients (5.5%) with splenic injuries failed secondary to delayed hemorrhage. Eighty-four percent of patients with renal injuries, 80% with hepatic injuries, and 77% with splenic injuries were mobilized within 72 hours of admission. Day of mobilization was not associated with delayed splenic rupture in multivariate analysis (odds ratio, 0.97; 95% confidence interval, 0.90-1.05).

Conclusions: The timing of mobilization of patients with blunt solid organ injuries does not seem to contribute to delayed hemorrhage requiring laparotomy. Protocols incorporating periods of strict bed rest are unnecessary.

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See Invited Critique at end of article

Nonoperative management (NOM) of blunt solid organ injuries has become the standard of care in hemodynamically stable patients. It is highly successful, with overall failure rates for renal, hepatic, and splenic injuries ranging from 0% to 11%, 1% to 15%, and 2% to 52%, respectively.1-13 Delayed hemorrhage is a rare but well-described complication of NOM, occurring in 0% to 6% of renal, 3% to 14% of hepatic, and 0% to 11% of splenic injuries.2,3,5,6,9,11,13-15 Delayed hemorrhage is thought to occur secondary to hyperosmolar conditions in a hematoma caused by hemoglobin breakdown, resulting in water absorption, increase in size and pressure of the hematoma, and eventual rupture. Most delayed ruptures happen within several days of the injury, but longer delays have been reported.4,6,7,9,15-17 To decrease the risk of delayed hemorrhage, many surgeons have incorporated a period of strict bed rest into their protocols of NOM.6,9,12,18-22 The presumed rationale is that patient movement or an unexpected fall may disrupt a stable clot, leading to hemorrhage and the need for operative intervention. The risk of delayed hemorrhage must be weighed against the risks of prolonged bed rest, which include deep venous thrombosis/pulmonary embolus, pneumonia, increased hospital length of stay, and increased hospital costs.16,23-27 The benefits of strict bed rest in NOM of blunt solid organ injuries may be overestimated and may even contribute to complications.2 Protocols that have incorporated early mobilization of patients with blunt solid organ injuries have shown equivalent outcomes, shorter lengths of hospital stay, and reduced resource use.16,26 However, these...
studies did not specifically evaluate the relationship between the timing of mobilization and rates of delayed solid organ rupture. The objective of this study was to determine whether there is an association between the day of mobilization and rates of delayed hemorrhage from blunt solid organ injuries.

METHODS

This is a retrospective cohort study. Patients 16 years and older admitted to the University of California, Davis Medical Center, Sacramento, between January 1, 2000, and December 31, 2004, with blunt renal, hepatic, or splenic injuries were identified from the trauma registry. Patients who died in the emergency department, presented longer than 24 hours after injury, or underwent a laparotomy at an outside facility were excluded from the study.

Patient demographics, mechanism of injury, and hospital course were abstracted from the trauma registry. Measures of injury severity were obtained by converting International Classification of Diseases, Ninth Revision, codes to International Classification of Diseases–based Injury Severity Score using ICDMAP-90 software (Tri-Analytics Inc, Forest Hill, Maryland), a verified method.28,29 Medical records were reviewed to determine the day patients were mobilized out of bed, the indication for and day of surgery, and whether angiography was used as an adjunct to management. Computed tomographic (CT) scans were reviewed to determine the grade of solid organ injury. When CT scans could not be located, injuries were graded according to the radiologists’ dictated reports. Solid organ injuries were graded according to the Organ Injury Scale of the American Association for the Surgery of Trauma.30

The following definitions were used. Immediate laparotomy was one performed within 24 hours after injury. Delayed laparotomy was one performed for any reason after the first 24 hours of hospital admission. Any patient who had a delayed laparotomy performed was defined as a failure of NOM. Delayed rupture was defined as an organ-specific (spleen, liver, or kidney) therapeutic laparotomy performed more than 24 hours after hospital admission in a patient with 3 consecutive stable hematocrit measurements within 24 hours. A stable hematocrit value was defined as the first and third hematocrit measurements being no more than 3 percentage points from one another. Day of mobilization was determined by review of the nursing documentation from the time the patient arrived in the intensive care unit or ward.

Although no formal protocol exists, all the trauma surgeons at our institution manage solid organ injuries in a similar manner. Hemodynamically unstable patients with blunt abdominal trauma undergo either a focused abdominal ultrasound for trauma (FAST) or, rarely, diagnostic peritoneal lavage. If the results are positive, the patients are transported to the operating room for immediate laparotomy. We obtain a CT scan of the abdomen in hemodynamically stable patients. Patients with solid organ injuries who are hemodynamically stable and without other indications for laparotomy are admitted to the intensive care unit or ward at the discretion of the chief trauma resident or the attending surgeon. The need for subsequent laparotomy is determined by the attending surgeon, and usual indications include hemodynamic instability, a falling hematocrit, or signs of peritonitis. Patients who remain hemodynamically and hematologically stable are transferred out of the intensive care unit in 24 to 48 hours, unless their associated injuries require intensive care unit care. Patients are encouraged to ambulate at the earliest opportunity and as much as their associated injuries allow. Patients with injuries or a clinical status that precluded mobilization within 48 hours (eg, spine fractures, pelvic fractures, intubation, and hemodynamic instability) were identified and were excluded from the analysis. For much of the study period, our practice was to observe patients with blunt splenic injuries for 7 days to detect delayed hemorrhage. Most of our trauma surgeons have since adopted a less conservative approach and discharge patients home when their conditions are medically stable. We selectively perform angiographic embolization as an adjunct to NOM of solid organ injuries.

Categorical variables were evaluated using χ² or Fisher exact tests where appropriate. Continuous variables were evaluated using the t test or the Mann-Whitney test depending on whether normality could be assumed. Multivariate logistic regression was used to determine whether there was an association between early mobilization and failure of NOM. Variables were included in the model if they changed the point estimate by at least 10% or were of clinical relevance. All the statistical analyses were performed using STATA 8SE (StataCorp LP, College Station, Texas). The institutional review board of our facility approved this study.

RESULTS

RENAL INJURIES

Of the 155 patients identified as having blunt renal injuries, 53 (34.2%) underwent immediate laparotomy for their injuries. Of the remaining 102 patients, 26 (25.5%) had associated injuries that prevented mobilization within 48 hours, leaving 76 patients admitted to the hospital for planned NOM. Demographic and injury characteristics are outlined in Table 1. The mean (SD) grade of injury was 2.4 (1.1), and almost half of these patients had an injury grade of 3 or above. Three patients (4.0%) failed
The operative indications and findings are detailed in Table 2. In addition, 2 patients with grade 4 renal injuries received ureteral stents, and 1 of these patients underwent angiographic embolization of the renal injury as an adjunct to NOM.

Thirty-eight percent of the patients were mobilized on the first hospital day, 72% by the second day, and 84% by the third day. The median day of mobilization was 2 (Table 1). No patient failed NOM as a consequence of bleeding from the renal injuries (Tables 1 and 2).

HEPATIC INJURIES

Of the 404 patients identified as having blunt hepatic injuries, 140 (34.7%) underwent immediate laparotomy for their injuries. Of the remaining 264 patients, 68 (25.8%) had injuries that prevented mobilization within 48 hours, leaving 196 patients admitted for planned NOM. Demographic and injury characteristics are detailed in Table 1. The mean (SD) hepatic injury grade was 2.3 (0.9), and 45.4% of these patients had an injury grade of 3 or higher. Two patients with successful NOM had injuries that could not be graded because neither the CT scans nor dictated reports could be located. Two patients (1.0%) with hepatic injuries failed NOM (Tables 1 and 2). One patient sustained a grade 3 hepatic injury and underwent percutaneous drainage of a biloma 6 days after admission. The biloma developed into an abscess, and the patient underwent operative drainage on hospital day 11. The remaining patient had a concurrent splenic injury that bled, and a splenectomy was performed. In addition, 2 patients received angiographic embolization of branches of their right hepatic artery on admission, and neither required further intervention.

Thirty percent of the patients with blunt hepatic injuries were mobilized on the first hospital day, 66% by the second day, and 80% by the third day. The median day of mobilization was 2 (Table 1). No patients failed NOM as a result of bleeding from hepatic injuries (Tables 1 and 2).

Table 3. Failure Due to Splenic Hemorrhage by Day of Mobilizationa

<table>
<thead>
<tr>
<th>Day Mobilized</th>
<th>Patients, No. (n = 182)</th>
<th>Failed, No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>31</td>
<td>2 (6.5)</td>
</tr>
<tr>
<td>2</td>
<td>59</td>
<td>1 (1.7)</td>
</tr>
<tr>
<td>3</td>
<td>50</td>
<td>3 (6.0)</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
<td>1 (6.3)</td>
</tr>
<tr>
<td>5</td>
<td>7</td>
<td>2 (28.6)</td>
</tr>
<tr>
<td>6</td>
<td>4</td>
<td>1 (25.0)</td>
</tr>
<tr>
<td>≥7</td>
<td>15</td>
<td>0</td>
</tr>
</tbody>
</table>

aFisher exact test, P = .05.

SPLENIC INJURIES

Of the 446 patients identified as having blunt splenic injuries, 177 (39.7%) underwent immediate laparotomy for their injuries. Of the remaining 269 patients, 87 (32.3%) had injuries that prevented mobilization within 48 hours, leaving 182 patients admitted for planned NOM. Demographic and injury characteristics are detailed in Table 1. The mean splenic injury grade was 2.3 (0.9), and 44.5% had injury grades of 3 or higher.

Of these 182 patients, 13 failed NOM (7.1%) (Tables 1 and 2). Two patients (patients 7 and 13) underwent splenectomy on a delayed basis because of abscess formation after initial treatment with angiographic embolization. Ten patients (5.5%) had delayed splenic rupture and required splenectomy.

Seventeen percent of the patients with blunt splenic injuries were mobilized on the first hospital day, 50% by the second day, and 77% by the third day (Table 3). The day of mobilization of patients who failed NOM due to bleeding is given in Table 3. A higher proportion of patients who were mobilized later in their hospital course (days 5 and 6) developed delayed splenic rupture compared with those mobilized earlier (P = .05).
Compared with patients who did not have delayed rupture, those with delayed splenic rupture had significantly higher mean (SD) injury severity scores (15.1 [7.8] vs 31.3 [7.1], P < .001) and higher mean (SD) splenic injury grades (2.2 [0.90] vs 3.2 [0.83], P < .001) (Table 4). No significant differences were noted regarding when patients were mobilized. The median day of mobilization for those with and without splenic rupture were days 3 and 2, respectively (P = .29).

All the significant variables in the univariate analysis were placed in a multivariate analysis to assess whether they confounded the relationship between delayed splenic rupture and the timing of mobilization. The day the patient was mobilized was not associated with delayed splenic rupture (odds ratio, 0.97; 95% confidence interval, 0.90–1.05).

DEATHS

There was 1 death among patients initially admitted for NOM of their blunt solid organ injuries. This resulted from associated injuries and was not a result of the solid organ injury.

COMMENT

This is the first study, to our knowledge, to evaluate the timing of mobilization of patients with blunt solid organ injuries in relation to the rates of delayed rupture. We found that the timing of mobilization in these patients was not associated with an increased incidence of delayed rupture. In fact, there were no cases of delayed rupture from renal or hepatic injuries despite a median day of mobilization of 2 and more than 80% of patients in both groups mobilized on or before hospital day 3. Although there was an association between splenic rupture and patients mobilizing later in their hospital course (days 5 and 6), this became nonsignificant when adjusting for confounding variables.

There are many well-identified complications of NOM, including biloma, infection, urinoma, infarction, pseudoneurysms, and delayed rupture. Delayed ruptures of blunt solid organ injuries are uncommon but do occur, with rates in the literature ranging from 0% to 14%.3,5,6,9,11,13-15 The rates of delayed rupture in this study were 0% for renal and hepatic injuries and 5.5% for splenic injuries, well within the ranges reported in previous studies.

Patient age, grade of injury, transfusion requirements, contrast extravasation, and the size of the hemoperitoneum on CT have all been reported to be risk factors for the failure of NOM.2,3,5,9,32 In the present study, the age of the patient did not affect the risk of delayed rupture of any solid organ. Higher injury grade and Injury Severity Scores were found to be significantly associated with delayed splenic rupture, although this was not true for renal or hepatic injuries. Despite the lack of evidence linking early mobilization with failure of NOM or delayed rupture of a solid organ, some surgeons have incorporated a period of strict bed rest in the treatment of patients with blunt solid organ injuries. The duration of strict bed rest usually ranges from 3 to 7 days for hepatic and splenic injuries and until hembaturia resolves in those with renal injuries.5,9,22

We believe that a period of strict bed rest is unjustified. The findings from this study show that the day the patient was mobilized was not associated with an increased incidence of delayed rupture of the solid organ. This study's findings are consistent with previous studies suggesting that patients who were mobilized early in their hospital course did not have higher rates of rupture of their solid organs.16,26 On the contrary, there may be significant benefits to early mobilization and serious consequences to strict bed rest. Several studies16,26 have indicated that protocols that incorporate early mobilization in the NOM of blunt solid organ injuries reduce hospital length of stay, resource utilization, and overall hospital costs without increasing failure rates of NOM, morbidity, or mortality. On the other hand, bed rest has been implicated in several well-described complications, such as pneumonia and deep venous thrombosis/pulmonary embolus.23-25

This study has several limitations. This was a retrospective study and, therefore, has all the criticisms that may be associated with it. The timing of mobilization was abstracted from the nursing notes, which may be inaccurate. Indications for operative intervention were inferred from a review of the patients' medical records and may not be an accurate reflection of the thought process behind the decision to operate.

The low numbers of delayed rupture in patients with renal or hepatic injuries precludes any type of meaningful statistical analysis. Nevertheless, the fact that no patients in these groups had delayed rupture strongly supports the hypothesis. The exact day on which it is safe to mobilize patients was not addressed in this study. In addition, this study did not evaluate other outcomes or complications related to bed rest, such as pneumonia or deep venous thrombosis/pulmonary embolus. We also did not evaluate other outcomes that potentially may be affected by an early mobilization policy, such as transfusion requirement and length of hospital stay.

In summary, we found that the timing of mobilization of patients with blunt solid organ injuries was not associated with a higher incidence of delayed rupture. Protocols that incorporate a period of strict bed rest are unjustified and may contribute to morbidity, longer hospital lengths of stay, and higher hospital costs.

Table 4. Univariate Analysis of Splenic Injuries Comparing Patients Without vs With Delayed Rupture

<table>
<thead>
<tr>
<th>Variable</th>
<th>No Delayed Rupture (n = 172)</th>
<th>Delayed Rupture (n = 10)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age &gt;55 y, No. (%)</td>
<td>22 (12.8)</td>
<td>1 (10.0)</td>
<td>.62</td>
</tr>
<tr>
<td>ISS, mean (SD)</td>
<td>15.1 (7.8)</td>
<td>31.3 (7.1)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Mobilization, median, d</td>
<td>2</td>
<td>3</td>
<td>.29</td>
</tr>
<tr>
<td>Grade, mean (SD)</td>
<td>2.2 (0.90)</td>
<td>3.2 (0.83)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Grade, No. (%)</td>
<td>1-2</td>
<td>98 (57.0)</td>
<td>2 (20.0)</td>
</tr>
<tr>
<td>3-5</td>
<td>74 (43.0)</td>
<td>7 (70.0)</td>
<td></td>
</tr>
<tr>
<td>Unknown</td>
<td>0</td>
<td>1 (10.0)</td>
<td></td>
</tr>
</tbody>
</table>

Abbreviation: ISS, Injury Severity Score.